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FINAL ENVIRONMENTAL IMPACT STATEMENT

For the Proposed Issuance of a Multiple Species Incidental Take Permit for the Tacoma Water Habitat Conservation Plan, Green River Water Supply Operations and Watershed Protection, King County, Washington

VOLUME I

December 2000

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River Mile Locations

Geographic Features	River Mile
Upstream extent of estuary	RM 11.0
Lower Green River (lower end)	RM 11.0
City of Kent	RM 24.0
Mill Creek confluence	RM 24.2
Green River near Auburn USGS gauge	RM 32.0
Mueller Levee–Auburn Narrows	RM 32.9
Big Soos Creek confluence	RM 33.8
Lower Green River (upper end)	RM 33.8
Middle Green River (lower end)	RM 33.8
Active side channel area	RM 34.0-46.0
City of Auburn	RM 41.0
Newaukum Creek confluence	RM 41.2
Flaming Geyser Recreation Area	RM 42.9-45.0
Green River Gorge–lower end	RM 45.6
Kanaskat-Palmer Recreation Area	RM 56.0
Green River Gorge–upper end	RM 58.0
Signani Slough	RM 59.6
Fish Restoration Facility	RM 60.1
Green River near Palmer USGS gauge	RM 60.3
Treatment Facility	RM 60.3
Tacoma Headworks Diversion	RM 61.0
Middle Green River (upper end)	RM 61.0
Upper Green River (lower end)	RM 61.0
Upstream inundation of headworks pool	RM 61.5
Howard Hanson Dam	RM 64.5
North Fork Green River confluence	RM 65.5
Smay Creek confluence	RM 76.8
Friday Creek confluence	RM 83.9
Sunday Creek confluence	RM 86.2

Preface

The *Tacoma Water Conservation Plan for the Green River Water Supply Operations and Watershed Protection*, dated December 1999, and the associated Draft Environmental Impact Statement (DEIS) dated January 2000, were made available for a 60-day public comment period on 14 January 2000 (65 FR 2390). The comment period was extended for 17 days to 14 March 2000 (65 FR 13947) in direct response to requests from the public. This resulted in a total comment period of 77 days. In addition to the Federal Register announcement, comments were also solicited via: 1) a news release sent out to all western Washington news agencies and various federal, state, tribal, and local jurisdictions; and 2) via letters mailed directly to individuals and organizations included on the USFWS public notification mailing list.

Three public meetings were held during the public comment period to provide an information exchange opportunity for interested parties. The following is a list of the locations and dates of those meetings:

#	Washington State History Museum Tacoma, Washington	10 February 2000
#	Kent Senior Center Kent, Washington	29 February 2000
#	Covington Water District Office Covington, Washington	2 March 2000

Following the public comment period, a Final Environmental Impact Statement (FEIS) was prepared. The FEIS is presented in two volumes. Volume I is an edited version of the DEIS, and includes strike-outs of old text and underlines of updated or new text (or as otherwise noted). Volume II details the public comments and subsequent Services' responses and includes the three HCP chapters that were revised as a result of public comments. The following tables illustrate key changes that were made to the DEIS and HCP.

These table summaries do not identify all changes made; they describe changes in wording that affect content, intent, or explanations of commitments contained in the documents.

The following table contains the major changes made to the Tacoma Water HCP since the document was

submitted for public comment in January 2000. There have been numerous changes that were made primarily for editorial reasons or purposes of clarification, and these were not included in the table. The location of text modifications has been denoted by subsection and by the page number where the text appeared in the draft document sent out for public comment.

Table P-1. Major changes made to the HCP.

Draft HCP Section	Page[1]	Summary of Major Changes Made to the Tacoma Water Green River HCP
5.1.1	5-13	Wording in HCM 1-01 clarified to define summer period.
5.1.2	5-19	Wording in HCM 1-02 clarified to indicate that water stored behind Howard Hanson Dam through exercise of Tacoma's Second Diversion Water Right can subsequently be used for municipal supply.
5.1.3	5-21	Added condition to HCM 1-03 to evaluate whether introduction of adult salmonids into upper watershed posed a risk to public health; clarified description and supporting rationale for selection of upstream fish passage facility.
5.1.4	5-23	Text added to HCM 1-04 and supporting rationale to minimize risk of salmon injury associated with downstream passage over Headworks spillway.
5.1.4	5-24	Added condition to HCM 1-04 to indicate that debris that collects on trash racks or screens at Headworks must be passed downstream.
5.2.1	5-30	Clarified description of operational flexibility of proposed downstream fish passage facility to improve water temperature control compared to existing conditions.
5.2.3	5-49	Modified text in HCM 2-03 to reduce reliance on use of boulders for habitat enhancement.
5.2.3	5-50	Eliminated Lower Bear Creek from HCM 2-03 as site for potential conservation measure.
5.2.6	5-58	Section 1135 Project mentioned as potential implementation strategy for HCM 2-06 Low Flow Augmentation.
5.2.7	5-60	Added text to allow measure to be modified if alternate measure will have greater environmental benefit.
5.2.8	5-61	Added flexibility to HCM 2-08 to increase size distribution of wood transported below Howard Hanson Dam to transport larger size of wood entering reservoir.
5.2.8	5-61	Added footnote to HCM 2-08 that defined the term "allocated" as it relates to disposition of large woody debris pieces.
5.2.8	5-62	Modified term of log storage in HCM 2-08 to reflect observed effect of decay on usability of wood for ecosystem rehabilitation projects.
5.2.8	5-62	Added condition to HCM 2-08 that in the event that five trash-truck loads of small woody debris are not available, the available quantity of small woody debris would be transported.
5.2.9	5-67	Text clarified in HCM 2-09 to indicate gravel nourishment would be an annual commitment, and stated conditions under which quantity of gravel could be reduced.

Table P-1. Continued.

Draft HCP Section	Page[1]	Summary of Major Changes Made to the Tacoma Water Green River HCP
5.2.11	5-72	Added text to allow measure to be modified if alternate measure will have superior benefits at comparable cost.
5.3.1	5-82	Text added to HCM 3-01F to address disposition of danger trees; condition the number of safe snags to be left during salvage harvesting; prevent salvage of wood that has entered a stream channel; and condition felling of live, coniferous trees during salvage harvesting.
5.3.2	5-92	Clarified disposition of trees cut in no-harvest riparian buffer in HCM 3-02A.
5.3.2	5-94	Footnotes within Table 5-2 modified as part of HCM 3-02A to define measurement of buffer width; limit type of activity in no-harvest riparian buffer; condition number and size of trees that would be left in partial-harvest buffer; address influence of roads on buffer width; and limit cutting of wood adjacent to road tread.
5.3.3	5-101	Updated status of watershed analyses in Table 5-6.
5.3.3	5-109	Clarified description of road or water quality conditions in HCM 3-03G that would result in road closures.
5.3.4	5-124	Extended protection of bald eagle nests and communal winter night roosts as part of HCM 3-04N.
5.3.4	5-130	Expanded protection of Larch Mountain salamander habitat as part of HCM 3-04U.
5.3.4	5-132	Modified HCM 3-04W to address protection of suitable marbled murrelet nesting habitat that has not been surveyed, and added text to clarify use of available information.
6.1.4	6-30	Text added to CMM-04 to address water quality monitoring in association with passing adult salmonids upstream of Tacoma's Headworks and Howard Hanson Dam.
6.1.5	6-31	Text added to CMM-05 to monitor rate of injury of salmonids passing downstream over Tacoma's Headworks spillway; additional monitoring task to record volume of wood and drift manually removed from Headworks trash racks and fish screens.
6.2.3 (new)	6-50	New Effectiveness Monitoring Measure (EMM-03) added to address species-specific habitat management validation.
6.3.1	6-58	Expanded research funding measure (RFM-01C) to include use of screw traps at outlet of Howard Hanson Dam to address fish guidance efficiency and survival.
6.3.3	6-69	Clarified description of procedure that would be used to monitor large woody debris distribution below Tacoma's Headworks as part of RFM-03A.
6.3.3	6-70	Added detail to rationale supporting RFM-03A to describe mainstem Green River large woody debris monitoring procedures.
8.1	8-2	Insert description of lost opportunity costs associated with merchantable timber into footnote 5 in Table 8-1.
8.2.1	8-4	Note increase in compliance monitoring costs associated with expanded commitments identified in Chapter 6, such as CMM-04 and CMM-05.
8.2.3	8-6	Corrected error in addition in Table 8-2; modified subtotal format of sediment/wood transport categories.
8.3	8-8	Updated Table 8-3 listing total estimated HCP costs to reflect expanded commitments identified in Chapter 6.

[1]Page number found in public review draft of the HCP dated December 1999, and distributed in January 2000.

The following table contains major changes made to the DEIS. The most extensive changes related to augmentation of the cumulative effects analyses in Section 4.0. Changes were also made for editorial reasons or purposes of clarification, and these were not included in this table. The location of text modifications is denoted by subsection where the text appeared in the draft document sent out for public comment.

Table P-2. Major changes made to the DEIS.

DEIS Section	Summary of Major Changes Made to the DEIS
Preface	A Preface was added to the FEIS to describe the public comment period and changes made to the DEIS as a result of those comments.
1.6, 3.3, 4.2, 4.3	Added information on land use plans and policies.
1.3	Updated to reflect public comment period and the Services' responses.
Table 2-1, Table 3-6	Status of Canada lynx changed from proposed for ESA listing to threatened.
Table 2-1, Table 3-6	Status of bull trout changed from proposed for ESA listing to threatened.
Table 2-2	Changed units in Table 2-2, Water Use column, from "million gallons per day" to "million gallons" and clarified annual use.
2.4.1	Edited text to indicate the specific date each of the four Watershed Analyses was initiated.
2.4.1	Edited text to clarify road construction maintenance measures.
2.5.2	Forest and Fish Report discussion was added.
Figure 3-1	Updated land ownership map to reflect the Plum Creek Company/U.S. Forest Service land exchange.
4.2	Added discussion of potential for effects to surface water from withdrawal of water from North Fork Wellfield.
4.3	Updated Larch Mountain salamander habitat mitigation under Upper Watershed Alternative B.
4.3.10	Provided cost information by alternative (see table additions); updated estimated employment effects.

Table P-2. Continued.

DEIS Section	Summary of Major Changes Made to the DEIS
4.4.3	Augmented Cumulative Effects analyses.
5.0	The Distribution List was edited to include those who requested documents during the review of the DEIS and those who attended public meetings during the comment period.
Volume II	Created a second volume that includes a summary of the public comments; the Services' responses to those comments; and revised HCP chapters 5, 6, and 8.

TOC

Preface 1-1

Table P-1. Major changes made to the HCP 1-2
Table P-2. Major changes made to DEIS 1-4

Final Environmental Impact Statement
Cover Sheet

Title of Proposed Action: Issuance of a Multiple Species Permit for Incidental Take and Implementation of the Tacoma Water Green River Water Supply Operations and Watershed Protection Habitat Conservation Plan

Responsible Agencies and Officials:

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Legal Mandate: Endangered Species Act of 1973, as amended, Section 10(a), as implemented by 50 CFR 17.32(b)(1)

Location of Proposed Action: Tacoma Water
Howard Hanson Dam/Upper Green River Watershed
King County, Washington

Applicant Name: Tacoma Water
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Contact: Mr. John Kirner
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Glossary

Age class — A management classification using the age of a stand of trees.

Alevin — Recently hatched salmon that still have an attached yolk sac.

Alluvial — Referring to deposits resulting from natural river activity, including sediments laid down in river beds, flood plains, lakes, fans at the foot of mountain slopes, and estuaries.

Anadromous — A life history strategy in which fish are born and rear in fresh water, move to the ocean to grow and mature, and return to fresh water to reproduce; an example is chinook salmon (*Oncorhynchus tschawytscha*).

Best management practices — Methods, measures, a practice, or combination of practices that is determined to be the most effective and practical means of preventing or reducing the amount of pollution generated by non-point sources to a level compatible with water quality goals (after 40 CFR 130.2(m)).

Broadcast burning — The use of fire throughout a defined area to prepare it for regeneration. It does not include burning of organic matter that is piled during mechanical site preparation.

Candidate species — The USFWS classifies those species for which the agency has sufficient information to warrant a proposed listing as candidate species. For NMFS, candidate species are "any such species being considered [by NMFS] for listing as endangered or threatened species, but not yet the subject of a proposed rule."

Canopy closure — The point at which the vertical projections of crown perimeters within a canopy touch.

Canopy cover — The proportion of ground or water covered by a vertical projection of the outermost perimeter of the natural spread of foliage or plants, including small openings within the canopy.

Chimney snags — Live or dead trees with centers that are hollow over several continuous vertical feet, usually as a result of disease, insects or excavation by woodpeckers.

Clearcut/ clearcutting — A harvest method where an entire stand of trees is removed in one cutting operation, leading to the establishment of an even-aged stand.

Coarse sediment — Fine gravel and larger-sized particles deposited by water or ice.

Commercial harvest — Removal of merchantable trees from a stand.

Covered species — The 32 species requested by Tacoma Water to be covered under the ITP.

Diameter at breast height (dbh) — The diameter of a tree 4.5 feet above the ground on the uphill side of the tree.

DNR Water Types

Type 1: All waters, within their OHWM, as inventoried as "shorelines of the state" under chapter 90.58 RCW and the rules promulgated pursuant to chapter 90.58 RCW, but not including those waters' associated wetlands as defined in chapter 90.58 RCW.

Type 2: Segments of natural waters that are not classified as Type 1 and that have a high fish, wildlife, or human use. Segments of natural waters are classified as Type 2 if:

- Diverted for domestic use by more than 100 residential or camping units or by a public accommodation facility licensed to serve more than 100 persons. Such waters will include 1,500 feet upstream from the point of diversion or until the drainage area is reduced by 50 percent, whichever is less.
- Diverted for use by federal, state, tribal, or private fish hatcheries. Such waters will include 1,500 feet upstream from the point of diversion and tributaries if highly significant for protection of downstream water quality.

Are used by substantial numbers of anadromous or resident game fish for spawning, rearing, or migration. Waters having the following characteristics are presumed to have highly substantial fish populations:

- Stream segments having a defined channel 20 feet or greater in width between the OHWM and having a gradient of less than 4 percent.
- Lakes, ponds, or impoundments having a surface area of 1 acre or greater at seasonal low water.

Are used by salmonids for off-channel habitat. This habitat shall be identified based on the following criteria:

- The site must be connected to a stream bearing salmonids and accessible during some period of the year.
- The off-channel water must be accessible to juvenile salmonids through a drainage with a less than 5 percent gradient.

Type 3: Segments of natural waters not classified as Types 1 or 2 water and having a moderate to slight fish, wildlife, and human use. Segments of natural waters are classified as Type 3 if:

Diverted for domestic use by more than 10 residential or camping units or by a public accommodation facility licensed to serve more than 10 persons. Such waters will include 1,500 feet upstream from the point of diversion or until the drainage area is reduced by 50 percent, whichever is less.

Are used by significant numbers of anadromous or resident game fish for spawning, rearing, or migration. If fish use has not been determined, waters having the following characteristics are presumed to have significant anadromous or resident game fish use:

- Stream segments having a defined channel of 2 feet or greater in width between the OHWM and having a gradient of 16 percent or less.
- Stream segments having a defined channel of 2 feet or greater in width between the OHWM, having a gradient greater than 16 percent and less than or equal to 20 percent, and having a contributing drainage basin greater than 50 acres.

Ponds or impoundments having a surface area of less than 1 acre at seasonal low water and having an outlet to an anadromous fish stream.

For resident game fish, ponds or impoundments having a surface area greater than 0.5 acre at seasonal low water.

Are highly significant for protection of downstream water quality. Tributaries that contribute greater than 20 percent of the flow to a Type 1 or 2 water are presumed to be significant for 1,500 feet from their confluence or until their drainage area is less than 50 percent of their drainage area at the point of confluence, whichever is less.

Type 4: Segments of natural waters not classified as Type 1, 2, or 3, and are at least 2 feet wide between the ordinary high-water marks. For the purpose of this HCP, all perennial non-fish-bearing streams will be considered Type 4 streams.

Type 5: All natural waters not classified as Type 1, 2, 3, or 4 including streams with or without well-defined channels, areas of perennial or intermittent seepage, ponds, natural sinks, and drainageways having short periods of spring or storm runoff.

Type A wetland: — All non-forested wetlands greater than 0.5 acre, including any acreage of open water where the water is completely surrounded by the wetland, and associated with at least 0.5 acre of ponded or standing open water. The open water must be present on the site for at least seven consecutive days between 1 April and 1 October.

Type B wetland: — All other non-forested wetlands greater than 0.25 acre.

Non-forested wetlands: — Any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of less than 30 percent.

Forested wetlands: — Any wetland or portion thereof that has, or if the trees were mature would have, a crown closure of 30 percent or more.

Dominant trees — Trees with well-developed crowns extending above the general level of the forest canopy and receiving full light from above and partly from the sides.

Drainage — An area (basin) mostly bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed.

Edge — The place where different plant communities meet or where different successional stages or vegetative conditions within plant communities come together.

Emergent — Wetland class characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens.

Endangered — A plant or animal in danger of extinction throughout all or significant portions of its range.

Endangered Species Act — A federal act amended in 1973, designed to set up processes by which plant or animal species can be designated (listed) as threatened or endangered of extinction. Two federal agencies, the U.S. Fish and Wildlife and the National Marine Fisheries Service, administer the act. Once species are listed, the act provides that these agencies develop recovery plans for these species, including conserving the ecosystems on which listed species depend.

Escapement — The portion of an anadromous fish population that escapes the commercial and recreational fisheries and reaches the freshwater spawning grounds.

Estuary — Area at the mouth of a river where it enters the sea and fresh water mixes with salt water.

Even-aged — A forest stand composed of trees with less than a 20-year difference in age.

Even-aged harvest — The forest practice application in which the harvest removes the majority of the trees producing a regenerated forest condition with trees essentially the same age. Clearcut, seed tree, shelterwood, and overstory removal methods can create even-aged stands.

Extirpation — The complete removal or elimination of a species or subspecies from a given portion of its geographic range.

Fell — The act of cutting down a tree.

Felling — The act of cutting down trees.

Fine sediment — Coarse sand and smaller-sized particles deposited by water or ice.

Fish-bearing streams — All DNR Type 1, 2, and 3 streams. See DNR water type definition above.

Floodplain — The lowland and relatively flat areas adjoining streams.

Fluvial — Transport processes occurring as a result of flowing water, produced by stream action.

Freshets — Rapid increase and decrease in flow that usually occurs in response to a rainstorm.

Forest fragmentation — Isolating or breaking up large tracts of forest as a result of natural events (such as wildfire), or by the implementation of timber management, or other human activities.

Forest management — Activities undertaken for the purpose of harvesting, transporting, protecting, changing, replenishing or otherwise using forest resources to meet specified goals and objectives while maintaining the productivity of the forest.

Full bench construction — A method of road construction employed in steep terrain whereby the bed of the road is created entirely by cutting into the side of a slope, and not by the placement of fill material on the slope.

Gravel interstices — Spaces between the individual substrate particles within a river bed.

Habitat — The sum environmental conditions at the landscape, patch, and element scales, necessary to meet the life requirements of individuals of a species.

Habitat Conservation Plan (HCP) — An agreement between the Secretaries of the Interior and Commerce and a private entity or state, that specifies conservation measures that will be implemented in exchange for a permit that would allow incidental taking of a threatened or endangered species.

Implementation Agreement — An agreement that legally binds the permittee to the requirements and responsibilities of a habitat conservation plan and Section 10 permit.

Incidental take — Take of any federally listed wildlife species that is incidental to, but not the purpose of, otherwise lawful activities.

Incidental Take Permit — A permit issued by the USFWS and the NMFS to either a private entity or a state, that allows incidental take of a threatened or endangered species; permit also requires permittee to carry out specified actions that minimize and mitigate the incidental take, and may contribute to the recovery of the species.

Intragravel — Flow within the bed of a river, in the spaces between individual substrate particles.

Lacustrine — Lake environment.

Landscape — A heterogenous land area with interacting ecosystems that are repeated in similar form throughout.

Large Woody Debris (LWD) — Logs, root wads and large branches that intrude into a stream channel.

Late-seral, or Late-successional — The stage in forest development that includes mature and old-growth forest.

Leaching — Loss of chemical or nutrients that occurs as water drains through the soil.

Leave-tree (live recruitment tree) — A standing tree retained at the time of even-aged harvest, with the intent to provide snags and/or wildlife trees for the future.

Life history requirements — Physical and biological requirements of a species necessary to carry out essential behaviors from birth to death.

Listed species — Species, including subspecies and distinct vertebrate populations, of fish, wildlife or plants listed as either endangered or threatened under Section 4 of the federal Endangered Species Act.

Mainstem rivers — Large rivers (>32 feet wide), typically DNR Type 1 and 2 waters.

Mass wasting — Geologic processes in which large masses of earth materials move downslope by means of gravitational forces.

Mature forest — A stand of trees for which the annual net rate of growth has culminated. Stand age, diameter of dominant trees, and stand structure at maturity vary by forest cover types and local site conditions. Mature stands generally contain trees with a smaller average diameter, less age-class variation, and less structural complexity than old-growth stands of the same forest type.

Microbiotic activity — The microscopic activity of the flora and fauna of a region, such as reproduction, growth, decomposition.

Microclimatic variations — Differences in temperature, relative humidity, moisture and other climatic variables that occur on a scale of tend to hundreds of feet.

Natal streams — Streams where fish were originally spawned and reared.

Old-growth — A forest stand with moderate-to-high canopy closure; a multi-layered, multi-species canopy dominated by large overstory trees; a high incidence of large trees with large, broken tops, and other indications of decadence; numerous large snags; and heavy accumulations of logs and other woody debris on the ground.

Oxidizing — Reaction that occurs in the presence of oxygen.

Redds — A nest that salmon construct in the bed of a river in which to lay their eggs.

Residual — A tree that remains standing after an event, such as selection harvest.

Riparian — That portion of the watershed or shoreline influenced by surface or subsurface waters, including stream or lake margins, marshes, drainage courses, springs, and seeps.

Riparian zone — The transitional zone between upland and aquatic habitats.

Riparian Management Zone (RMZ) — An area allocated in a plan primarily to protect the riparian and/or streamside zone.

Roost — A site where an animal rests. Can refer to locations used during the day or night. Sites often provide protection from environmental conditions and predators.

Rotation — The planned number of years required to establish (including the regeneration

period) and grow timber crops to a specified condition or maturity for regeneration harvest.

Rotation age — The period between stand establishment and final cutting.

Salmonid — A member of the fish family Salmonidae that includes all species of salmon and trout.

Second-growth — Timber stands established after natural or human-caused removal of the original stand or previous forest growth.

Sedimentation — The deposition of material along a stream channel.

Seep — A small spring, pool or other place where water oozes from the ground.

Side-casting — The placement of excavated material to the side of the new road bed during road construction.

Silviculture — The science and practice of controlling the establishment, composition, and growth of the vegetation of forest stands.

Site potential tree height — The height a dominant tree may attain given site conditions where the tree grows.

Snag — A standing dead tree.

Species of concern — Listed and unlisted species covered under the HCP.

Staging area — The area where construction equipment is stored and maintained for use during construction. Also where materials are delivered and stored, and where worker vehicles are parked during the work day. May be either on-site or nearby.

Status — The classification of a species regarding its position in the listing process under state or federal endangered species acts.

Suitable habitat — Conditions conducive to support the habitat requirements of a plant, animal, or fish species.

Take — Defined under Section 3(19) of the federal Endangered Species Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect or attempt to engage in any such conduct," with respect to federally listed endangered species of wildlife. Federal regulations provide the same taking prohibitions for threatened wildlife species.

Talus — A slope landform, typically covered by coarse rock debris forming a more or less continuous layer that may or may not be covered by duff and litter.

Thinning — A forest management practice involving the removal of trees in a stand to improve growth, enhance forest health, or recover potential morality.

Threatened — A plant or animal species likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Understory — Vegetation (tree or shrubs) growing under the canopy formed by larger trees.

Uneven-aged — A forest stand with trees of three or more distinct age classes, either intimately mixed or in groups.

Uneven-aged management — The application of a combination of actions needed to simultaneously maintain continuous forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through the range of diameter or age classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Unforeseen circumstances — Changes in the circumstances surrounding an HCP that were not or could not be anticipated by the HCP participants and the Services that result in a substantial and adverse change in the status of a covered species. Examples include natural causes like fire and wind storms.

Ungulate — A hoofed mammal such as deer.

Unlisted species — Fish, wildlife or plant species not currently listed as threatened or endangered under the federal or state Endangered Species Acts.

Watershed Administrative Unit (WAU) — The state of Washington has been divided into approximately 800 watershed administrative units, which generally range in size from 10,000 to 70,000 acres, and include the entire land area draining to a specific location.

Yarding — A method of bringing logs to a roadside area or landing for truck transport.

Young-of-the-year — A life stage of salmonid fish species referring to juvenile fish that are residing in rearing streams during the year of their emergence.

Summary

Introduction

The City of Tacoma Water Division (Tacoma Water) is applying for an Incidental Take Permit (ITP) from the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (collectively the "Services") under Section 10(a)(1)(B) of the Endangered Species Act of 1973 (ESA), as amended[1]. The ITP will cover various activities relating to Tacoma Water's diversion of water from the Green River, as well as Tacoma Water's management of its ownership in the upper Green River Watershed. The geographic areas to be covered are located in King County, Washington. Species for which Tacoma Water seeks ITP coverage include the chinook salmon, bull trout, northern spotted owl, and marbled murrelet, as well as 28 other listed and unlisted species that may be affected by Tacoma Water's activities in the Green River and the Upper Green River Watershed.

Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to issue an ITP for 32 listed and unlisted species in the Green River downstream of Tacoma Water's Headworks diversion, and on Tacoma Water's ownership in the Upper Green River Watershed, for a period of 50 years. As part of its application for the ITP, Tacoma Water has prepared an HCP in accordance with Section 10(a)(2)(A) of the ESA. Under provisions of the ESA, the Secretary of the Interior (through the USFWS) and the Secretary of Commerce (through NMFS) may issue a permit for the taking of a listed species if the Services find that the application conforms with the issuance criteria listed below in subsection 1.5, Decisions to be Made.

[1]Two permits would be issued, one from the USFWS and one from NMFS; however, for purposes of this DEIS, both permits are referred to as "the ITP" or "the Permit".

The Services have received an application for an ITP from Tacoma Water, to cover currently listed and unlisted species. In accordance with their responsibilities under the ESA, the Services must respond to this application. The ITP is requested by Tacoma Water because activities associated with Tacoma Water's water withdrawal and land management activities may, in the opinions of the Services, result in take of listed species and/or impacts to unlisted species that could become listed during the term of the ITP. Tacoma Water believes that regulations promulgated for the conservation of these listed species, and those that may become listed in the future, may result in severe curtailment of water withdrawal activities at the Tacoma Headworks, and/or severe limitation or cessation of timber harvest in ~~suitable (i.e.,~~ forested habitat occupied or potentially occupied by listed species.~~) habitat.~~

Tacoma Water has informed the Services that curtailment of water withdrawal activities would have severe consequences on the reliability of its water supply, which serves approximately 83,000 service customers (approximately 300,000 people) and provides critical public water supply infrastructure to communities in Pierce and south King Counties. In addition, Tacoma Water has informed the Services that potential reductions in timber harvest and concomitant reduction of revenues would adversely affect Tacoma Water's ability to manage its lands in the upper watershed, thus creating impediment to ~~disincentives for~~ its water quality and habitat management efforts both now and in the future.

The need for unlisted species coverage is to provide further assurances to Tacoma Water that no additional water withdrawal limitations, land restrictions, or financial compensation would be required from Tacoma Water for species adequately covered by a properly functioning HCP in light of unforeseen or extraordinary circumstances.

Finally, the needs and goals of the Services are to conserve listed species and their habitats and associated species during Tacoma Water's proposed actions and to ensure compliance with the ESA, NEPA, and other applicable laws and regulations. The Services, as well as Tacoma Water, consider the implementation of an HCP to be the most effective means of reconciling Tacoma Water's proposed activities with the prohibitions against take and other conservation mandates of the ESA.

Alternatives

Three water withdrawal alternatives are analyzed in detail: the No Action Alternative, the Proposed Action, and a third alternative involving construction of a new water withdrawal facility (diversion) approximately 30 miles downstream of the existing Tacoma Headworks diversion. Four additional water withdrawal options were identified during public scoping, but they are not analyzed in detail as alternatives to the Proposed Action because they would not accomplish Tacoma Water's objective of meeting current and future water demands, and/or because speculative information would be required to adequately analyze impacts. They are discussed briefly in subsection 2.3.

Three alternatives are analyzed for Tacoma Water's watershed land management: No Action, Tacoma Water's proposed management of its watershed lands (i.e., with implementation of an HCP), and management of its watershed lands with no commercial harvest of timber. ~~One additional~~ A fourth watershed management option was identified during public scoping, but it is not analyzed in detail as an alternative to the Proposed Action because it would not accomplish Tacoma Water's objective of managing its watershed lands to protect water quality as described in subsection 2.5.

Lastly, the Services identified a possible fifth alternative during public review of the DEIS involving Forests and Fish Report measures. However, it was not considered in detail because it would not be substantially different from the two action alternatives already considered. Although the Forests and Fish Report includes measures not required under previous Forest Practices Rules, various agreements between Tacoma Water and other stakeholders will obligate the City of Tacoma to meet or exceed the Forests and Fish Report requirements under any of the alternatives analyzed in the FEIS. The fifth option is described in subsection 2.5.2.

Anticipated Impacts

Environmental impacts associated with each of the three water withdrawal and three upper watershed management alternatives are summarized in Tables S-1a and S-1b and are described in detail in Section 4.0, Environmental Consequences.

Table S-1a. Summary of potential environmental impacts associated with each of the Water Withdrawal Alternatives.

Element	**Alternative A**	**Alternative B**	**Alternative C**
	No Action.	Proposed Action. Issue an Incidental Take Permit for 32 species of fish and wildlife in conjunction with the continued operation of the Green River Project, and require Tacoma Water to develop and implement a Habitat Conservation Plan.	New Diversion. Issue an Incidental Take Permit for 32 species of fish and wildlife in conjunction with the construction and operation of a new water diversion at approximately RM 29.2, and require Tacoma Water to develop and implement a Habitat Conservation Plan.
OWNERSHIP AND LAND USE	Property ownership and the use of adjacent lands would not be affected by changes in stream flows.	Same as Alternative A.	Property ownership and the use of adjacent lands would not be affected by changes in stream flows. Construction of the new diversion would impact property ownership and land use in the vicinity of the new diversion and impoundment area.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
GEOLOGY AND SOILS	Sediment transport associated with peak flows would not be affected by diversion activities because of the small percentage diverted relative to peak flows, and the likely cessation of diversions during peak flow events due to turbidity.	Same as Alternative A. Additional beneficial effects on in-stream geomorphologic processes due to habitat conservation measures that replenish gravel in the river. Temporary disturbance impacts would occur due to construction of pipelines and Tacoma Headworks improvements.	Same as Alternative A. Additional beneficial effects on instream geomorphologic processes due to habitat conservation measures that replenish gravel in the river. Temporary disturbance impacts would occur due to construction of pipelines and Tacoma Headworks improvements. Also, temporary disturbance impacts would occur due to construction and staging areas (about 25 acres total) associated with the new diversion. The new diversion would also interfere with instream geomorphologic processes (e.g., sediment transport) during its operation.
AIR QUALITY	Air quality conditions would not be affected by changes in streamflows.	Same as Alternative A.	Same as Alternative A. Construction and operation of the new diversion would temporarily generate dust (including PM_{10}) and other criteria air pollutants (e.g., ozone precursors).

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
SURFACE WATER QUALITY AND QUANTITY	Warm water temperatures and low dissolved oxygen concentrations are sometimes present in the lower river during the summer and early fall low-flow period. Some pollutants are also present in the lower river. Water quality conditions are considered to be good in the middle Green River.	Minimum flow agreements in the Habitat Conservation Plan would marginally benefit water quality conditions during the summer low-flow period in the middle and lower river relative to Alternative A. Impacts of Tacoma's Headworks Diversions on water quality conditions in the middle and lower river during winter and spring would be minor.	Increased flows in the middle Green River would marginally improve water quality conditions in the middle Green River compared to Alternative A. Water quality conditions below the new diversion would marginally improve during the summer low-flow period. Impacts of Tacoma's Headworks Diversions on water quality conditions in the middle and lower river during winter and spring would be minor.
VEGETATION	Plant communities along the Green River would not be affected by changes in streamflows.	Same as Alternative A. Additional beneficial effects to plant communities would occur due to habitat conservation measures (e.g., reconnection of Signani Slough to the mainstem Green River).	Same as Alternative A. Additional beneficial effects to plant communities would occur due to habitat conservation measures (e.g., reconnection of Signani Slough to the mainstem Green River). However, disruption of plant communities would occur at the new diversion site (±25 acres) and up to 1 mile upstream (i.e., the impoundment area).

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
FISH **Flows**	Tacoma withdrawals would be 113 cfs at RM 61.5 (Headworks) during the entire year. Base flows at Auburn from July through October would be about 220 cfs in dry and average years with an extreme low flow of about 180 cfs during both dry and average years, and about 260 cfs in wet years with an extreme low flow of about 230 cfs. Flows would be substantially higher and more variable during the remainder of the year, as determined by the Army Corps of Engineers' operation of Howard Hanson Dam.	Flows at Auburn would be reduced by up to 400 cfs during the March through mid-April high-flow period in the Green River compared to Alternative A because of the implementation of the Additional Water Storage Project. Water stored during this period would be used for fisheries low-augmentation and Tacoma's municipal water supply. Reduced flows in March through mid-April would be partially offset by increased flows from mid-April through mid-June. Tacoma's diversions would reduce average flows by 100 cfs compared to Alternative A except when conditioned by minimum instream flow requirements under the MIT Agreement during low-flow periods. Minimum flows during the summer and fall would increase relative to Alternative A because of instream flow provisions of the MIT	Compared to Alternative A, flows upstream of the new diversion at RM 29.2 would increase by 113 cfs from early November through mid-February, decrease by 100 to 300 cfs from mid-February through mid-April due to Additional Water Storage Project operations, and increase by 100 to 550 cfs from mid-April through mid-June due to the Additional Water Storage Project. Flows above the new diversion would increase between 200 and 300 cfs from July through October in average and wet years and between 110 and 230 cfs in dry years. Downstream of the new diversion at RM 29.2, flows would be the same as described under Alternative B.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Spawning Gravels	The availability of spawning gravel would continue to decline in the middle and lower Green River due to blocked gravel movement by Howard Hanson Dam.	Gravels would be introduced in the middle river, alleviating the decline in gravels that would occur under Alternative A.	Gravels would be introduced in the middle river, alleviating the decline in gravels that would occur under Alternative A.
Peak Flows	No effect on peak flows in the Green River.	Same as Alternative A.	Same as Alternative A.
Side Channels and Tributaries	Access to side channel areas is restricted due to historical modifications of stream channel and Tacoma's withdrawal of 113 cfs under the First Diversion Water Right claim.	Access to side channels and tributaries would be increased relative to Alternative A during extreme low flows and reduced during other flow conditions. Reconnection of Signani Slough opens up additional habitat.	Improved year-round access to side channels and tributaries above new diversion at RM 29.2. Access to side channel habitats below new diversions and reconnection of Signani Slough would be the same as described for Alternative B.
Large Woody Debris	LWD levels in the middle and lower river would decrease due to blockage of LWD inputs from upper watershed by Howard Hanson Dam.	LWD levels in the middle and lower river would increase due to the implementation of a LWD management program.	LWD levels in the middle and lower river would increase due to the implementation of a LWD management program.
Estuarine Habitat	No effects on estuarine habitat conditions.	Improvement in water quality during extreme low-flow conditions; marginal degradation or no effect during other flow conditions.	Improvement in water quality during extreme low-flow conditions; marginal degradation or no effect during other flow conditions.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Fish Passage	Fish passage conditions would remain the same (i.e., fish passage would continue to be blocked by the Tacoma Headworks diversion and by Howard Hanson Dam).	Fish passage around the Tacoma Headworks Diversion and Howard Hanson Dam would improve due to construction of fish passage facilities.	Fish passage around the Tacoma Headworks Diversion and Howard Hanson Dam would improve due to construction of fish passage facilities. Fish passage facilities would be installed at the new diversion at RM 29.2.
Juvenile Salmon Outmigration	Index of juvenile outmigration survival would decrease for all salmon species due to Tacoma's 113 cfs First Diversion Water Right claim withdrawal.	Chinook and coho salmon juvenile outmigration survival index would slightly increase in the lower and middle river compared to Alternative A. Chum fry outmigration survival index would decrease in the lower and middle river.	Chinook and coho juvenile outmigration survival index would slightly increase in the lower and middle river compared to Alternative A. The juvenile survival index for chum salmon would slightly increase in the middle river, and would decrease below the new diversion.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Salmon Mainstem Spawning Habitat	Low flows may cause the concentration of redds in the center of the river channel, and may affect fall spawners.	Lower flows from March through mid-April would slightly impact spawning conditions for early steelhead spawners. Higher flows from mid-April through July would improve conditions for late steelhead spawners and their incubating eggs. However, reduced flows in late fall and winter caused by Tacoma's increased diversions would slightly lower spawning conditions for salmon	Spawning conditions for salmon would improve above the new diversion at RM 29.2 compared to Alternative A. Below the new diversion, spawning conditions would be the same as described for Alternative B.
Salmon Side Channel Spawning Habitat	Hydraulic modifications and Tacoma's 113 cfs First Diversion Water Right claim withdrawals hinder access and use of side channels.	Average side channel spawning habitat would slightly decrease for chinook, coho, and chum salmon compared to Alternative A.	Average side channel habitat would substantially increase in the middle river for chinook salmon, and would moderately increase for coho and chum salmon compared to Alternative A. Below the new diversion, side channel spawning habitat conditions would be the same as described for Alternative B.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Salmon Mainstem Rearing Habitat	Tacoma's First Diversion Water Right claim withdrawals of 113 cfs have a negative effect on salmon rearing habitat under low-flow conditions in lower and middle river.	Mainstem juvenile rearing habitat would increase for chinook, coho, and chum salmon in the lower and middle river.	Mainstem rearing habitat would decrease in the middle river for chinook, coho, and chum salmon from Alternative A. Below the new diversion, mainstem rearing habitat for chinook, coho, and chum salmon would be the same as described for Alternative B.
Salmon Side Channel Rearing Habitat	Hydraulic modifications and Tacoma's 113 cfs First Diversion Water Right claim withdrawals hinder access and use of side channels.	Side channel rearing area would slightly decrease for chinook, coho, and chum salmon from Alternative A.	Side channel rearing area would increase for chinook, coho, and chum salmon from Alternative A.
Steelhead and Cutthroat Trout Juvenile Outmigration Survival	Index of juvenile outmigration survival would decrease for steelhead and cutthroat trout due to Tacoma's 113 cfs First Diversion Water Right claim withdrawal.	The juvenile outmigration survival index would increase the lower and middle river from Alternative A.	Fry outmigration survival index would moderately increase in the middle river from Alternative A. Below the new diversion, the fry outmigration survival index would be the same as described for Alternative B.
Steelhead and Cutthroat Trout Mainstem Spawning Habitat	Tacoma's First Diversion Water Right claim withdrawals have minor effect on steelhead and cutthroat trout spawning habitat in mainstem river during their spring spawning period.	Mainstem spawning habitat would slightly decrease in the lower and middle river from Alternative A.	Mainstem spawning habitat would decrease in middle river from Alternative A. Below the new diversion, mainstem spawning habitat would be the same as described for Alternative B.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Steelhead and Cutthroat Trout Side Channel Spawning Habitat	Hydraulic modifications and Tacoma's 113 cfs First Diversion Water Right claim withdrawals hinder access and use of side channels.	Side channel spawning area would substantially increase in the middle river from Alternative A.	Side channel spawning area would substantially increase in the middle river from Alternative A.
Steelhead and Cutthroat Trout Mainstem Rearing Habitat	Tacoma's First Diversion Water Right claim withdrawals of 113 cfs have a negative effect on steelhead and cutthroat trout rearing habitat under low-flow conditions in lower and middle river.	Average mainstem rearing area would increase in the lower and middle river from Alternative A.	Average mainstem rearing area would slightly decrease in the middle river from Alternative A. Below the new diversion, average mainstem rearing area would be the same as described for Alternative B.
Steelhead and Cutthroat Trout Side Channel Rearing Habitat	Hydraulic modifications and Tacoma's 113 cfs First Diversion Water Right claim withdrawals hinder access and use of side channels.	Average side channel rearing area would slightly decrease from Alternative A.	Average side channel rearing area would increase from Alternative A.
Bull Trout/Dolly Varden Spawning Habitat	Tacoma's 113 cfs First Diversion Water Right claim withdrawals would have minor impact on bull trout/Dolly Varden spawning habitat in mainstream river during extreme low flows.	Same as Alternative A.	Same as Alternative A.
Bull Trout/Dolly Varden Juvenile Rearing Habitat	Potential impacts on juvenile rearing areas similar to steelhead above.	Same as Alternative A.	Same as Alternative A.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
WILDLIFE	Wildlife habitats would not change with continuation of water withdrawal activities.	Potential benefit to amphibian habitat in the lower and middle river due to guaranteed summer flows. Loss of about 7 acres of upland forest habitat due to expansion of the Tacoma Headworks inundation pool, which would also increase calm water habitat. Connection of Signani Slough wetland to the mainstem Green River would alter local habitat conditions. Short-term habitat disturbance impacts would occur in various locations due to implementation of Habitat Conservation Plan mitigation measures.	Potential benefit to amphibian habitat in the lower and middle river due to guaranteed summer flows, but increased flows might also adversely affect amphibians dependent on calm water habitat. Loss of riparian habitat about 1 mile upstream of new diversion due to inundation, but potential for creation of higher value riparian habitat. Permanent removal of about 20 acres of riparian pasture and golf course for new diversion, plus about an additional 5 acres of riparian/park habitat for temporary construction staging areas. Connection of Signani Slough wetland to the mainstem Green River would alter local habitat conditions. Short-term habitat disturbance impacts would occur in various other locations (i.e., not related to the new diversion) due to implementation of Habitat Conservation Plan mitigation measures.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Bald Eagle	No effect on bald eagles.	Habitat conditions for bald eagles would improve relative to Alternative A.	Habitat conditions for bald eagles would improve relative to Alternative A.
Cascade Torrent Salamander	No effect on Cascade torrent salamanders.	Same as Alternative A.	Same as Alternative A.
Van Dyke's Salamander	No effect on Van Dyke's salamanders.	Same as Alternative A.	Same as Alternative A.
Larch Mountain Salamander	No effect on Larch Mountain salamanders.	Same as Alternative A.	Same as Alternative A.
Tailed Frog	No effect on tailed frogs.	Same as Alternative A.	Same as Alternative A.
Cascades Frog	No effect on Cascades frogs.	Same as Alternative A.	Same as Alternative A.
Oregon Spotted Frog	No effect on Oregon spotted frogs.	Potential for adverse effects relative to Alternative A due to alteration of flows and modification of side channels.	Potential for adverse effects relative to Alternative A due to alteration of flows and modification of side channels.
Northwestern Pond Turtle	No effect on northwestern pond turtles.	Potential for beneficial effects relative to Alternative A due to commitment to prepare site-specific plans.	Potential for beneficial effects relative to Alternative A due to commitment to prepare site-specific plans.
Common Loon	No effect on common loons.	Habitat conditions for common loons would improve relative to Alternative A due to specific Habitat Conservation Plan mitigation measures.	Habitat conditions for common loons would improve relative to Alternative A due to specific Habitat Conservation Plan mitigation measures.
Northern Goshawk	No effect on northern goshawks.	Same as Alternative A.	Same as Alternative A.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
Vaux's Swift	No effect on Vaux's swifts.	Same as Alternative A.	Same as Alternative A.
Pileated Woodpecker	No effect on pileated woodpeckers.	Minor loss of pileated woodpecker foraging habitat due to expansion of	Same as Alternative A.
Olive-Sided Flycatcher	No effect on olive-sided flycatchers.	Same as Alternative A.	Same as Alternative A.
RECREATION	Whitewater rafting and kayaking activities would occur in a similar manner as existing conditions.	Fewer preferred days for whitewater rafting and kayaking would be available in the average March, but more days would be available in the average May. Overall there would be a slight decline in the number of days with flows in the preferred range for whitewater rafting and kayaking.	Fewer preferred days for whitewater rafting and kayaking would occur in the average March, but more days would occur in the average May. Overall there would be a slight increase in the number of days with flows in the preferred range for whitewater rafting and kayaking.
	Other water-use recreation activities would occur in a similar manner as existing conditions.	Same as Alternative A.	Same as Alternative A upstream of the new diversion. However, the new diversion might adversely affect current water-use recreation activities in the local area.
	Non-water-use recreation activities would occur in a similar manner as existing conditions.	Same as Alternative A.	Same as Alternative A upstream of the new diversion. However, the new diversion may adversely affect current non-water-use recreation activities in the local area.

Table S-1a. Continued.

Element	Alternative A	Alternative B	Alternative C
VISUAL RESOURCES	Visual resources would be maintained in a similar manner as existing conditions.	Same as Alternative A.	Same as Alternative A upstream of the new diversion. However, the new diversion may adversely affect visual resources in the local area.
SOCIAL AND ECONOMIC CONDITIONS	Potential for severe economic and social consequences in the region due to water supply uncertainty.	Potential economic and social consequences under Alternative A would be avoided.	Substantial increased cost for water supply; loss of all or a portion of the Auburn Golf Course; potential flooding of property above RM 29.2 for approximately 1 mile; construction and operation a treatment plant in a current residential and recreational use area.
	Water supply costs would increase to reflect new mitigation requirements.	Water supply costs would increase due to the cost of new facilities.	
CULTURAL RESOURCES	Cultural resources impacts resulting from water withdrawal activities unlikely.	Same as Alternative A.	Unquantified potential to impact unknown cultural sites due to ground disturbance on approximately 25 acres; however, prior ground disturbance has occurred in this area.

Table S-1b. Summary of potential environmental impacts associated with each of the Upper Watershed Alternatives.

Element	**Alternative A**	**Alternative B**	**Alternative C**
	No Action.	Proposed Action. Issue an ITP for 32 species of fish and wildlife in conjunction with the continued management of Tacoma Water lands in the Upper Green River Watershed, and require Tacoma Water to develop and implement a Habitat Conservation Plan.	No Commercial Timber Harvest. Issue an ITP for 32 species of fish and wildlife, and require Tacoma Water to develop and implement a Habitat Conservation Plan that eliminates all commercial timber harvest on Tacoma Water's lands in the Upper Green River Watershed.
OWNERSHIP AND LAND USE	Tacoma Water's lands in the upper watershed would continue to be managed primarily for water quality protection and secondarily for growing and harvesting forest products, consistent with current land use practices and policies.	Same as Alternative A.	Tacoma Water's lands would continue to be managed for water quality protection, but commercial timber harvesting would not occur.

Table S-1b. Summary of potential environmental impacts associated with each of the Upper Watershed Alternatives.

Element	**Alternative A**	**Alternative B**	**Alternative C**
GEOLOGY AND SOILS	Timber and road management activities may increase the potential for surface soil erosion and mass wasting (e.g., landslides). Mitigation would be provided by the riparian buffer requirements of the Forest Land Management Plan and the MIT/TPU Agreement, which generally exceed the requirements of the Washington Forest Practices Rules (including Watershed Analysis	The amount of surface soil erosion would be less than under Alternative A because of additional no-harvest and partial-harvest riparian buffer requirements.	The amount of surface soil erosion and mass wasting would be less than under Alternative A because commercial timber harvesting would not occur and road use activity would decrease.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
AIR QUALITY	Slash burning would generate a limited amount of smoke.	Same as Alternative A.	No slash burning would be necessary in the absence of harvest; therefore, the amount of smoke generated would be less than under Alternative A.
	Road construction, maintenance, and use would generate a limited amount of dust.	Less dust would be generated compared to Alternative A due to improved road surfacing.	Less dust would be generated compared to Alternative A because commercial timber harvesting would not occur, and road use activity would decrease.
SURFACE WATER QUALITY AND QUANTITY	Timber harvest can affect the input of thermal energy, fine sediment, dissolved solids, fine particulate and dissolved organic matter, and nutrients to surface waters, with mitigation above the requirements of the Forest Practices Rules (including Watershed Analysis prescriptions) provided by the Forest Land Management Plan and the MIT/TPU Agreement.	Potential water quality effects would be less than under Alternative A because of additional no-harvest and partial-harvest riparian buffers.	Potential water quality effects would be less than under Alternative A because commercial timber harvesting would not occur.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
	Road construction, maintenance, and use could affect water quality by delivering sediment and dissolved solids to streams. Mitigation above Forest Practices Rules would be provided by Watershed Analysis prescriptions.	Potential water quality impacts would be less than under Alternative A because of additional road maintenance, improvement, and abandonment measures.	Potential water quality impacts would be less than under Alternative A because road use activity would decrease in the absence of timber harvest.

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Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
VEGETATION	Timber management activities might affect special-status plants, but the potential for impacts would be limited because of no-harvest and limited-harvest areas and occurrence of special-status plant species in protected habitats.	Timber management activities would be similar to Alternative A. Potential benefits to special-status plants would be greater than under Alternative A due to increased road abandonment and subsequent recolonization.	Potential benefits to special-status plants would be greater than under Alternative A because no commercial timber harvest would occur, and due to increased road abandonment and subsequent recolonization.
FISH **Erosion and Sedimentation**	The level of sediment entering watercourses is expected to remain below levels experienced in recent years due to implementation of Forest Practices Rules, Watershed Analysis prescriptions, Tacoma Water's Forest Land Management Plan, and the MIT/TPU Agreement.	Similar to Alternative A. The level of sediment entering watercourses would decrease relative to Alternative A due to the reduced activity near stream channels and additional filtering provided by wider riparian buffers.	The level of sediment entering watercourses would decrease relative to Alternative A because no commercial timber harvest would occur.
Woody Debris	The amount of instream LWD would slowly increase over time due to implementation of Forest Practices Rules, Watershed Analysis prescriptions, Tacoma Water's Forest Land Management Plan, and the MIT/TPU Agreement.	LWD recruitment would increase relative to Alternative A because of wider riparian buffers, especially along Type 3 streams.	LWD recruitment would increase relative to Alternative A conditions because no commercial timber harvest would occur near riparian areas.
Nutrients/Litter Input	Timber harvesting within riparian zones of small, Type 3 fish-bearing waters would impact nutrient and litter input. There would be no impact to larger watercourses.	Nutrient and litter input to streams would increase relative to Alternative A because of wider riparian buffers, especially along Type 3 and Type 5 streams.	Nutrient and litter input to streams would increase relative to Alternative A because no commercial timber harvest would occur near riparian areas.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
Shade	Timber harvesting within riparian zones would impact shade levels in small fish-bearing (Type 3) and non-fish-bearing (Types 4 and 5) streams, but shading would be higher than required under the Forest Practices Rules due to implementation of the Forest Land Management Plan.	Shade levels could increase along small Type 3, 4, and 5 streams compared to Alternative A conditions because of wider riparian buffers.	Shade levels could increase relative to Alternative A conditions because no commercial timber harvest would occur near riparian areas.
Salmon, Steelhead, and Coastal Cutthroat Trout	The Forest Land Management Plan and Watershed Analysis prescriptions are expected to result in improved rearing habitat conditions for salmon and steelhead, and improved spawning habitat conditions for salmon, steelhead, and coastal cutthroat trout.	Increased LWD levels would improve spawning and rearing habitat conditions to a greater degree than under Alternative A.	Spawning and rearing habitat conditions would improve to a greater degree than under Alternative A because no timber harvest would occur.
Bull Trout/Dolly Varden	The Forest Land Management Plan and Watershed Analysis prescriptions would result in improved habitat conditions for bull trout/Dolly Varden.	Increased LWD recruitment would improve spawning and rearing habitat for bull trout/Dolly Varden to a greater degree than under Alternative A.	Habitat conditions would improve to a greater degree than under Alternative A because no timber harvest would occur near riparian areas.
WILDLIFE **Mature Forest**	A 10-fold increase in mature coniferous forest (over 100 years old) would occur over the next 50 years.	Similar to Alternative A.	Mature coniferous forest would increase to a greater degree than under Alternative A.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
Snags and Residual Live Trees	Snags and residual live trees would be available on nearly all forested acres by the end of 50 years.	Similar to Alternative A.	More snags and residual live trees would occur on the forest than under Alternative A because no commercial timber harvest would occur.
Riparian Forest	Riparian forest habitat would increase due to the riparian buffers prescribed in the Forest Land Management Plan and the MIT/TPU Agreement.	Similar to Alternative A.	Similar to Alternative A.
Hardwood Forest	Hardwood forest acreage would decrease overall, but this habitat type would persist in areas where it occurs naturally.	Similar to Alternative A.	Existing hardwood forest would not be converted to conifer as in Alternative A, resulting in more hardwood forest overall.
Forest Edge	Forest edges would decrease, but edges would continue to be created on a sustainable basis within timber harvest areas.	Similar to Alternative A.	Forest edges would decrease to a greater extent than under Alternative A.
Gray Wolf	Little or no effect on gray wolves.	Same as Alternative A.	Same as Alternative A.
Peregrine Falcon	No effect on peregrine falcons.	Protection given to peregrine falcon nests would increase relative to Alternative A.	Protection given to peregrine falcon nests would increase relative to Alternative A.
Bald Eagle	The potential for bald eagle nesting or winter roosting would increase.	Same as Alternative A.	Same as Alternative A.
Marbled Murrelet	No effect on marbled murrelet.	Same as Alternative A.	Same as Alternative A.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
Northern Spotted Owl	Approximately 48 percent of the existing spotted owl habitat would be protected from all harvest, and another 29 percent would be managed without clearcutting. The total amount of habitat would increase over time due to harvest restrictions and extended rotations.	Same as Alternative A, except that an additional 135 acres of suitable habitat would be available for harvest in the short term.	All existing suitable habitat would be protected, and new habitat would develop. Benefits to spotted owls would be greater than Alternative A.
Grizzly Bear	Little or no effect on grizzly bears.	Same as Alternative A.	Same as Alternative A.
Cascade Torrent Salamander	Wider riparian buffers under the Forest Land Management Plan and MIT/TPU Agreement would benefit Cascade torrent salamanders.	Habitat benefits for Cascade torrent salamanders would be greater than under Alternative A due to wider riparian buffers.	Habitat benefits for Cascade torrent salamanders would be greater than under Alternative A because no timber harvest would occur near riparian areas.
Van Dyke's Salamander	Wider riparian buffers under the Forest Land Management Plan and MIT/TPU Agreement would benefit Van Dyke's salamanders.	Habitat benefits for Van Dyke's salamander would be greater than under Alternative A due to wider riparian buffers.	Habitat benefits for Van Dyke's salamander would be greater than under Alternative A because no timber harvest would occur near riparian areas.
Larch Mountain Salamander	Mortality of Larch Mountain salamanders could occur during timber harvesting in suitable habitat.	Restrictions on the disturbance of talus fields would protect Larch Mountain salamanders to a greater degree than under Alternative A.	Cessation of timber harvesting would protect Larch Mountain salamanders to a greater degree than under Alternative A.
Tailed Frog	Wider riparian buffers under the Forest Land Management Plan and MIT/TPU Agreement would benefit tailed frogs.	Habitat benefits and mortality avoidance would be greater than under Alternative A due to wider riparian buffers.	Habitat benefits and mortality avoidance would be greater than under Alternative A due to wider riparian buffers.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
Cascades Frog	Mortality of Cascades frogs could occur during timber harvesting in suitable habitat.	Same as Alternative A.	Habitat benefits and mortality avoidance would be greater than under Alternative A because no timber harvest would occur.
Oregon Spotted Frog	No effect on Oregon spotted frogs.	Same as Alternative A.	Same as Alternative A.
Northwestern Pond Turtle	No effect on northwestern pond turtles.	Same as Alternative A.	Same as Alternative A.
Common Loon	Nesting habitat for the common loon would be protected.	Same as Alternative A.	Same as Alternative A.
Vaux's Swift	Short-term adverse impacts could occur to Vaux's swifts due to harvesting of snags. Snag and residual live tree measures would eventually lead to increased habitat for Vaux's swifts.	Increased protection for nest and roost trees would provide greater benefits to Vaux's swifts than Alternative A.	Cessation of timber harvesting would protect Vaux's swifts to a greater degree than under Alternative A.
Pileated Woodpecker	An increase in the amount of mature coniferous forest would benefit pileated woodpeckers.	Habitat benefits for pileated woodpeckers would be greater than under Alternative A due to measures to protect snags and residual live trees.	Habitat benefits for pileated woodpeckers would be greater than under Alternative A because there would be no timber harvest.
Olive-Sided Flycatcher	Habitat for olive-sided flycatchers would decrease due to a decrease in edge habitat.	Same as Alternative A.	Habitat for olive-sided flycatchers would decrease to a greater degree than under Alternative A.
Canada Lynx	No effect on Canada lynx.	Same as Alternative A.	Same as Alternative A.
California Wolverine	Little or no effect on California wolverines.	Same as Alternative A.	Same as Alternative A.

Table S-1b. Continued.

Element	Alternative A	Alternative B	Alternative C
Pacific Fisher	An increase in mature coniferous forest would benefit Pacific fishers.	Same as Alternative A.	Habitat for Pacific fishers would increase to a greater degree than under Alternative A.
Northern Goshawk	An increase in mature coniferous forest would benefit northern goshawks.	Increased protection of nest trees would provide greater benefits to northern goshawks than under Alternative A.	Increased protection of nest trees would provide greater benefits to northern goshawks than under Alternative A.
RECREATION	No impacts to recreation.	Same as Alternative A.	Same as Alternative A.
VISUAL RESOURCES	No impacts to visual resources.	Same as Alternative A.	Same as Alternative A.
SOCIAL AND ECONOMIC CONDITIONS	Impacts would be primarily the costs and revenue associated with forest management activities. Revenue would exceed costs under Alternative A and would be used for management and operational improvements in the upper watershed.	Same as Alternative A.	Watershed maintenance costs would exceed revenues because no harvesting would occur.
CULTURAL RESOURCES	Cultural resource impacts resulting from timber harvesting activities would be unlikely.	Same as Alternative A.	Same as Alternative A.

1.0 Purpose and Need for the Proposed Action

1.1 Introduction

The City of Tacoma Water Division (Tacoma Water) is applying for an Incidental Take Permit (ITP) from the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) (collectively the "Services") under Section 10(a)(1)(B) of the Endangered Species Act of 1973 (ESA), as amended[1]. The ITP will cover various activities relating to Tacoma Water's diversion of water from the Green River, as well as Tacoma Water's management of its ownership in the Upper Green River Watershed. The geographic areas to be covered are located in King County, Washington. Species for which Tacoma Water seeks ITP coverage include the chinook salmon, bull trout, northern spotted owl, and marbled murrelet, as well as 28 other listed and unlisted species that may be affected by Tacoma Water's activities in the Green River and the Upper Green River Watershed.

Tacoma Water supplies water to approximately 83,000 service customers (approximately 300,000 people) in Tacoma and in other nearby areas. Most of Tacoma Water's supplies originate from the Green River. Tacoma Water has diverted water from the Green River since 1913, and it expects to increase its diversions to meet growing customer demands. Tacoma Water recently expanded its water rights, and is seeking to expand its Green River diversion and delivery facilities. However, recent concerns over the listing of anadromous salmonids under the federal ESA has prompted concern about the long-term reliability and certainty of Tacoma's Green River water supplies, and about the ability to successfully implement proposed water development projects. In addition, ESA concerns may also affect Tacoma's ability to manage its ownership in the Upper Green River Watershed.

[1] Two permits would be issued, one from the USFWS and one from NMFS; however, for purposes of this DEIS, both permits are referred to as "the ITP" or "the Permit".

To pursue certainty of its existing and future water supplies and to its lands in the upper watershed, Tacoma Water is seeking an ITP that would provide long-term assurances for the reliability of water supplies and certainty for its watershed management. To obtain an ITP, Tacoma Water must prepare a conservation plan that meets the issuance criteria established by the Services as described in subsection 1.5, Decisions to be Made. Accordingly, Tacoma Water has prepared a draft Habitat Conservation Plan (HCP) in support of its ITP application. This HCP is hereby incorporated by reference.

Federal action on Tacoma Water's ITP application requires environmental review under the National Environmental Policy Act (NEPA). This Draft Environmental Impact Statement (DEIS), and subsequent Final EIS (FEIS), are intended to meet the Services' environmental documentation requirements under NEPA. This DEIS evaluates the environmental consequences associated with Tacoma's operations under its proposed HCP, as well as under several alternatives to the HCP (including the No Action Alternative).

1.2 Purpose and Need for the Proposed Action

1.2.1 Purpose of the Proposed Action

The purpose of the Proposed Action is to issue an ITP for 32 listed and unlisted species in the Green River downstream of Tacoma Water's Headworks diversion, and on Tacoma Water's ownership in the Upper Green River Watershed, for a period of 50 years. As part of its application for the ITP, Tacoma Water has prepared an HCP in accordance with Section 10(a)(2)(A) of the ESA. Under provisions of the ESA, the Secretary of the Interior (through the USFWS) and the Secretary of Commerce (through NMFS) may issue a permit for the taking of a listed species if the Services find that the application conforms with the issuance criteria listed below in subsection 1.5, Decisions to be Made.

To minimize and mitigate the incidental take and to adequately address the needs of the Covered Species, Tacoma Water would implement the HCP for the full 50 years of ITP coverage. Implementation would include monitoring the effectiveness of the HCP prescriptions and regular reporting to the Services. Compliance monitoring by the Services would include use of remote and on-site techniques to ensure the HCP is implemented in accordance with the commitments of the parties. Adaptive management, as

specified in the HCP and Implementation Agreement (IA), could result in modification and improvement of HCP measures ("Habitat Conservation Measures") in response to new information (HCP Chapter 6).

Specific activities to be covered under the ITP are detailed in subsection 2.6 of the proposed HCP and include:

- timber harvesting, inventory, and monitoring;
- silvicultural treatments;
- site preparation;
- tree planting;
- road construction, maintenance, and use;
- quarrying stone and gravel;
- fish and wildlife habitat enhancement;
- tribal access;
- water withdrawal;
- monitoring, surveying, and maintenance;
- fish passage; and
- headworks construction.

1.2.2 Need for the Proposed Action

The Services have received an application for an ITP from Tacoma Water, to cover currently listed and unlisted species. In accordance with their responsibilities under the ESA, the Services must respond to this application. The ITP is requested by Tacoma Water because activities associated with Tacoma Water's

water withdrawal and land management activities may, in the opinions of the Services, result in take of listed species and/or impacts to unlisted species that could become listed during the term of the ITP. Tacoma Water believes that regulations promulgated for the conservation of these listed species, and those that may become listed in the future, may result in severe curtailment of water withdrawal activities at the Tacoma Headworks, and/or severe limitation or cessation of timber harvest in suitable (i.e., forested habitat occupied by listed species) habitat.

Tacoma Water has informed the Services that curtailment of water withdrawal activities would have severe consequences on the reliability of its water supply, which serves approximately 83,000 service customers (approximately 300,000 people) and provides critical public water supply infrastructure to communities in Pierce and south King Counties. In addition, Tacoma Water has informed the Services that potential reductions in timber harvest and concomitant reduction of revenues would adversely affect Tacoma Water's ability to manage its lands in the upper watershed, thus creating disincentives for its water quality and habitat management efforts both now and in the future.

The need for unlisted species coverage is to provide further assurances to Tacoma Water that no additional water withdrawal limitations, land restrictions, or financial compensation would be required from Tacoma Water for species adequately covered by a properly functioning HCP in light of unforeseen or extraordinary circumstances.

Finally, the needs and goals of the Services are to conserve listed species and their habitats and associated species during Tacoma Water's proposed actions and to ensure compliance with the ESA, NEPA, and other applicable laws and regulations. The Services, as well as Tacoma Water, consider the implementation of an HCP to be the most effective means of reconciling Tacoma Water's proposed activities with the prohibitions against take and other conservation mandates of the ESA.

1.3 Environmental Review Process

Publication of this ~~D~~FEIS is a key milestone in the environmental review process for Tacoma Water's proposed HCP. Prior actions regarding this ~~D~~FEIS have been related to the public/agency scoping process

and the decision to prepare a DEIS. A complete discussion of the scoping process is described in the Scoping Report for this project (on file with the Services).

In summary, a 30-day public scoping period, announced in the Federal Register on 21 August 1998 (63 FR 44918), was held from 21 August 1998 to 21 September 1998. A public scoping meeting was held on 25 August 1998 at the Enumclaw Public Library to introduce the proposed HCP and the NEPA review process. Public and agency comments were received, both orally at the meeting and in writing in subsequent letters. The decision to prepare an EIS was announced in a subsequent Federal Register notice (64 FR 3066, 20 January 1999), in letters sent to interested parties, and through a press release. The Services also conducted internal scoping activities to address key components of alternative descriptions, to develop the level of detail for impact and cumulative impact analyses, and to prepare the DEIS framework and schedule. The DEIS was prepared in consideration of issues raised during the public and internal scoping process.

The Tacoma Water Habitat Conservation Plan for the Green River Water Supply Operations and Watershed Protection, dated December 1999, and the associated DEIS, dated January 2000, were made available for a 60-day public comment period on 14 January 2000 (65 FR 2390). The comment period was extended for 17 days to 14 March 2000 (65 FR 13947) in direct response to requests from the public. This resulted in a total comment period of 77 days. In addition to the Federal Register announcement, comments were also solicited via 1) a news release sent to all western Washington news agencies and various federal, state, tribal, and local jurisdictions; and 2) letters mailed directly to individuals included on the USFWS public notification mailing list.

Three public meetings were held during the public comment period to provide an information exchange opportunity for interested parties. The following is a list of the locations and dates of those meetings:

#	Washington State History Museum Tacoma, Washington	10 February 2000
#	Kent Senior Center Kent, Washington	29 February 2000

#	Covington Water District Covington, Washington	2 March 2000

Following the 77-day public comment period, a FEIS was prepared. The FEIS is presented in two volumes. Volume I is an edited version of the DEIS, and includes strike-outs of old text and underlines of updated or new text (or as otherwise noted). Volume II details public comments and subsequent Services' responses, and includes the three HCP chapters that were revised as a result of public comments. Tables P-1 and P-2 in the Preface section of this document (i.e., Volume I) lists key changes that were made to the DEIS and HCP.

The FEIS will be distributed for a 30-day review period. Following the review period, the Services will conduct a final review of the FEIS and proposed HCP to decide whether or not to issue the requested ITP. The final decision-making process will involve analyses and documentation in an ESA Section 10 Findings document, an ESA Section 7 Biological Opinion, and a NEPA Record of Decision (ROD). Any comments on the FEIS will be considered in this final decision-making process and in preparation of the ROD. The final decision is anticipated to occur in the first quarter of 2001.

~~During the public review period, the Services will participate collaboratively with Tacoma Water to conduct three informal public meetings to discuss the HCP. Specific dates have not been set, but information will be published in local newspapers and in Tacoma Water's Green River Currents newsletter. Meetings are planned to be held in Enumclaw, Tacoma, and Tukwila, Washington.~~

~~Following the close of the 60-day comment period, the Services and Tacoma Water will review all public and agency comments and develop responses. These responses to comments, as well as changes to the DEIS, will be published in the FEIS shortly after the comment period closes. Revisions to the HCP will also be considered during this time. After a reasonable time is given for review of the FEIS and the HCP as revised, the Services will decide whether or not to issue the ITP. Certification of the EIS as part of this process will be accompanied by a Record of Decision (ROD). Any comments on the FEIS will be considered in this final decision-making process and in preparation of the ROD.~~

1.4 Issues and Concerns

Issues and concerns regarding the proposed Action and the NEPA documentation were raised during the public and internal scoping process. Details of the issues raised are provided in the Scoping Report (on file with the Services). Based on scoping comments, key issues and concerns considered in preparation of this ~~D~~EIS included the following:

- the scope of issues considered in this NEPA analysis of the HCP in consideration of other actions, including Tacoma Water's Second Supply Project, the U.S. Army Corps of Engineers' (USACE) Additional Water Storage Project, and existing agreements between Tacoma Water, the USACE, and the Muckleshoot Indian Tribe;

- the appropriate geographic scope of the impact assessment area;

- the appropriate environmental baseline: current or pre-existing conditions (i.e., prior to construction of Howard Hanson Dam and the Tacoma Headworks diversion), and flow modeling methods;

- the ability of HCP measures to potentially benefit Covered Species, including contributing to their recovery, and consideration of this issue in the EIS analyses;

- the ability of the EIS to accurately describe impacts given future uncertainty and potential changed circumstances, and the use of the "No Surprises" policy;

- the role of effectiveness monitoring and adaptive management;

- the range of alternatives considered, including potential alternatives to Green River diversions (e.g., increased groundwater withdrawals and/or conservation);

- an accurate definition of the No Action Alternative; and

- the scope of the cumulative effects analyses and data requirements.

1.5 Decisions to be Made

The decision to be made by the Services is whether to issue or to deny the ITP. The Services could issue an ITP pursuant to Section 10(a)(1)(B) of the ESA conditioned on implementation of an HCP as submitted by Tacoma Water, or conditioned on implementation of Tacoma Water's HCP together with other measures specified by the USFWS or NMFS. In reaching their decision to issue an ITP, the Services must make the following findings:

- the proposed take is incidental to an otherwise lawful activity (i.e., water diversion, timber management, and harvesting);

- the impacts of the proposed taking are minimized and mitigated to the maximum extent practicable;

- Tacoma Water ensures that adequate funding will be provided to implement the measures proposed in the HCP, and the HCP provides procedures for addressing unforeseen circumstances;

- the proposed take will not appreciably reduce the likelihood of the survival and recovery of the Covered Species in the wild; and

- Tacoma Water will carry out any other measures or assurances that the Secretary of the Interior or the Secretary of Commerce may require as necessary.

If the Services make the above findings, the ESA requires the Services to issue the ITP to Tacoma Water. In such case, the Services will decide whether to issue a permit conditioned on implementation of the HCP as submitted by Tacoma Water, or to issue a permit conditioned on implementation of the HCP as submitted together with other measures specified by the Services. If the above criteria are not satisfied, the Services must deny the permit request.

The proposed Section 10(a)(2)(B) permit would include the listed and unlisted species identified in Table 2-1 of this DEIS. Tacoma Water would receive immediate coverage for the listed species under the ITP. Should any of the unlisted species become listed during the term of the ITP, coverage would be extended to Tacoma Water for those species as well, consistent with the conditions specified in an IA to be signed by Tacoma Water and the Services at the time the ITP is issued.

1.6 Relationship to Other Plans

1.6.1 Green River Projects

Improvements to the water supply system on the Green River are currently being developed and implemented. Two projects are the focus of these improvements: 1) Tacoma Water's Second Supply Project, and 2) the USACE Additional Water Storage Project. These projects are detailed in Section 2.0, Alternatives.

1.6.2 State and Private Plans

Plum Creek Timber Company and the Washington Department of Natural Resources (DNR) have developed HCPs for their lands in the Upper Green River Watershed, and Weyerhaeuser Company currently operates under a special management agreement with the USFWS for spotted owls.

Analyses of five of the six Washington State Watershed Administrative Units (WAUs) in the Green River Watershed have been conducted by non-federal landowners (including Tacoma Water) following DNR methodology. Forest management prescriptions developed through Watershed Analyses have been approved for the Lester WAU, and draft prescriptions are currently being implemented by Tacoma Water in the Upper Green, Sunday, Howard Hanson, and Smay WAUs.

1.6.3 Federal Plans

The U.S. Forest Service (USFS) lands north of the Green River lie within the Snoqualmie Pass Adaptive Management Area, while the majority of USFS lands south of the Green River are designated as matrix

lands. These lands are managed under the provisions of the Northwest Forest Plan (U.S. Forest Service and U.S. Bureau of Land Management 1994). The USFS has also conducted a Watershed Analysis following federal protocol.

1.6.4 Tacoma Comprehensive Water Plan Update

Tacoma Water's HCP is consistent with its Comprehensive Water Plan Update. The HCP addresses Tacoma Water's obligations under the ESA that arise from the decision to implement the water supply strategy resulting from the Integrated Resource Planning analysis described in Tacoma Water's Comprehensive Water Plan Update. The Comprehensive Water Plan Update was prepared in 1998 in response to Washington State Department of Health regulations that require all water purveyors to update their water system plans on a regular basis (WAC 246-290-100). The Comprehensive Plan is updated every 5 years.

The Comprehensive Water Plan Update is a guidance document designed to assist Tacoma Water to make the best use of its available resources to provide quality water services and to protect customer health. It serves as a guide for the planning and design of future water system facilities, and assists Tacoma Water in developing a strategy for using its water resources in the most effective and efficient manner possible. The document describes the existing water system, predicts future demands on the system over a 50-year planning horizon, presents a conservation plan designed to lessen the predicted demands on the system, and evaluates a number of potential supply measures to provide more water where it will be needed in the upcoming years. An integrated resource planning approach was used to select the best combination of available supply options to provide needed increments of water in the most cost-effective manner.

As part of the Comprehensive Water Supply Plan Update process, 22 options were identified in the Resource Availability Report (CH2M Hill 1997) and characterized to provide additional water supplies to Tacoma Water. Options included Green River options, other surface water supply options, groundwater supply options, and water reuse. Water conservation was a part of each of the options. Fifteen candidate surface water supply projects were evaluated that would use water from 10 different sources. Each of the identified resources was evaluated for yield, potential development costs, and regulatory feasibility. All but

three of the surface water options were eliminated from future consideration for at least one of the following reasons:

- no water rights were currently in place for the options, and there is no likelihood of attaining such rights due to instream flow concerns;
- extensive tribal, environmental, and other political opposition was expected;
- expensive water treatment facilities would be required; or
- another agency is the lead for determining the feasibility of the project (Tacoma-Seattle Intertie).

The Second Supply Project, Parallel Pipeline to Pipeline No. 1, and Additional Storage at Howard Hanson Dam were considered the surface water options to be included for further analyses in the integrated resource planning analysis. An optimization model that uses a linear programming method was used to determine the optimum mix of resources required to meet Tacoma Water's needs. To reflect the complexity of the pipeline resource options and the areas served by the pipelines, two demand areas were used by the model. Area 1 corresponds to the Tacoma/Pierce County area (Local Reliance); Area 2 corresponds to South King County and other possible demands from the north (Full Regionalization).

In the Local Reliance scenario, Tacoma Water would supply only its own water needs in the existing retail and wholesale service areas of Pierce and King Counties. Water sources would vary in this scenario depending on the level of demand forecasts used and reliability of the resources. The Full Regionalization scenario considers Tacoma Water as a regional water supplier, and contains a larger number of variables than the Local Reliance scenario. In addition to Tacoma Water's own demands, the demands of other entities were considered. One known additional demand would be for Tacoma Water to supply three south King County utilities (City of Kent, Covington Water District, and Lakehaven Utility District) with a specified amount varying with the seasons of the year.

Another potential demand that arose following completion of the demand forecast model was Seattle Public Utilities. Incorporation of the Full Regionalization scenario into the model dictated that the Second Supply Pipeline Project must be considered in the resource mix as the only viable option to convey the Second Diversion Green River water to meet that demand.

Tacoma Water has decided to move forward with the Full Regionalization scenario. The Washington State Departments of Health and Ecology have expressed support of the Full Regionalization scenario as a means to help meet the future water demands of the Puget Sound area. Based on the results of the Integrated Resource Planning model and other supporting factors such as the need for Tacoma Water to either implement, or lose, the Second Diversion Water Right, Tacoma Water has proceeded with the first elements in the Full Regionalization scenario. These include plans to construct the Second Supply Pipeline and the Howard Hanson Dam Additional Water Storage Project.

1.6.5 Growth Management Act

A number of the activities covered by the ITP would enable Tacoma Water to continue with existing and future operations throughout its service area. These activities include the withdrawal of water at the Tacoma Headworks Diversion and the operation of the North Fork Wellfield. The service of this water within Tacoma's service area and the service area of Tacoma Water's partners, the City of Seattle and South King County Regional Water Association, is done in accordance with urban growth planning carried out by local and state governments in the region.

Prior to the decision to serve water in a particular area, a series of events occur to evaluate the appropriate nature, magnitude, and density of the development. The first action that is taken is the allocation of growth to counties under the state's Growth Management Act (GMA). The counties subsequently manage the distribution of this growth throughout their boundaries by the development and implementation of Growth Management Plans. The development of Growth Management Plans is required for many counties, and other counties are allowed to develop plans, under the Revised Code of Washington (RCW), Chapter 36.70. Pierce and King Counties, which are directly affected by Tacoma's service of water from the Green River, are required to develop growth plans under the GMA.

Under the GMA, growth projected for the state by the state's Office of Fiscal Management is allocated to the counties, which then develop plans to address the projected population increase and the associated needs for services. Cities may also prepare plans under the GMA. Plans developed under the Act then guide both zoning and development permits within the jurisdictional boundaries of the plans. In the case of Tacoma's service area, GMA plans have been developed by Pierce County, the City of Tacoma, King County, the City of Seattle, and a number of other cities in King County. These plans forecast and direct urban growth with Tacoma Water's service area.

1.6.5.1 Local Comprehensive Plans

Local jurisdictions potentially affected by this proposal (King County, Enumclaw, Auburn, Kent, and Tukwila) have also developed Comprehensive Plans to control and direct growth within their incorporated and growth management boundaries.

1.6.6 Shoreline Management Act

Jurisdictions must comply with the Shoreline Management Act of 1971 and develop a shoreline master program as part of their planning efforts. The King County Shoreline Management Master Program sets forth guidelines to regulate development along shorelines under the jurisdiction of the Shoreline Management Act.

1.6.7 State Environmentally Sensitive Areas

King County has included Environmentally Sensitive Areas (Chapter 21A.24) within the King County Code. This chapter sets forth policies and regulations to protect the natural environment and public health. Local jurisdictions within the project area have also developed sensitive areas regulations.

1.7 Overview of DEIS Sections

This DEIS has been prepared in accordance with NEPA and with the NEPA guidelines adopted by the USFWS and NMFS. The DEIS is a stand-alone document; however, the DEIS should be reviewed together with Tacoma Water's proposed HCP, which contains detailed background information and

justification for the Habitat Conservation Measures contained in the Proposed Action. The proposed HCP is incorporated herein by reference.

In addition to this section, which describes the purpose of and need for the Proposed Action, other key sections of the DEIS include the following:

Section 2.0, Alternatives

Describes the Proposed Action and alternatives to the Proposed Action. Alternative A is the No Action Alternative, or what actions would be expected to occur if the Proposed Action (i.e., issuance of an ITP) were not federally approved. Management in accordance with Tacoma Water's Proposed Action is described as Alternative B, proposed HCP. For clarity, these alternatives are described first in terms of Tacoma Water's water withdrawal activities (i.e., Water Withdrawal Alternative B, proposed HCP), and then for its timber management activities (i.e., Upper Watershed Alternative B, proposed HCP).

A third alternative is proposed for each category. Under the water withdrawal alternatives, Alternative C would include issuance of an ITP and implementation of an HCP and Tacoma Water's Second Supply Project downstream near the City of Auburn rather than at the Tacoma Headworks. For the upper watershed management alternatives, no commercial timber management activities would occur under Alternative C on Tacoma Water's lands in the Upper Green River Watershed. An HCP would be implemented and an ITP issued under Upper Watershed Alternative C. In addition, other options that were considered but were not carried forward for detailed analysis as alternatives are described in subsections 2.3, Water Withdrawal Options Raised During Scoping but not Analyzed in Detail as an Alternative, and 2.5, Upper Watershed Options Raised During Scoping but not Analyzed in Detail as an Alternative.

Section 3.0, Affected Environment

This section describes the existing environmental conditions of the areas to be covered by Tacoma Water's proposed HCP. The discussion of the affected environment is grouped into various subsections corresponding to the resources potentially affected by the Proposed Action (e.g., fisheries, recreation).

Section 4.0, Environmental Consequences

This section describes the potential impacts of the Proposed Action and alternatives on the resources described in Section 3.0, Affected Environment. The environmental consequences of the Proposed Action (and Alternative C) are described relative to the environmental consequences of the No Action Alternative. Also included in this section is a discussion of cumulative impacts, or the impacts of the Proposed Action in consideration of other projects (i.e., past, present, and reasonably foreseeable future projects) that may affect fish and wildlife habitat and populations.

In addition, the following are also included in this ~~D~~FEIS:

- List of Acronyms (inside front cover)
- Preface
- Cover Sheet
- Glossary
- Summary
- Section 5.0, List of Agencies, Organizations, and Individuals Consulted; and Distribution List
- Section 6.0, List of Preparers
- Section 7.0, References
- River Mile Locations (inside back cover)

2.0 Alternatives

2.1 Introduction

Tacoma Water has prepared an HCP and requested an ITP for the continued operation and planned expansion of its primary water withdrawal facility on the Green River in King County, Washington (Section 1.0, Purpose and Need for the Proposed Action). Tacoma Water is requesting incidental take coverage for two distinct sets of activities (i.e., actions) within the Green River Watershed: a) the withdrawal of water at the Tacoma Headworks facility (River Mile [RM] 61.0) and associated activities (Figure 2-1), and b) the management of City of Tacoma-owned lands in the upper watershed above the point of withdrawal. *These two, distinct actions are interrelated, but they are not interdependent; an ITP could be issued for one action and not for the other. The water withdrawal facilities could be operated with or without incidental take coverage for the upper watershed, and management of Tacoma Water's upper watershed lands could continue regardless of the manner in which water is withdrawn.* For this reason, the analyses in this DEIS are done in two parts; one covering the alternatives for water withdrawal activities, and the other covering alternatives for land management activities in the upper watershed. Alternatives to the proposed water withdrawal activities are addressed in subsection 2.2, and alternatives to the proposed management of Tacoma's upper watershed lands are addressed in subsection 2.4. All alternatives are compared and summarized in Tables 2-18a and 2-18b at the end of this section.

Three water withdrawal alternatives are analyzed in detail: the No Action Alternative, the Proposed Action, and a third alternative involving construction of a new water withdrawal facility (diversion) approximately 30 miles downstream of the existing Tacoma Headworks diversion. Four additional water withdrawal options were identified during public scoping, but they are not analyzed in detail as alternatives to the Proposed Action because they would not accomplish Tacoma Water's objective of meeting current and future water demands, and/or because speculative information would be required to adequately analyze impacts. They are discussed briefly in subsection 2.3.

Figure 2-1. Project area and facilities.

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Three alternatives are analyzed for Tacoma Water's watershed land management: No Action, Tacoma Water's proposed management of its watershed lands (i.e., with implementation of an HCP), and management of its watershed lands with no commercial harvest of timber. One additional watershed management option was identified during public scoping, but it is not analyzed in detail as an alternative to the Proposed Action because it would not accomplish Tacoma Water's objective of managing its watershed lands to protect water quality as described in subsection 2.5.

All water withdrawal and watershed land management alternatives (except the No Action Alternatives) would provide incidental take coverage for the same set of 32 fish and wildlife species (6 listed and 15 unlisted wildlife species, 21 total; 2 listed and 9 unlisted fish species, 11 total).[1] (Table 2-1) (Appendix A). Some of these species are more prevalent or more likely to occur in one portion of the watershed than in another (e.g., the upper watershed versus the lower watershed). For simplicity, however, there has been no attempt to distinguish species covered under the water withdrawal alternatives from those covered under the watershed management alternatives. The distributions of these species within the watershed are presented in Section 3.0, Affected Environment, and the relative effects of the covered activities under each of the alternatives are presented in Section 4.0, Environmental Consequences, of this DEIS.

2.2 Water Withdrawal Alternatives

The following subsections (i.e., 2.2.1, Background and Identification of Water Withdrawal Alternatives, through 2.2.4, Water Withdrawal Alternative C) describe the basis for forming the Water Withdrawal Proposed Action and alternatives to that action.

2.2.1 Background and Identification of Water Withdrawal Alternatives

Tacoma Water supplies municipal and industrial water to Pierce County and to communities in neighboring South King County. Tacoma Water is also expected to participate in a regional intertie with suppliers in King and Snohomish Counties to make efficient use of regional water supplies (an

[1]Note: While the peregrine falcon has been recently de-listed as a threatened species by the USFWS, it was analyzed as a listed species in this DEIS.

Table 2-1. Species proposed for coverage in the Tacoma Green River Habitat Conservation Plan.

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intertie is a water conduit system that allows an exchange of water between adjacent suppliers and service areas). Over the past several years, Tacoma Water has assessed a number of options for meeting its current and future water demands. Those options that Tacoma Water identified as technically, economically, and environmentally feasible form the basis for the Proposed Action (i.e., issuance of an ITP). The remaining options are not part of the Proposed Action for one or more of the reasons identified in subsections 2.2.1.1 through 2.2.1.7.

Tacoma Water's current and potential future obligations as a regional supplier of water occur in six geographic service areas, as described below (Figure 2-2) (Economic and Engineering Services, Inc. and CH2M Hill 1995). To be considered feasible, a water supply option must enable Tacoma Water to meet its various commitments in these geographic areas.

- *Tacoma Water's Current Service Area* includes locations where Tacoma Water has existing commitments to provide water service. Generally, this service area follows the City of Tacoma's municipal boundary and abutting areas. However, there are certain areas outside the City limits that are adjacent to existing water transmission facilities to which Tacoma Water provides service, as well as several other water systems that purchase wholesale water from Tacoma.

- *The City of Tacoma Urban Growth Area Service Area* includes water demands for all geographic areas of the City of Tacoma Urban Growth Area (UGA) beyond the current Tacoma Water Service Area.

- *The Pierce County Urban Growth Area Serviceable Service Area* represents locations outside of the current Tacoma Water Service Area and City of Tacoma UGA Service Area that are expected to be reasonably served by existing or proposed water transmission and distribution pipelines.

- *The Pierce County Urban Growth Area Not Serviceable Service Area* represents locations that cannot reasonably be supplied by Tacoma Water with existing or currently proposed transmission and distribution lines. These areas are geographically removed from the current service territory, and extension of service to these locations is not anticipated within the forecast period, which ends in 2050.

- *The Rural Pierce County Service Area* represents the remainder of Pierce County that is not included within either the City of Tacoma UGA or the Pierce County UGA. According to the Pierce County Comprehensive Land Use Plan (Pierce County Planning and Land Services 1999), these areas will remain rural. Urban services will not be expanded within these areas.

- *The King County Service Area* includes those areas served by South King County purveyors (i.e., Lakehaven Utility District, City of Kent, and Covington Water District) and Seattle Public Utilities, including its purveyors that are currently considering or requesting additional water supply from Tacoma Water.

Roughly 93 percent of the current Tacoma Water service area is in Pierce County and 7 percent in King County. Approximately 80 percent of Tacoma Water's service area is currently within an urban land use designation, with the remaining 20 percent in a rural designation. Tacoma Water's customer categories and uses in 1998 were characterized as shown in Table 2-2.

Future water demand forecasts (Figure 2-3) are based, in large part, on population projections (Table 2-3). The population forecasts used to estimate Tacoma Water's future water demand (Table 2-4) were based on the March 1995 population and employment information available from the Puget Sound Regional Council.

Tacoma Water evaluated several water resource options prior to developing the proposed HCP and prior to identifying feasible alternatives. These options included conservation without additional water withdrawal, reuse of water, other sources of surface and groundwater, elimination of the existing water withdrawal facilities, limitation of Tacoma Water's service area, and relocation of the Tacoma Headworks. With the exception of a Tacoma Headworks relocation, these options were eliminated for various reasons, as described below.

Figure 2-2. Tacoma Water Geographic Service Areas.

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Table 2-2. Tacoma Water's customer base as of 1998.

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Figure 2-3. Forecasted net average day resource requirements for Tacoma Water.

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Table 2-3. Historic and forecasted population of the Tacoma Water service area.

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Table 2-4. Forecast of water use in the Tacoma Water service area.

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2.2.1.1 Water Conservation

Conservation without additional water withdrawal was eliminated as a water resource option because conservation cannot, of itself, provide sufficient water to meet water resource needs of the region. However, water conservation is included as a component of all the withdrawal alternatives. Conservation has become an important component of Tacoma Water's management planning. A water conservation plan was developed to provide a systematic and coordinated approach to conservation that will ensure the wise use of Tacoma Water's available water resources. This plan is updated as new feasible conservation technologies become available and gain acceptance in the community.

The goals of Tacoma Water's conservation program are designed to protect and preserve present and future water resources and to maintain or reduce present per capita water usage levels in all customer categories. The following objectives have been formulated to accomplish these goals to:

- develop a conservation program that meets or exceeds state requirements for public systems;
- develop a conservation program that ensures the efficient use of water ;
- coordinate and integrate water conservation programs with other Tacoma Water and Public Utilities programs;
- develop reuse programs for irrigation and/or industrial processing; and
- achieve a consistent reduction in the peak 4-day demand (peak 4-day demand is a measure of the maximum amount of water used in four consecutive days and is a key design factor for source requirements).

Since the 1980s, Tacoma Water's conservation plan has been included as a part of its overall water resource plan. The primary focus has been on developing long-term sustained conservation activities in a

balanced program with both effective supply management and demand management measures. A Water Conservation Plan was developed in 1991 and included conservation measures designed to increase customer awareness of conservation issues, to provide incentives for reduced consumption, and to reduce water losses within the system.

Tacoma Water hired a Water Conservation Specialist in 1992 to implement recommendations of the 1991 Water Conservation Plan, and several programs have since been implemented (Table 2-5). Also, in 1992, the rate structure was modified to encourage water conservation in all customer categories.

Existing Conservation Savings

Tacoma Water has been keeping conservation-related records since 1988 to determine the effectiveness of various water saving measures (Table 2-6). Figure 2-4 illustrates the reduction in overall water use as the result of implementing the programs listed in Table 2-5.

Since 1991, Tacoma Water has achieved an estimated overall water savings of over 15 million gallons per day (mgd), which represents an 18 percent decrease from its 1991 per capita base water consumption. The Simpson Tacoma Kraft mill accounts for nearly 9 mgd of these water savings based on its industrial conservation program implemented in 1992. The Tacoma Water Conservation Plan (1991) does not set specific savings goals due to different implementation schedules and different levels of conservation needs of each system. However, Figure 2-4 demonstrates that Tacoma Water's existing conservation program has had a substantial beneficial impact on the overall water demands on its system.

Evaluation of Conservation Measures

To evaluate the most effective measures to be pursued by Tacoma's Integrated Resource Plan (IRP) and, ultimately, to form the conservation program update, extensive analyses were conducted on various conservation measures, criteria, estimated water savings, and cost of implementation. There were 124 conservation measures originally identified and evaluated for water saving potential and cost of implementation. After initial screening, 28 measures were selected for further evaluation. These measures are generally within the following categories:

Table 2-5. Tacoma Water's existing Conservation Program.

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Table 2-6. Conservation Program savings since 1990.

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Figure 2-4. Forecasted Average Day Water Demand.

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- indoor/outdoor audits;
- low-flow fixtures (showerheads, faucets);
- toilet and toilet retrofit devices (dual flush, dams, displacement bags, toilet leak detection;
- irrigation system management devices;
- rebates/grants; and
- miscellaneous measures.

The measures were divided into four user classes: single family, multi-family, commercial/ industrial, and public authorities. Table 2-7 presents the 28 conservation measures that were evaluated within each class.

Each conservation measure was evaluated based on quantitative data such as product useful life, cost per device, administration cost, installation cost, number of units per customer, average water savings (per person or as a percentage of indoor or outdoor use), and penetration and retention rates. Additional information and data derived from Tacoma Water consumption records or the 1991 Water Conservation Plan were also included in the analysis. These additional factors include the percentage of system losses, number of persons per single family and multifamily dwelling, the percentage of residential use by single family and multifamily customers, irrigated areas, use per account for schools and parks, and the amount of water used by the top 25 industrial customers.

Program Savings Criteria

To perform the initial screening, the maximum potential savings available from each measure was estimated based on annual usage, summer usage, and 4-day peak usage. The maximum potential retained savings figures were adjusted to reflect device penetration and retention. The maximum savings level is used as a criteria measure to compare each measure to other measures to determine if conservation can generate sufficient demand reductions to avoid or delay the development of new supplies.

The cost of the various conservation devices was also assembled. A levelized cost per mgd was then computed for each measure using product life expectancy, retained water savings, cost per device, and real interest rate. The cost per mgd of water saved represents the amount of money that must

Table 2-7. Conservation measures evaluated for targeted customer categories.

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be spent to achieve a 1 mgd savings. The levelized cost per mgd is a convenient method of evaluating measures of varying product life on an equivalent basis, but does not imply that each measure has the potential to save 1 mgd. Most measures evaluated had a total savings potential much lower than 1 mgd. The market penetration rate was then applied to this retained savings to project the actual savings that could be realized from each measure.

Levelized Cost Ranking

Each of the various conservation measures was evaluated based on estimated water savings and costs. The measures were ranked from low to high on the basis of levelized cost in terms of average annual, summer, and 4-day peak savings and differentiated between customer class and distribution method.

Table 2-8 presents a summary of the ranked conservation measures that were selected for further consideration. Measures not selected included measures that cost more than $1 million per mgd and measures that had legal constraints. If there were two or more top-ranked measures remaining that targeted the same customer class and same category of water savings (for example, toilet dams and toilet rebates), the lowest levelized cost measure was generally selected. Typically, those measures determined to be the most cost-effective during the 4-day peak season were chosen for Program 1 because it was more desirable to reduce peak-season use rather than year-round use. The remaining measures were then grouped into similar or complementary categories to form Program 2.

Program costs were developed for joint programs from the measures previously ranked. Table 2-8 presents the two programs with associated 4-day peak savings.

Qualitative Screening

To further develop the potential conservation measures and to ensure that the conservation program was cost-effective, directly reflective of the utility's customer base, and practical to implement based on the utility's resources, Tacoma Water authorized that a Conservation Assessment be conducted (CH2M Hill 1997). This assessment included a second screening based on qualitative measures for the resultant conservation measures in Table 2-8, as well as four additional measures: 1) Rebate for

Table 2-8. Selected conservation programs.

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landscape technology; 2) Multi-family irrigation audits; 3) Mobile Test and Demonstration Unit (MDTU) Program, and 4) Batelle Partnership Program.

Each of the conservation measures was screened using 15 qualitative criteria, ranging from customer acceptance and impacts to ease of implementation and potential for cooperative effort. From the qualitative screening exercise, the following 13 measures emerged:

- commercial/industrial indoor water audit;
- MDTU program;
- public building outdoor water use evaluation;
- public schools outdoor water use evaluation;
- multi-family irrigation audits;
- public parks outdoor water use evaluation;
- rebates for landscape technology;
- public agency rebate for landscape technology;
- commercial/industrial ultra-low flush toilet rebate;
- public schools ultra-low flush toilet rebate;
- SF/MF ultra-low flush toilet rebate;
- commercial/industrial low-flow showerheads; and
- public building indoor water audits.

Each of the above measures was then more clearly defined, with supporting data validated to ensure that the estimated measure savings and implementation costs were based on Tacoma Water's actual customer base. Another economic screening was then conducted to assess which of the measures were cost-effective for Tacoma Water to implement when measured against the next new available water supply (Draft Integrated Resource Plan 1997).

Economic Evaluation

Twelve of the 13 measures were included in the economic evaluation. For each measure, the cost per ccf saved, payback period, and benefit-to-cost ratio was determined. The total measure costs were calculated over the implementation timeframe of the individual measure, and the total savings were derived with the benefits calculated over the life of the measure. For each measure, the value or benefit of the water savings was based on the levelized cost of the next new resource option. For indoor conservation measures, variable sewer costs were included in the benefit analysis.

Of the 12 measures evaluated, six measures were considered to be cost-effective with a benefit-to-cost ratio equal to or greater than 1.0 (Table 2-9). Program details for these measures are included in the Water Conservation Program Assessment (CH2M Hill 1997).

These six measures were packaged according to similarities in the measure components to form the new conservation program:

- Indoor Water Audit Program
  - Commercial/industrial indoor water audits
  - Public buildings indoor water audits

- Landscape Rebate Program
  - Rebate for landscape technologies
  - Public agencies rebate for landscape technologies

- Toilet Rebate Program
  - Commercial/industrial ultra-low flush toilet rebate

- Low-Flow Showerheads
  - Commercial/industrial low-flow showerheads

The Implementation Strategies were developed in the Water Conservation Program Assessment (CH2M Hill 1997). This report identifies timelines, budgets, and key issues and recommended monitoring for the above-mentioned programs.

Table 2-9. Economic evaluation of conservation measures.

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The 1999 Water Conservation Program has implemented the following two new programs:

- *Industrial Water Use Audits.* Water use audits will be conducted for five to 10 of Tacoma Water's largest (water use) industrial customers. The program will include preliminary audits at industrial facilities to verify the potential for water conservation savings. Where further study is merited, in-depth technical audits will be performed with input from the customers. Audits will prioritize conservation options and financial approaches that may make them economically attractive to implement.

- *Central Irrigation*. Two public agencies have been selected to participate in a 3-year pilot study of new wireless central irrigation technology: Tacoma Public Utilities Grounds Maintenance or Metropolitan Park District of Tacoma. While centralized irrigation technology has been available for nearly two decades, the system to be piloted requires an estimated one-tenth of the capitol costs for installation because it adapts to existing irrigation equipment, and because it does not require direct connection to the irrigation system being managed. Other systems tend to require the upgrade of existing equipment and the purchase of features that are considered beneficial, but not always cost-effective, toward the conservation of water and labor resources. Complementary to this effort are turf audits of sites where the technology will be employed.

2.2.1.2 Reuse of Water

Water reuse is an option that is increasingly being evaluated as a water supply alternative to replace or augment water supplies in specific applications. With three wastewater treatment plants located in the Tacoma Water service area, water reuse is viewed as an option that merits consideration. Potential conservation, recovery, and reuse are components of each of the three water withdrawal alternatives analyzed.

A water reuse feasibility study conducted in 1994 considered two categories of uses for reclaimed water: 1) landscape irrigation, and 2) industrial processes (CH2M Hill 1994). Potential irrigation sites (e.g., parks,

schools, and golf courses) were identified in the vicinity of each wastewater treatment plant. Ten industries were identified as potential candidates for reclaimed water use. The conclusion of the reuse feasibility study was that options to use reclaimed water for industrial processes appeared to be more attractive than options to use reclaimed water for landscape irrigation, primarily because of the cost of facilities attributed to distribution and part-time water usage. Further study was recommended to define the feasibility of industrial reuse in the Tacoma area.

In 1997, two industrial conservation and water reuse assessments further studied the potential for reducing water consumption at two identified pulp and paper mills, the Abitibi Consolidated West Tacoma Mill and the Tacoma Kraft Mill (CH2M Hill 1997). After conducting a water balance and evaluating water quality requirements, conservation measures and water reuse opportunities were identified. Results of the study indicated than an estimated 1.4 mgd of water savings were available through conservation and 5.2 mgd through water recovery and reuse at the Abitibi Consolidated West Tacoma Mill near Pierce County's Treatment Plant. However, conservation, recovery, and reuse are not considered feasible by the mill at this time in comparison to existing water supply costs.

At the Simpson Tacoma Kraft Mill near Tacoma's Treatment Plant, up to 8 mgd of water conservation savings were identified and 12 mgd of water savings through water recovery and reuse. Owners of the mill are planning to implement changes that would save some of the 8 mgd of conservation identified, but the 12 mgd of water savings identified from recovery and reuse is not cost-effective for the mill at this time. Tacoma Water plans to conduct a detailed engineering evaluation of the cost-effective conservation and water recovery measures. This will better define and quantify the volume of water savings, facilities, and costs necessary to achieve those water savings.

2.2.1.3 Other Sources of Surface Water

In addition to the Green River water supply, Tacoma Water evaluated 15 candidate surface water projects in western Washington as part of an integrated resource strategy study (CH2M Hill 1997). Each of the candidate projects was evaluated for yield, potential development costs, and regulatory feasibility. All but two of the evaluated sources of surface water were eliminated from future considerations either because no water rights were currently in place to utilize the water source, and/or because an agency other than Tacoma Water is the lead for determining the feasibility of the water source.

The two available sources of surface water considered to be feasible were the storage of additional water from the Green River at Howard Hanson Dam (i.e., Additional Water Storage Project), and withdrawal of additional water at the Tacoma Headworks (i.e., Second Supply Project) through use of Tacoma Water's Second Diversion Water Right. These sources are included as a part of the Proposed Action.

2.2.1.4 Groundwater Sources

In addition to its Green River groundwater and surface water supply, Tacoma Water currently has 20 operational wells in a number of aquifers within the Tacoma Water service area with a current peak groundwater supply of about 60+ million gallons per day (mgd). A 1997 Resource Availability Report (CH2M Hill 1997) reviewed six aquifers and two possible artificial recharge areas that could potentially yield additional groundwater supplies to augment Tacoma's water supply. After an initial screening, four of the groundwater sources were carried forward for further evaluation. Of those, three are described in Tacoma Water's Comprehensive Water Plan Update (CH2M Hill 1999). Tacoma Water owns two of these three groundwater sources (i.e., 15 wells), which are described below, and are part of each of the three water withdrawal alternatives considered.

<u>Tideflats Area</u>

Tacoma Water currently has two wells in the Tideflats Area. Tideflats Well No. 1 was installed in 1927 and produces approximately 1 mgd. A second well has been developed with a capacity of 1.8 mgd, but has not been tied into the water system. Based on a 1995 study, it is estimated that the aquifer below the Tideflats Area is capable of producing an additional 5 mgd (a total of 6 mgd). Facilities to procure the additional water would include two wells and transmission piping to convey the water to Tacoma Water's distribution system in the Tideflats industrial area. The total capital cost, including design and construction, of the groundwater development plan for the Tideflats Area is estimated at $2.8 million based on a feasibility level cost in 1995 dollars. The cost estimate includes the following:

- two wells at 2.5 mgd each;
- approximately 2,000 feet of 18-inch-diameter transmission pipeline; and

- pumping facilities.

This cost does not include the cost for additional treatment that could be required for aeration to remove volatile organic compounds or for removal of iron and manganese. The need for such facilities would depend on groundwater quality.

<u>South Tacoma Aquifer Additional Wells</u>

The South Tacoma Aquifer currently contains 13 production wells, with a combined pumping capacity of about 45 mgd. The aquifer system was the subject of further study in 1995 (AGI Technologies 1998). The study involved three elements: 1) an artificial recharge pilot, 2) a sea-level aquifer pump test, and 3) static water level measurements. Results indicated that more natural recharge to the aquifer system is occurring than had been estimated. Tacoma Water believes the aquifer could sustain an additional withdrawal of 29 mgd in the summer months. The total capital cost, including design and construction, of the groundwater development project in the South Tacoma aquifer is estimated at $6.4 million in 1996 dollars based on information developed by Tacoma Water. The cost estimate includes the following elements:

- nine wells at 2 mgd each;
- approximately 9,100 feet of 12- to 18-inch-diameter pipeline; and
- pumping facilities.

It is possible that additional capital costs for groundwater treatment facilities might be necessary when artificial recharge proceeds. However, the pilot study indicated that further treatment will probably not be needed.

2.2.1.5 Elimination of Water Withdrawal Facilities on the Green River

Ceasing water supply operations altogether on the Green River is not practicable according to Tacoma Water because the water currently supplied by the Green River Project is irreplaceable. No other sources within Pierce County or south King County (including the Green River Watershed) exist that are capable of supplying the quantity of water available from the Green River.

Up to 72 mgd (113 cfs) of water (i.e., Tacoma Water's First Diversion Water Right claim) are currently withdrawn from the Green River at the Tacoma Headworks diversion and/or pumped from the North Fork Wellfield and delivered via pipeline to the Green River treatment facility about 0.5 mile downstream of the Tacoma Headworks. The current groundwater supply is about 60+ mgd, with a potential additional supply of approximately 29 mgd, as described above. However, Tacoma Water concludes that groundwater supply is not comparable to the amount of water available from surface supply (i.e., Green River supply) because groundwater is limited. Consequently, groundwater sources are important to augment the surface water supply, but are not otherwise reliable sources to serve Tacoma's current and future water users. Loss of the Green River Project would result in significant reduction in the ability of Tacoma Water to supply municipal water, which would jeopardize the health and safety of Tacoma Water's approximately 83,000 service customers (approximately 300,000 people) in Tacoma, Pierce, and South King Counties.

2.2.1.6 Limitation of Tacoma Water's Service Area

Limiting Tacoma Water's service area was not considered to be a practicable water supply option because no adequate water supply replacements exist for the areas currently being served by the Utility. This option is not analyzed in detail, but is described briefly in subsection 2.3, Water Withdrawal Options Raised During Scoping but not Analyzed in Detail as an Alternative.

Summary

With the exception of a new diversion, the options described above are technically, economically, or environmentally infeasible to serve as an independent source for water supply, and are therefore not included in the Proposed Action or the two alternatives. The following describes those options that could be further analyzed as reasonable water withdrawal alternatives.

2.2.1.7 Constructing an Additional Diversion Downstream of the Existing Tacoma Headworks (i.e., New Diversion) on the Green River

Because Tacoma Water is unable to identify alternative water supplies to meet its current and future supply demands, constructing an additional diversion in the lower Green River to serve as the primary withdrawal facility and relegating the existing Tacoma Headworks to a supplementary water withdrawal function were considered reasonable for further detailed analysis in terms of meeting both water supply and species take avoidance objectives. This alternative is described in subsection 2.2.4, Alternative C.

2.2.2 Water Withdrawal Alternative A: No Action

> **Summary Description:** The Services would not issue incidental take coverage for Tacoma Water's withdrawal of water from the Green River, and would not require Tacoma Water to develop or implement an HCP. Operations of the Green River Water Withdrawal Project would be required to be in compliance with the take prohibitions under Section 9 of the federal ESA, as well as all applicable local, state, and federal laws and regulations.

Under Water Withdrawal Alternative A, Tacoma Water would not receive incidental take coverage for the effects of water withdrawal on covered species of fish and wildlife in the Green River. Tacoma Water would attempt to avoid/reduce take of federally listed fish species while continuing to meet current and future water supply demands within its service area. However, continued withdrawal of water from the Green River would have an effect on instream resources, which to date has not been linked to quantifiable levels of take. Since 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, continued withdrawal by Tacoma Water could result in undetermined federal restrictions on water supply operations.

To eliminate take-related water supply uncertainties, Tacoma Water considered the alternative water sources described above (subsection 2.2.1, Background and Identification of Water Withdrawal

Alternatives) as well as operation under an ITP (subsection 2.2.3, Alternative B, Proposed Action) and construction of a new diversion (subsection 2.2.4, Alternative C, New Diversion). If current operations (i.e., No Action Alternative) result in take, and if an ITP is not issued as an alternative to current operations, take avoidance/reduction measures could include adjustments to current water withdrawal operations to provide adequate habitat for listed fish species (e.g., seasonal flow management). However, this option would not provide certainty that: 1) take is avoided or reduced, or 2) current and future water supply demands could be met.

2.2.2.1 Water Supply Features and Operations Under Water Withdrawal Alternative A

Tacoma Water's system currently relies on the conjunctive use of surface and groundwater supplies, with the Green River being the primary water source. The main components of the system (collectively termed the "Green River Project") are the Green River Watershed, Howard Hanson Dam and Reservoir (which is operated by the USACE), the Tacoma Headworks diversion, the North Fork Wellfield in the Upper Green River Watershed, the Green River treatment facility, the First Diversion Pipeline, and McMillin Reservoir (Figure 2-1). The existing structure and operation of the Green River Project are described in detail in subsections 4.2 and 4.3, respectively, of Tacoma Water's proposed HCP.

As stated above, up to 72 mgd (113 cfs) of water (i.e., Tacoma Water's First Diversion Water Right claim) are currently withdrawn from the Green River at the Tacoma Headworks diversion and/or pumped from the North Fork Wellfield and delivered via pipeline to the Green River treatment facility about 0.5 mile downstream of the Tacoma Headworks. Water is chlorinated and fluoridated at the treatment facility as it moves through the First Diversion pipeline by force of gravity to McMillin Reservoir, located in the South Hill area of the City of Puyallup. From the reservoir, water is distributed to various parts of Tacoma Water's service area for customer use. Some of the water is delivered to customers upstream of McMillin Reservoir, notably those in the incorporated town of Cumberland in South King County, in the City of Enumclaw during the summer, and in the Tacoma Water service area between McMillin Reservoir and the City of Buckley (Figure 2-2).

The North Fork Wellfield was developed in the early 1970s to provide a source of clean water during periods when turbidity in the surface water supply exceeds 5 Nephelometric Turbidity Units (NTU). The system allows groundwater, pumped from the North Fork's seven wells, to be blended with Green River surface water. Because North Fork Wellfield groundwater represents an exercise of the First Diversion Water Right claim, it does not provide an additional net yield of water to the Green River Project. Withdrawal of water from this wellfield reduces the amount of surface water that can be withdrawn.

2.2.2.2 Fish and Wildlife Mitigation Measures Under Water Withdrawal Alternative A

There would be no fish and wildlife mitigation measures under Water Withdrawal Alternative A. Tacoma Water would not be able to fund the improvements that are a part of the Second Supply Project, Additional Water Storage Project, and Muckleshoot Indian Tribe/Tacoma Public Utilities (MIT/TPU) Agreement. This would include Tacoma Headworks fish screen and bypass modifications, habitat rehabilitations, and upstream and downstream fish passage facilities proposed under those projects (Table 2-10). Without Tacoma's involvement in the Additional Water Storage project, the opportunity would likely be lost to provide anadromous fish access to and egress to and from the upper watershed area, and to implement the other proposed fish and wildlife habitat improvements developed over approximately a 10-year period in cooperation with the USACE, Muckleshoot Indian Tribe, NMFS, USFWS, Washington Department of Fish and Wildlife (WDFW) and Washington Department of Ecology (Ecology).

2.2.3 Water Withdrawal Alternative B: Proposed Action

Summary Description: The Services would issue an ITP for the incidental take of 32 species of fish and wildlife in conjunction with the continued operation of the Green River Project (see subsection 2.1, Introduction). Covered activities would include the exercise of Tacoma's First Diversion Water Right claim, Second Diversion Water Right, and the storage of portions of Tacoma's Second Diversion Water Right behind Howard Hanson Dam under the Additional Water Storage Project. The Services would require the implementation of Tacoma Water's Proposed HCP. The ITP and the HCP would run concurrent for 50 years.

The Proposed Action alternative (Water Withdrawal Alternative B) is described in detail in Tacoma Water's HCP, which is hereby incorporated in its entirety by reference. Under Water Withdrawal Alternative B, the Services would issue an ITP for 32 species, including ~~seven~~ eight that are presently listed under the ESA as threatened or endangered (Table 2-1). Tacoma Water would implement an HCP designed to minimize and mitigate the effects of any anticipated incidental take of the 32 covered species. Tacoma Water would receive incidental take coverage for the ~~seven~~ eight listed species immediately upon issuance of the ITP. For the 24 unlisted species, the ITP would have a delayed effective date and would only become effective upon a future listing. Although an ITP would be issued to Tacoma Water under Water Withdrawal Alternative B, several of the covered activities would not occur until incidental take coverage is also issued to the USACE under Section 7 of the ESA. These covered activities (which are described in Section 2.6 of the HCP) would require simultaneous and/or cooperative actions by the USACE, and they could not occur until the USACE is in full compliance with the ESA. Tacoma Water's ITP would not cover any incidental take of listed species that might occur as a result of USACE actions.

2.2.3.1 Water Supply Features and Operations Under Water Withdrawal Alternative B

As summarized under Water Withdrawal Alternative A and described in detail in subsections 4.2 and 4.3 of Tacoma Water's proposed HCP, the utility's water supply system relies on the conjunctive use of surface and groundwater supplies, with the Green River being the primary water source. Under Water Withdrawal Alternative B, Tacoma Water would continue to withdraw its First Diversion Water Right claim; and operate the Tacoma Headworks diversion, the North Fork Wellfield, the Green River treatment facility, the First Diversion pipeline, and McMillin Reservoir as described under Water Withdrawal Alternative A (Table 2-10). In addition, under Water Withdrawal Alternative B, Tacoma Water would implement: 1) the Second Diversion Water Right and Second Supply Project, and 2) mitigation measures previously developed for the Additional Water Storage Project that would occur throughout the entire Action Area (i.e., these measures would not be restricted to the middle and lower watersheds) (Table 2-10). Although the ITP would not cover the Additional Water Storage Project, Tacoma Water would contribute funding to mitigation and restoration developed for the additional water storage.

Table 2-10. Summary of operational features, components, and water demand compliances under the water withdrawal alternatives.

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Second Diversion Water Right and Second Supply Project

Tacoma Water's first and only developed Green River water right claim consists of a senior water right claim of 72 mgd (113 cfs) established in 1911. In 1933, Tacoma Water filed a request with the State of Washington for the right to divert an additional 100 cfs (65 mgd) of water from the Green River. Since the water was not immediately needed, the state held the request ~~in abeyance indefinitely. In~~ until 1979, when Tacoma Water requested that Ecology reconsider the original 1933 filing for a Second Diversion Water Right. The water right was issued, subject to instream flow restrictions, in June 1986.

The Second Diversion Water Right would be exercised through implementation of the Second Supply Project (Table 2-10). The Second Supply Project would consist of improvements to the Tacoma Headworks diversion on the Green River, and construction of a new 33.5-mile-long pipeline from the Tacoma Headworks through South King County to northeast Tacoma, and then to Tacoma's Portland Avenue Reservoir. The proposed improvements at the Tacoma Headworks diversion would include:

- raising the existing Tacoma Headworks diversion by approximately 6.5 feet;
- realigning and enlarging the existing intake and adding fish screens and bypass facilities for downstream fish passage;
- reshaping the Green River channel downstream of the existing diversion dam to accommodate the installation of a fish ladder, trap, and future holding facilities for upstream fish passage; and
- replacing approximately 700 feet of existing concrete pipe with a larger steel pipe.

The purpose of the Second Supply Project would be to supply water to meet Tacoma's long-term water needs and to provide water to communities in King County that currently need additional water supplies. The improvements listed above would require local and state regulatory compliance in addition to incidental take coverage from the Services as described below:

King County

- T Shoreline Substantial Development Permit
- T Public Agency Utility Exceptions
- T Grading Permit

Washington State

- # Department of Ecology
  - T Water Quality Certification
  - T Temporary Modification of Water Quality Criteria
  - T NPDES Stormwater Permit
- # Department of Fish & Wildlife
  - T Hydraulic Project Approvals
- # Department of Natural Resources
  - T Aquatic Easement
- # U.S. Army Corps of Engineers
  - T Section 404 Clean Water Act

Additional Water Storage Project

The Howard Hanson Dam is maintained and operated by the USACE at RM 64.5 on the Green River to provide flood protection for the lower valley and to augment low flows during the summer for fish (HCP subsection 2.3, Overview of the Green River Basin and Tacoma's Water Supply Operations). Since the demand for flood control occurs primarily during the winter, additional water storage capacity is available behind the dam during the summer. Tacoma Water has requested the USACE to store up to 20,000 acre-feet of the Second Supply Water Right behind Howard Hanson Dam during the spring. The USACE

would then release the water for municipal and industrial water supply during the summer. An additional 5,000 acre-feet of water would be stored at the discretion of federal, state, and tribal fisheries resource agencies for fisheries purposes, in addition to the 24,200 acre-feet currently used to augment summer flows to benefit instream resources downstream of the Howard Hanson Dam (Table 2-10). *It should be noted, however, that the USACE maintains responsibility for water storage impacts associated with the Additional Water Storage Project. These impacts are addressed in the Howard Hanson Additional Water Storage Project Draft Project Feasibility Study Report and Environmental Impact Statement (U.S. Army Corps of Engineers 1998).*

The preconstruction engineering and design phase of the Additional Water Storage Project is currently underway, with costs being shared by the USACE and Tacoma Water (as the project's local sponsor). Implementation of the project would consist of construction of a downstream fish passage facility at Howard Hanson Dam that would enable juvenile salmonids and kelt steelhead (adult steelhead that have spawned and are returning to salt water) to exit the reservoir during periods of water storage. Also included would be river and upland habitat improvements to benefit fish and wildlife. The timing and rate of storage would be adaptively managed, while the delivery of water for municipal use would be determined by Tacoma Water.

2.2.3.2 Fish and Wildlife Mitigation Measures Under Water Withdrawal Alternative B

Tacoma Water would implement several measures to benefit fish and wildlife in the Green River as part of the Proposed Action. Those measures directed toward fish and other aquatic species affected by the Additional Water Storage Project and downstream of Howard Hanson Dam include: 1) measures to mitigate the impacts of Tacoma Water's operations on the Green River, and 2) measures to mitigate adverse conditions on the Green River unrelated to Tacoma Water's activities (HCP subsection 4.5, Factors Contributing to, or Reversing, the Decline of Fish Populations and Habitat), to the benefit of covered species (Table 2-11). These Habitat Conservation Measures are described in detail in subsections 5.1 and 5.2 of the proposed HCP (Habitat Conservation Measures–Type 1 and Type 2, respectively).

2.2.4 Water Withdrawal Alternative C: New Diversion

Summary Description: The Services would issue an ITP associated with the construction and operation of a new water diversion at approximately RM 29.2 on the Green River. The ITP would also cover the continued operation of the existing diversion with reduced withdrawals to serve communities in east King and Pierce Counties and to support upstream fish passage facilities. The Services would require the implementation of an HCP to mitigate the effects of the operation of both diversions. The ITP and the HCP would run concurrent for 50 years.

Under Water Withdrawal Alternative C, the Services would issue an ITP for all 32 species that would be covered under Water Withdrawal Alternative B, including the ~~seven~~ eight that are presently listed under the ESA as threatened or endangered (Table 2-1) (see subsection 2.1, Introduction). Tacoma Water would construct a new diversion structure at approximately RM 29.2 (31.8 river miles downstream of the existing Tacoma Headworks diversion) to reduce the length of river that would experience decreased flows.

The existing diversion would be retained to withdraw water for the surrounding communities and to operate a proposed upstream fish passage facility, but the withdrawals of water from the existing diversion would be substantially reduced compared to operations under Alternatives A and B

The Services would require implementation of an HCP to minimize and mitigate the effects of any anticipated incidental take of the 32 covered species under Alternative C. Tacoma Water would receive incidental take coverage for the ~~seven~~ eight listed species immediately upon issuance of the ITP. For the 24 unlisted species, the ITP would have a delayed effective date and would only become effective upon a future listing.

Table 2-11. Proposed Tacoma Water Habitat Conservation Measures.

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Table 2-11. Continued.

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2.2.4.1 Water Supply Features and Operations Under Water Withdrawal Alternative C

The physical features that would be operated under Alternative C would be the same as those under Alternative B (Proposed Action), with the exception that under Water Withdrawal Alternative C a new diversion structure would be constructed on the Green River at approximately RM 29.2, in the vicinity of the Auburn Regional Golf Course. While this alternative site has not been subjected to a detailed feasibility study or engineering review, it is presented as a potential location for a new diversion because of its proximity to the proposed Second Supply Pipeline crossing of the Green River. This is the only location on the Green River below the existing diversion where water could be withdrawn and conveyed to Tacoma Water's existing system without substantial acquisition of a new right-of-way and construction of new pipelines.

This alternative would include the utilization of Tacoma Water's First and Second Diversion Water Rights and the development of the Additional Water Storage Project at Howard Hanson Dam, as well as their associated mitigation measures (Table 2-10). Although the primary withdrawal of water would occur at the new diversion, Tacoma Water's existing diversion would remain in place to support a proposed fish trap and handling facility as well as to supply water to customers upstream of McMillin Reservoir. A fish ladder would be constructed at the new diversion to allow free upstream access, and screens would be installed at the intake to prevent entrainment of juvenile fish moving downstream.

This alternative would allow all but about 15 cfs (10 mgd) of Tacoma Water's First Diversion Water Right claim and Second Diversion Water Right to remain in the river downstream from Tacoma Water's current intake at RM 61.0 until it reached the vicinity of Auburn at RM 29.2. This reach includes the habitat below Tacoma Water's current diversion, the entire Green River Gorge, and the productive spawning habitat above the State Route 18 highway bridge.

River flows in the reach between the old and new diversions would increase compared to Water Withdrawal Alternative A by as much as 198 cfs from early November through mid-February. This coincides with the high flow period when MIT/TPU Agreement minimum flows are almost always

exceeded. From mid-February through mid-June, when 100 cfs is stored in Howard Hanson Reservoir for municipal and industrial use, flows would increase by 98 cfs between the old and new diversions, compared to Water Withdrawal Alternative A. Between mid-June and November, flows would increase between 98 and 198 cfs, between the old and new diversions, compared to Water Withdrawal Alternative A; depending on requirements of the MIT/TPU Agreement. The 15 cfs of water withdrawn at the existing Tacoma Headworks diversion would be used to serve Tacoma Water's customers between the Tacoma Headworks and McMillin Reservoir.

Under Alternative C, Tacoma Water would be able to provide water service regionally as envisioned under Alternative B. Water service would be provided to the City of Kent, the City of Covington (through the Covington Water District), the City of Federal Way (through Lakehaven Utility District), and to the Seattle service area. Tacoma Water would also be able to respond to requests for service in the adjacent areas of Pierce County.

Physical Features and Costs

Physical features that could be constructed under Alternative C include:

- new diversion dam approximately 12 feet in height and approximately 200 feet long, with approximately 1 mile of upstream inundation;
- new pipeline;
- upstream fish passage facility at the new RM 29.2 diversion;
- Fish screens and downstream bypass facility at the new RM 29.2 diversion;
- mitigation for inundation of approximately 1 mile of mainstem Green River habitat;
- approximately 5 acres of temporary staging areas, and approximately 20 acres for permanent facilities;
- temporary roads to access construction locations;
- at least one permanent road to access permanent facilities;
- permanent office building;

- shop/garage for maintenance equipment;
- treatment/filtration plant;
- pump station; and
- parking lot.

Preliminarily, it is estimated that all permanent facilities would be constructed on a total of approximately 20 acres, which would be located in the vicinity of the Auburn Regional Golf Course. Consequently, considerable golf course property would need to be acquired if a new diversion were to be located at RM 29.2. Construction would require approximately 2 to 3 years to complete.

This alternative would involve additional costs of approximately $200 million to Tacoma Water and its project partners for the following reasons:

- The acquisition of 20 acres of riverfront property would cost approximately $4,540,000 to $5,400,000 (1999 values).

- Construction of the diversion structure would cost approximately $5 million (this cost does not include pumping, filtering, or other associated costs).

- New and upgraded pipelines would cost approximately $46 million. A portion of the proposed Second Supply Pipeline (from the existing Tacoma Headworks diversion to the vicinity of the new diversion) would not be necessary under this alternative. In its place, a duplicate or enlarged pipeline would be necessary from the new diversion to Tacoma to carry water that is now withdrawn at the existing diversion. This pipeline would be in addition to the currently sized pipeline for the second supply project. In addition, another smaller pipeline would also be necessary from the new diversion to the Tacoma-Seattle intertie location. Eliminating a portion of the Second Supply Pipeline would result in savings of approximately $44 million, but the replacement pipelines would cost an estimated $90 million, for a net cost increase of $46 million.

- A new water treatment plant would cost approximately $125 million. Additional treatment would be required to make the water supply from the new diversion acceptable for delivery as potable water. The new point of diversion would be more susceptible to contamination than the current diversion within a protected watershed. At a minimum, a filtration plant would have to be constructed and operated.

- A new pump station would cost approximately $14 million. Water currently withdrawn from the Green River flows by gravity to the City of Tacoma. Water withdrawn at the new diversion would have to be pumped uphill to Tacoma. This would require a pump station of approximately 22,000 horsepower, which would cost approximately $14 million, not including the costs of land acquisition or construction of the intake structure. A pump station of this capacity would also require its own electrical substation, which would have additional costs.

- Annual operation would cost approximately $6 million, including $4 million in power costs to pump diverted water to system operating pressures (based on a power cost of $.04 per kilowatt hour and a uniform power use rate). Additional costs could be incurred to guarantee standby power.

- Additional costs would be incurred annually to handle waste from the treatment facility. The approach to addressing waste handling is undefined at this time and could not be further refined without the development of a pilot treatment study at the Auburn location.

2.2.4.2 Fish and Wildlife Mitigation Measures Under Water Withdrawal Alternative C

In a manner similar to that described under Water Withdrawal Alternative B, Tacoma Water would implement several measures to benefit fish and wildlife in the Green River as part of Water Withdrawal Alternative C. To address potential resource impacts under Water Withdrawal Alternative C, it is assumed that lower and middle Green River Watershed mitigation measures would be the same as those under Water Withdrawal Alternative B (Table 2-11).

2.3 Water Withdrawal Options Raised During Scoping but not Analyzed in Detail as an Alternative

Four water withdrawal options were considered, but were not analyzed. Three of these options would have focused on reducing the volume of water withdrawn from the Green River through immediate withdrawal reductions, or through foregoing expansion of water withdrawal to meet projected, future need. The fourth of these options would have involved immediate diversion dam removal.

2.3.1 Reduced Water Withdrawal

The three reduced water withdrawal options considered, but not analyzed in detail, include the following:

- reduce current water withdrawal volume, and supply Tacoma Water's Service Area Only, Without the Howard Hanson Dam Additional Water Storage Project;

- reduce current water withdrawal volume, and supply Tacoma Water's Current Service Area and Lakehaven Utility District, Without the Howard Hanson Dam Additional Water Storage Project; and

- supply Tacoma, Seattle, and South King County Communities Without the Howard Hanson Dam Additional Water Storage Project.

These three alternatives were not fully analyzed because they would not fulfill the Purpose and Need. As stated in Section 1.0, the Purpose and Need of this action is to: 1) provide protection and conservation to listed and proposed species and their habitats, to the extent intended under 10(a)(1)(b) of the ESA, and 2) allow Tacoma Water to fulfill its water supply obligations in a practicable manner. Specifically, these alternatives would not allow Tacoma Water to completely fulfill its current, or projected future, water supply obligations.

The first two of these options would not provide enough water to supply Tacoma Water's current service area. Additional water sources would be necessary to overcome this reduced availability from the Green

River. These sources have not been identified and speculative information would need to be assumed to adequately analyze potential impacts.

The third of these options would continue providing the current volume of water throughout the 50-year life of the ITP. The current level of demand would be satisfied with this volume of water, but projected increases in service area demand would not be met. Other sources of water would be needed to fulfill these needs. As previously mentioned, these sources have not been identified.

2.3.2 Diversion Dam Removal

The following water withdrawal option was also identified during scoping, but was not analyzed in detail:

- cessation of water withdrawal operations at the Tacoma Headworks, and removal of the Headworks diversion dam.

This alternative was not fully analyzed because it would not fulfill the Services' Purpose and Need. Specifically, if Tacoma Water were to cease operations at the Tacoma Headworks diversion and remove the diversion dam, neither an ITP or HCP for water withdrawal activities would be necessary. This alternative is, therefore, outside the scope of this environmental review. Additionally, ceasing operations needed to supply approximately 83,000 customers (approximately 300,000 people) in the region when other sources of water supply cannot be identified would have a significant adverse impact on public health, safety, and commerce.

2.4 Upper Watershed Management Alternatives

2.4.1 Upper Watershed Alternative A: No Action

Summary Description: The Services would not issue incidental take coverage for the management of Tacoma Water lands in the Upper Green River Watershed, and would not require Tacoma Water to develop or implement an HCP for upper watershed management

activities. Management of City-owned lands in the upper watershed would continue in compliance with the take prohibitions under Section 9 of the federal ESA, as well as all applicable local, state, and federal laws and regulations.

The Services could choose to take no action on that portion of Tacoma Water's ITP application regarding coverage for forest management activities in the Upper Green River Watershed. *Tacoma Water would receive no incidental take coverage for watershed management activities above its Headworks diversion, although it could receive coverage for impacts to fish from: 1) operation of the water supply project, 2) operation of fish passage facilities (at the Tacoma Headworks and Howard Hanson Dam), and 3) fish and wildlife mitigation activities in the Upper Green River Watershed* associated with Water Withdrawal Alternatives B or C. As noted in subsection 2.1, Introduction, ITP coverage for activities associated with water withdrawal could occur separate from coverage for upper watershed management.

Under the upper watershed No Action Alternative, Tacoma Water would continue to manage forestlands in the Upper Green River Watershed according to its existing City of Tacoma Green River Watershed Forest Land Management Plan (Forest Land Management Plan) (Ryan 1996), and in compliance with current Forest Practices Rules. Tacoma Water would also implement existing agreements for habitat enhancement with the Muckleshoot Indian Tribe, and any approved mitigation plans for the Additional Water Storage Project and Second Supply Project, if the Services issue ITP coverage for Water Withdrawal Alternative B.

Tacoma Water would continue its participation in Watershed Analyses in the basin under Upper Watershed Alternative A, and would implement the resulting prescriptions. Additionally, prescriptions that provide greater resource protection would be implemented over comparable Forest Land Management Plan measures. The Upper Action Area is within six WAUs. Watershed Analyses have been completed and approved for one WAU (Lester WAU); another four are in the process of being completed. The final Lester Watershed Analysis and a draft version of the Upper Green/Sunday Watershed Analysis reports are available and were reviewed for preparation of this EIS. Final or draft prescriptions were available for all WAUs (but the North Fork Green River WAU), and all are currently utilized by Tacoma Water for its

forest management (see Table 3-1 for Analysis status and HCP Table 5-6 in FEIS Volume II, Section 5.0 for information on Analysis dates and components). Tacoma Water would also make a commitment to complete slope stability and road surface erosion assessments comparable to those conducted under Watershed Analysis if draft Watershed Analysis assessment reports and prescriptions are not completed for the remaining WAUs in a timely manner.

Tacoma Water's Forest Land Management Plan (Ryan 1996) would continue to have the following elements, which are detailed in the Forest Land Management Plan and in the proposed HCP.

Forest Management in Three Zones

Tacoma Water would manage according to three forest management zones based on the potential to affect surface water quality (Figure 2-5) and would apply timber harvest and forest management restrictions within these zones. These three zones are the Natural Zone, Conservation Zone, and Commercial Zone. The following measures under Upper Watershed Alternative A would exceed current Forest Practices Rules:

- The Natural Zone would include all areas adjacent to the Green River and its major tributaries, where the potential to influence water quality is the greatest. No timber harvest would occur in the Natural Zone, except to salvage dead or damaged timber or to implement specific habitat improvement projects developed cooperatively with the Services, the State of Washington, and the Muckleshoot Indian Tribe;

- The Conservation Zone would include lands upland of the Natural Zone and would be managed with emphasis on wildlife habitat enhancement;

- The Commercial Zone would be those lands most distant from major surface waters and would be managed with emphasis on commercial timber production;

- no even-aged harvesting (clearcutting) would occur in conifer-dominated stands in the Conservation Zone, and no harvesting of any kind (except salvage) would occur in conifer-dominated stands over 100 years old in the Conservation Zone (Table 2-12);

- the Commercial Zone would be managed on a 70-year even-aged rotation, allowing harvest of an average of no more than 1.5 percent of the conifer-dominated stands per year (Table 2-12);

- no harvesting or salvage of timber would occur on sites of low productivity (i.e., Douglas-fir Site Index of less than 80);

- no salvage harvesting would occur in riparian zones, or in more than 120 contiguous upland acres outside of riparian zones;

- even-aged harvest units would be limited to 40 acres in size;

- uneven-aged harvest units (e.g., thinning) would be limited to 120 contiguous acres;

- at least six safe snags, at least four green recruitment trees, and at least four down logs would be retained per acre in areas that are salvage harvested; and

- no burning of logging slash would occur in the Natural Zone, and no broadcast burning would occur in the Conservation Zone.

Riparian Buffers

Tacoma Water would designate riparian buffers along all streams and around all lakes and wetlands on its lands in the Conservation and Commercial Zones of the Upper Green River Watershed as described in its Forest Land Management Plan (Ryan 1996). The entire Natural Zone would be managed as a no-harvest riparian buffer. Therefore, additional buffer designations would not be necessary. Management activities would be subject to the riparian buffer restrictions in Tables 2-13a and 2-13b.

Figure 2-5. Management zones.

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Table 2-12. Estimated annual harvest acreages that would occur under each alternative.

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Road Construction and Maintenance

Tacoma Water would implement measures to minimize water quality and fisheries impacts of road construction, maintenance, and use, including the following measures that exceed current Forest Practices Rules:

- there would be no net increase in the miles of roads in the Natural Zone;

- new roads would be constructed in accordance with prescriptions developed for unstable landforms identified during ~~across unstable soils identified through~~ Watershed Analysis;

- full bench construction with no side-casting would be used when constructing roads on side slopes of greater than 60 percent;

- mulching and/or grass seeding would be used on road cuts and fills with slopes over 40 percent, at water crossings, and in other areas of severe erosion;

- Tacoma Water would develop site-specific measures to minimize impacts to resident and anadromous fish at stream crossings. If necessary to build a road through a stream buffer, Tacoma Water would minimize the right-of-way clearing, cross streams at right angles, minimize disturbance to natural stream flows, and minimize side-casting during construction;

- roads controlled by Tacoma Water would be closed to public traffic at all times and closed to heavy truck traffic (e.g., log hauling) when a potential exists for extraordinary damage to the road(s) and/or impact to water quality;

- low-growing vegetation would be maintained along all roads; and

- roads no longer needed for watershed management or forestry operations would be abandoned.

Table 2-13a. Stream buffer widths for the Tacoma Green River HCP Area.

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Table 2-13b. Wetland buffer widths for the Tacoma Green River HCP Area.

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Species-specific Protection

Tacoma Water would avoid the incidental take of federally listed species in the Upper Green River Watershed (the spotted owl and marbled murrelet are the only listed species currently known to be present on or adjacent to Tacoma Water lands). Beyond the avoidance of incidental take, Tacoma Water would implement no special measures to maintain or improve habitat for listed species.

2.4.2 Upper Watershed Alternative B: Proposed Action

> **Summary Description:** The Services would issue an ITP for 32 species of fish and wildlife in conjunction with the continued management of Tacoma Water lands in the Upper Green River Watershed, and would require Tacoma Water to develop and implement an HCP.

Tacoma Water has requested incidental take coverage for the effects of continued watershed management on 11 species of fish and 21 species of wildlife. Consistent with Section 10(a) of the ESA, Tacoma Water would implement an HCP in the watershed to minimize and mitigate the effects of watershed management on the 32 species. The HCP would consist of a modified version of Tacoma Water's Forest Land Management Plan (Ryan 1996) and a set of species-specific habitat management measures. All management activities within the watershed would be conducted in compliance with the modified plan and the species-specific measures, as well as all pertinent local, state, and federal laws.

Upper watershed management and measures are described in detail in Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, of the proposed HCP. Tacoma Water's modified Forest Land Management Plan (Ryan 1996) would have the following elements, some of which would exceed current Forest Practices Rules.

Forest Management in Three Zones

Tacoma Water would continue to manage its timberlands according to three forest management zones (Natural, Conservation, and Commercial) under Water Withdrawal Alternative B. Tacoma would harvest

an estimated 51 acres of conifer forest and 29 acres of hardwood forest annually in the Commercial and Conservation Zones (Table 2-12). No harvest would occur in the Natural Zone, except for the removal of unsafe snags (standing dead trees) along roads. Conifer harvest in the Commercial Zone would occur by clearcutting an average of no more than 1.5 percent of the forest in the zone each year, and would continue for the term of the ITP. Conifer harvest in the Conservation Zone would involve the selective thinning of stands less than 100 years old to accelerate the development of late-seral forest characteristics. Eventually, all conifer stands in the Conservation Zone would exceed 100 years old, and all conifer timber harvest would cease.

Hardwood harvest in the Commercial and Conservation Zones would be by clearcutting, and it would be done to convert hardwood-dominated sites to coniferous trees. Once all hardwood stands capable of supporting conifers were converted to conifer, harvest of hardwoods would cease. Hardwood-dominated stands not capable of supporting conifers would be allowed to remain in hardwood for the full term of the ITP as Upland Management Areas (UMA). Tacoma Water would apply timber harvest and forest management restrictions within the Natural, Conservation, and Commercial Zones as outlined in Table 2-14.

Tacoma Water would continue its participation in Watershed Analyses in the basin under Upper Watershed Alternative B, and would implement the resulting prescriptions as under Upper Watershed Alternative A. The Upper Action Area is within six WAUs. Watershed Analyses have been completed for one WAU (Lester WAU), another four are in the process of being completed. In addition, Tacoma Water would make a commitment to complete Watershed Analysis-type assessments of mass wasting and surface erosion on the remaining lands within the Action Area in the unlikely event that draft Watershed Analysis Prescriptions and Assessment Reports are not available for all WAUs in the upper watershed within 2 years of ITP issuance.

Riparian Buffers

Tacoma Water would designate riparian buffers along all streams and around all lakes and wetlands in the Action Area. Some of these buffers would exceed those under Upper Watershed Alternative A (Tables 2-13a and 2-13b). Management activities would be restricted in riparian buffers as detailed in Chapter 5 of the proposed HCP and as summarized in Table 2-15.

Table 2-14. Tacoma Water Upper Green River Watershed Habitat Conservation Measures for forest management.

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Table 2-14. Tacoma Water Upper Green River Watershed Habitat Conservation Measures for forest management (continued).

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Road Construction and Maintenance

Tacoma Water would implement measures to minimize impacts to water quality and fisheries through road construction, maintenance, and use as detailed in Chapter 5 of the proposed HCP and as summarized in Table 2-16. These measures are comparable to management that would occur under Alternative A, with the exception that Tacoma Water's commitment to complete all slope stability analyses within 2 years of ITP issuance (Measure Habitat Conservation Measure 3-03C) would not occur under Alternative A. Habitat Conservation Measure ~~303-B~~ 3-03B and ~~303-J~~ 3-03J and portions of measures ~~303-C~~ 3-03C and ~~303-F~~ 3-03F provide additional protection compared to Water Withdrawal Alternative A.

Species-specific Protection

Tacoma Water would implement species-specific protection measures to avoid or minimize short-and long-term disturbance of specific covered species. For listed species, these measures would replace take avoidance measures under Upper Watershed Alternative A. For unlisted species, measures under Alternative B would exceed those under Upper Watershed Alternative A. The Habitat Conservation Measures are described in detail in Chapter 5 of the proposed HCP and are detailed in Table 2-17.

2.4.3 Upper Watershed Alternative C: No Commercial Timber Harvest

> **Summary Description:** The Services would issue an ITP for 21 Wildlife Species and 11 Fish Species, and Require Implementation of an HCP that Eliminates all Commercial Timber Harvest on Tacoma Water's Lands in the Upper Green River Watershed.

Under this alternative, Tacoma Water would receive ITP coverage for all 21 wildlife species and 11 fish species identified in the proposed HCP (Table 2-1). As mitigation for the ITP, Tacoma Water would discontinue all commercial timber harvest on covered lands in the Upper Green River Watershed. Management that would occur under this alternative is described below.

Table 2-15. Tacoma Water Upper Green River Watershed Habitat Conservation Measures for riparian management.

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Table 2-16. Tacoma Water Upper Green River Watershed Habitat Conservation measures for road construction and maintenance.

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Table 2-16. Tacoma Water Upper Green River Watershed Habitat Conservation measures for road construction and maintenance (continued).

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Table 2-17. Tacoma Water Upper Green River Watershed Habitat Conservation measures for species-specific management.

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Table 2-17. Tacoma Water Upper Green River Watershed Habitat Conservation measures for species-specific management (continued).

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Table 2-17. Tacoma Water Upper Green River Watershed Habitat Conservation measures for species-specific management (continued).

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Table 2-17. Tacoma Water Upper Green River Watershed Habitat Conservation measures for species-specific management (continued).

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Forest Management in Three Zones

Tacoma Water would not designate forest management zones, as Tacoma Water's entire ownership in the upper watershed would be managed uniformly without commercial timber harvest (Table 2-12). Salvage harvesting would be conducted under this alternative only to maintain safety along roads in the watershed.

Tacoma Water would continue its participation in Watershed Analyses in the basin under Upper Watershed Alternative C, and would implement the resulting prescriptions. Additionally, prescriptions that provide greater resource protection would be implemented over comparable Forest Land Management Plan measures. The Upper Action Area is within six WAUs. Watershed Analyses have been completed for one WAU (Lester WAU), another four are in the process of being completed.

Riparian Buffers

Tacoma Water would not need to designate riparian buffers along streams or around all lakes and wetlands in the Action Area because commercial timber harvesting would be restricted on all Action Area lands (Tables 2-13a and 2-13b).

Road Construction and Maintenance

Tacoma Water would need to continue patrolling the watershed to protect water quality, and all roads necessary to provide access for patrol would be maintained. As one of several landowners in the Upper Green River Watershed, Tacoma Water would also continue to comply with existing road agreements that allow adjacent landowners access across Tacoma-owned lands. Tacoma Water would maintain (or arrange for other landowners to maintain) all roads necessary to provide access. Several road construction, maintenance, and use measures would be implemented comparable to those in the proposed HCP as outlined in Table 2-16.

Species-specific Protection

In addition to mitigation afforded to all covered species, Tacoma Water would also implement species-specific protection measures similar to those proposed under Alternative B as summarized in Table 2-17.

2.5 Upper Watershed Options Raised During Scoping but not Analyzed in Detail as an Alternative

2.5.1 Issue an ITP for 21 Wildlife Species and 11 Fish Species, and Require Implementation of an HCP that Provides Greater Habitat Benefits on Tacoma's Lands in the Green River Watershed than the Proposed Action

This alternative was considered, but not analyzed in detail because it was determined that an alternative that would provide greater habitat benefits than the HCP (i.e., Proposed Action) would require timber-harvest activities in the Natural Zone. These types of activities in the Natural Zone would temporarily impact water quality and fish habitat due to reduced canopy closure and the resulting water temperature effects, sediment runoff, and stream channel disturbance.

Improving habitat for wildlife under Upper Watershed Alternative B would be accomplished through: 1) conversion of hardwood stands in the Conservation Zone (subsection 2.4.2, Upper Watershed Alternative B) (through clearcutting and replanting) to mixed hardwood/coniferous stands or coniferous stands, and 2) uneven-aged harvesting in second-growth coniferous stands to accelerate the development of a late-seral forest with a healthy understory. To improve habitat conditions for fish and wildlife species beyond those that would occur under Upper Watershed Alternative B, this strategy would need to be extended to the Natural Zone. Such activities would cause temporary, adverse water quality impacts because much of the Natural Zone borders the reservoir and streams leading into the reservoir. Such impacts would be contrary to Tacoma Water's policy of no-harvest in the Natural Zone, a policy intended to protect the quality of water in its water supply and would, therefore, not fulfill the Services' Purpose and Need.

As stated in Section 1.0, the Purpose and Need is to: 1) provide protection and conservation to listed and proposed species and their habitats to the extent intended under 10(a)(1)(b) of the ESA, and 2) allow Tacoma Water to fulfill its water supply obligations in a practicable manner. Specifically, this alternative would not allow Tacoma Water to fulfill its water supply obligations in a practicable manner because it would cause avoidable water quality impacts and associated complications (e.g., filtering, treatment).

The only non-riparian portions of the Natural Zone consist of approximately 1,500 acres of roadless, mature coniferous and old-growth forests located in uplands near the eastern portion of the Action Area between Rock Creek and Sunday Creek on both sides of the Green River. This area has little need for hardwood conversion or uneven-aged management because it displays the future desired condition that all of the Conservation and Natural Zones would be managed for under Alternative B.

Reducing the amount of commercial timber harvest in the Commercial Zone could also provide greater habitat benefits than under Upper Watershed Alternative B, but this would only be a variation of the no-harvest alternative, which is analyzed in detail as Upper Watershed Alternative C.

All alternatives are compared and summarized in Tables 2-18a and 2-18b at the end of this section, beginning on page 2-79.

THE FOLLOWING NEW TEXT REFLECTS
PUBLIC COMMENTS ON THE DEIS

2.5.2 Consideration of the Forests and Fish Report as an Alternative for Upper Watershed Management under the Green River HCP

At the direction of the Washington State Legislature (1999 First Special Session), the Washington Forest Practices Board is in the process of adopting new Forest Practices Rules (Proposed Rules) based on the Forests and Fish Report from 29 April 1999. The Forests and Fish Report is a set of riparian and upland management measures intended to protect and enhance water quality and fish habitat on Washington's non-

federal forestlands. Portions of the Forests and Fish Report are currently being implemented under an Emergency Forest Practices Rule adopted in March 2000. A permanent rule is expected to be adopted and become effective some time in 2001.

The DEIS prepared for the Green River HCP identified the No Action Alternative for upper watershed management (Upper Watershed Management Alternative A) as the current (2000) Forest Practices Rules, along with a number of management commitments Tacoma Water has made apart from the HCP process. The DEIS also analyzed the proposed HCP (Upper Watershed Management Alternative B), which incorporates the same land management commitments Tacoma Water has made outside the HCP process plus additional methods to be implemented under the HCP. During public review of the DEIS, the Services raised the question as to whether or not the Proposed Rules (based on the Forests and Fish Report) should be analyzed, as either a No Action Alternative (with no ITP coverage) or an action alternative (with ITP coverage) due to progress in the state's process for implementing the Proposed Rules. The Services have concluded that analysis of the Proposed Rules in the FEIS is not warranted for the following reasons.

Implementation of the Proposed Rules on Tacoma Water lands would result in no substantial change in management from that described under either Upper Watershed Alternative A or Alternative B, which are virtually identical with respect to riparian management and maintenance of water quality because of several commitments to resource management Tacoma Water has made separate from the HCP process. While it is true that the Proposed Rules would increase state requirements for riparian protection, road management, assessment of ~~unstable soils~~ unstable slopes, and other aspects of watershed management, these changes would not alter management of Tacoma Water lands because Tacoma already meets or exceeds standards of the Proposed Rules. This is because in addition to meeting current Forest Practices Rules, Tacoma Water has made binding commitments through its Forest Land Management Plan and its agreements with the Muckleshoot Indian Tribe to:

- participate in and implement results of Watershed Analysis;

- manage its lands and roads according to its Forest Land Management Plan (Ryan 1996), as approved and adopted by the Tacoma Public Utilities Board on 11 September 1996;

- maintain riparian and wetland buffers that exceed those in the Proposed Rules; and

- implement aquatic habitat enhancement measures as mitigation for the Additional Water Storage Project.

Tacoma Water would be obligated to implement these measures even in the absence of an ITP and HCP. Consequently, an alternative based on the Proposed Rules would look no different than the existing Upper Watershed No Action Alternative (Alternative A) or the proposed HCP (Alternative B) with regard to riparian management and aquatic habitat protection on Tacoma's lands in the upper watershed.

The following is a brief summary of how Tacoma Water forestlands would be managed under the Proposed Rules. Comparisons to Upper Watershed Alternative A and Alternative B are made where appropriate.

Forest Management Zones

The Proposed Rules would place no new restrictions on the harvest of timber other than those related to the maintenance of riparian function and protection of ~~unstable soils~~ unstable slopes (discussed below). The Proposed Rules would place no limits on the overall rate or type of timber harvesting outside specified sensitive areas. In contrast, Tacoma Water's Forest Land Management Plan (Ryan 1996) would continue to set limits on the type, amount, and location of timber harvesting on Tacoma Water lands. The Forest Land Management Plan requires that lands in the upper watershed be managed according to three zones (Natural, Conservation, and Commercial). Under the plan, there would be no timber harvest in the Natural Zone, except for the removal of unsafe snags along roads and the implementation of wildlife habitat improvements for the Additional Water Storage Project. Timber harvest in the Conservation Zone would involve the conversion of hardwood stands (by clearcutting and replanting with conifer seedlings) and the selective thinning of conifer stands less than 100 years old to accelerate the development of late-seral forest characteristics. Eventually, all stands in the Conservation Zone would exceed 100 years old, and all harvest in the zone would cease. Conifer harvest in the Commercial Zone would occur by clearcutting an average of no more than 1.5 percent of the forest in the zone each year. Hardwood conversion in the Commercial Zone would not be restricted. Overall, Tacoma Water would harvest an estimated 51 acres of conifer forest and 29 acres of hardwood forest annually in the Commercial and Conservation Zones combined.

Surface Water Typing

The Proposed Rules would use a revised system of designating stream types. Streams would be identified as Type S (shorelines of the state), Type F (waters containing fish habitat that are not shorelines of the state), or Type N (all other waters). For purposes of comparison, Type S would include the old Type 1, Type F would include the old Types 2 and 3, and Type N would include the old Types 4 and 5. All site-specific type determinations of fish habitat would be done according to the methodology in the current Forest Practices Rules until alternate methodologies are developed. While the Proposed Rules may result in changes to stream type designations, those changes would not be treated differently under Upper Watershed Alternative A, Alternative B, or the Proposed Rules.

Riparian and Wetland Buffers

The Proposed Rules call for a number of no-harvest and partial harvest buffers along streams (Table 2-A). As described in the DEIS, Tacoma Water has made commitments to the Muckleshoot Indian Tribe that also require buffers along all streams, and define how those buffers will be measured. In all cases, the widths of the buffers required on Tacoma Water lands would meet or exceed those of the Proposed Rules, and the amount of harvesting in the buffers would be less than allowed under the Proposed Rules.

Under the Proposed Rules, Channel Migration Zones (CMZ) would be delineated where they exist on Type S and F streams, and no timber harvesting or salvage logging would occur within the CMZ. Under all alternatives on Tacoma Water lands, riparian buffers on all streams (including Type N) would be measured horizontally from the bankfull width, channel migration zone, or channel disturbance zone (whichever is greater), and no timber harvesting would occur on the stream side of that line.

Wetland buffers under the Proposed Rules would be unchanged from Current Forest Practices (Table 2-B). Wetland buffers under Tacoma Water's commitment to the Muckleshoot Indian Tribe would be larger than current Forest Practices Rules, and all would be no-harvest.

Table *2-A*. Comparison of stream buffers on Tacoma Water lands and non-Tacoma Water lands under the Proposed Forest Practices Rules.

Management on Tacoma Water Lands Under All Alternatives				**Management on Non-Tacoma Lands Under the Proposed Rules**	
Old Stream Type	New Stream Type	No-harvest Buffer Width [1]	Partial-harvest Buffer Width	No-harvest Buffer Width	Partial-harvest Buffer Width
1	S	200 feet	none	50 feet (Core Zone)	up to 150 feet [3] (Inner and Outer Zones)
2	F	200 feet	none	50 feet (Core Zone)	up to 150 feet [3] (Inner and Outer Zones)
3		150 feet	50 feet		
4	Perennial N	50 to 100 feet	none	50 feet at sensitive sites; totaling $50% of stream length [2]	none
5	Seasonal N	25 feet	25 feet	Variable; on steep and ~~unstable soils~~ unstable slopes [1]	none

[1]Effective buffer widths would be greater in the Natural Zone because the entire zone is no-harvest.

[2]All type N streams also have an equipment limitation zone extending 30 feet horizontally beyond bankfull width.

[3]The total width of the no-harvest and partial harvest zones is equal to one site potential tree height (90 to 200 feet, depending on site class). A total buffer of 200 feet would only occur in a riparian area with Site Class I.

Table *2-B.* Comparison of wetland buffers on Tacoma Water lands and non-Tacoma Water lands under the Proposed Forest Practices Rules.

		Buffer Width and Management	
		Tacoma Water Lands Under All Alternatives	**Non-Tacoma Lands Under the Proposed Rules**
Wetland Type	**Wetland Size**		
Non-forested Wetlands with $0.5 acre open water			
Type A (all)	> 5.0 acres	200 feet minimum; no-harvest	100 feet average; partial-harvest
Type A (all)	0.5 to 5.0 acres	100 feet minimum; no-harvest	50 feet average; partial-harvest
Type A (bogs/fens only)	0.25 to 0.5 acre	100 feet minimum; no-harvest	50 feet average; partial-harvest
Non-forested Wetlands with < 0.5 acre open water			
Type B (all)	> 5.0 acres	100 feet minimum; no-harvest	50 feet average; partial-harvest
Type B (all)	0.5 to 5.0 acres	50 feet minimum; no-harvest	25 feet average; partial-harvest
Type B (all)	0.25 to 0.5 acre	50 feet minimum; no-harvest	none
Forested Wetlands (>30 percent canopy cover)			
Type C (all)	> 5.0 acres	50 feet minimum; no-harvest	none
Type C (all)	0.5 to 5.0 acres	25 feet minimum; no-harvest	none

Unstable Slopes

Under the Proposed Rules, timber harvesting, road construction, landing construction, gravel/rock extraction and spoils disposal on inner gorges, convergent headwalls, bedrock hollows, deep-seated landslides, groundwater recharge areas, and other potentially ~~unstable soils~~ unstable slopes would be preceded by a SEPA Environmental Checklist and expert review; or they would be protected in accordance with site-specific prescriptions from a completed and approved Watershed Analysis. Since the Tacoma Water lands are or will be covered under completed Watershed Analysis, future management of ~~unstable soils~~ unstable slopes would be no different under the Proposed Rules than under any of the other alternatives analyzed in the EIS.

Road Construction and Maintenance

The Proposed Rules would require that a Road Maintenance and Abandonment Plan be prepared within 5 years, and all roads be in compliance with the plan within 15 years of final adoption of the rules. During each of the first 5 years of plan development, landowners would have to complete planning for at least 20 percent of their lands and provide results to the DNR. Items to be addressed in Road Maintenance and Abandonment Plans would include:

- current condition of road surfaces, road drainage structures and stream crossings on all active, inactive and orphan roads;
- necessary repair or maintenance to permit or improve fish passage;
- necessary repair of maintenance to limit mass wasting and sediment delivery to streams, particularly on stream-adjacent parallel roads;
- necessary repair or maintenance to disconnect road drainage from streams; and
- necessary repair or maintenance to improve hydrologic connectivity of surface and subsurface waters.

Under the Proposed Rules, stream culverts would have to be designed to accommodate 100-year flood events. No new stream-adjacent roads paralleling streams could be constructed unless all other alternatives would likely cause greater damage to public resources.

Tacoma Water's roads in the watershed would meet or exceed standards of the Proposed Rules with or without ITP coverage (i.e., under any of the alternatives analyzed in the EIS). Subsection 6.1.3 of Tacoma Water's Forest Land Management Plan obligates the City to construct all new roads on its lands in the watershed to meet DNR standards. By definition, this would include standards of the Forests and Fish Report if they become incorporated into Forest Practices Rules. In the absence of the Proposed Rules, the Forest Land Management Plan sets standards for road maintenance comparable to those of the Forests and Fish Report.

Specifically, subsection 6.1.4 (Road Maintenance) of the Forest Land Management Plan requires Tacoma Water to:

- conduct an annual forest road survey and report on road status, with recommendations on necessary maintenance, repair and decommissioning;
- maintain road maintenance agreements with other road users on joint use roads in the watershed;
- close roads to heavy truck traffic when there is potential for extraordinary damage to roads or impact on water quality (e.g., when road surfaces are saturated);
- maintain low growing vegetation along roadsides to stabilize soils and minimize erosion;
- control roadside vegetation by mechanical methods (i.e., no herbicides); and
- decommission roads no longer needed for forest management by removing culverts, fills, and water blockages and by stabilizing and revegetating old road cuts and surfaces.

Tacoma Water has implemented the forest road survey, and is currently in the process of inventorying its roads. The forest road survey report includes maps and descriptions of all roads and water crossing structures. All areas in need of repair or maintenance are identified and assigned priorities. This places Tacoma Water more than 5 years ahead of the Proposed Rules in the development and implementation of a road maintenance plan.

As a general policy, all Tacoma Water roads in the watershed are closed to the general public to limit impacts to water quality. Roads are open only to Tacoma Water personnel, representatives of regulatory agencies, neighboring landowners in need of access to their lands, and members of the Muckleshoot Indian Tribe (for traditional and cultural practices).

The Forest Land Management Plan also sets standards similar to the Proposed Rules for the construction of new roads. Subsection 6.1.3 (Road Development) requires that:

- # there will be no net gain in permanent road miles in the Natural Zone;
- # no new roads will be constructed across ~~unstable soils~~ unstable slopes;
- # roads constructed on slopes over 60 percent must utilize full bench construction, with no side-casting of excavated material;
- # disturbed soils associated with roads on slopes over 40 percent near surface waters will be mulched and/or seeded to control erosion and slumping;
- # roads constructed across streams will be designed to minimize right-of-way clearing, cross streams at right angles, minimize disturbance to the natural flow of streams, and minimize side-casting of excavated materials; and
- # no new roads will be constructed by other landowners across Tacoma Lands being managed to federal standards (portions of the Natural and Conservation Zones acquired from the USFS in a 1995 land exchange) unless no alternative exists for Tacoma Water to fulfill its legal obligations to provide access.

Watershed Analysis

Under the Proposed Rules, new Watershed Analyses and renewals of previous Watershed Analyses would be performed according to new guidelines. The new guidelines include modified modules for hydrology and water quality, new modules for cultural resources and habitat restoration, and elimination of the need for riparian prescriptions and mass wasting hazard mapping. Tacoma Water's commitment to participate in Watershed Analysis would continue under all alternatives, and Watershed Analyses would conform to the Forest Practices Rules in effect at the time. If the Proposed Rules were finalized, future Watershed Analyses in the Upper Green River Watershed would conform to the new guidelines, regardless of the HCP alternative implemented.

Adaptive Management

The Proposed Rules concerning riparian management and protection of water quality would be subject to evaluation through monitoring and research, and the rules could be modified in the future as a result of that

evaluation. This is a general provision of the Proposed Rules to allow for future improvements in resource protection, and no specific direction or magnitude of modification has been suggested at this time. Under any No Action Alternative (including Upper Watershed Alternative A analyzed in the EIS), Tacoma Water would be required to comply with new Forest Practices Rules that result from adaptive management. However, since the nature of any change is impossible to predict, the results of adaptive management are too speculative to address in the EIS.

As currently written, the Proposed Rules would allow an approved HCP to serve in lieu of future Forest Practices Rules covering the protection of fish and aquatic habitat. With an approved HCP, Tacoma Water would not be required to alter its management to meet new Forest Practices Rules related to the protection of covered species and their habitats. The potential effects of this are inconsequential, however, because Tacoma Water's riparian management strategy already exceeds requirements of the Proposed Rules. The conservative nature of the riparian protection measures in the HCP (analyzed as Alternative B in the EIS) makes it unlikely that adaptive management would result in Forest Practices Rules with a higher level of protection than the HCP. As also noted for the Upper Watershed No Action Alternative above, the nature of any change in the Forest Practices Rules resulting from adaptive management would be impossible to predict and too speculative to address in the EIS.

Forest Pesticides

The Proposed Rules would include a number of new restrictions on the use of pesticides in and near riparian buffers. Tacoma Water is not seeking ITP coverage for the use of pesticides at this time, so the effects of pesticides were not analyzed under any of the alternatives in the EIS. If the Proposed Rules were finalized, Tacoma Water would be required to comply with the new restrictions. Tacoma Water already limits the use of pesticides on its lands to protect water quality, and it is not anticipated that the Proposed Rules would result in any change from current management.

END OF NEW TEXT

Table 2-18a and 2-18b. Alternative Comparison Summary MANUALLY INPUT THE PAGE #s on TOC

PLACEHOLDER

Table 2-1. Species proposed for coverage in the Tacoma Green River Habitat Conservation Plan.

COMMON NAME	SCIENTIFIC NAME	FEDERAL ESA STATUS
Listed Wildlife Species		
Gray wolf	*Canis lupus*	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Marbled murrelet	*Brachyramphus marmoratus*	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened
Grizzly bear	*Ursus arctos*	Threatened
Canada lynx	*Lynx canadensis*	~~Proposed~~ Threatened
Listed Fish Species		
Chinook salmon	*Oncorhynchus tshawytscha*	Threatened
Bull trout	*Salvelinus confluentus*	~~Proposed~~ Threatened
Unlisted Wildlife Species		
Peregrine falcon	*Falco peregrinus*	Species of Concern, (~~Recently~~ De-
Cascade torrent salamander	*Rhyacotriton cascadae*	Species of Concern
Van Dyke's salamander	*Plethodon vandykei*	Species of Concern
Larch Mountain salamander	*Plethodon larselli*	Species of Concern
Tailed frog	*Ascaphus truei*	Species of Concern
Cascades frog	*Rana cascadae*	Species of Concern
Oregon spotted frog	*Rana pretiosa*	Candidate for Listing
Northwestern pond turtle	*Clemmys marmorata*	Species of Concern
Common loon	*Gavia immer*	None
Vaux's swift	*Chaetura vauxi*	None
Pileated woodpecker	*Dryocopus pileatus*	None
Olive-sided flycatcher	*Contopus borealis*	Species of Concern
California wolverine	*Gulo gulo luteus*	Species of Concern
Pacific fisher	*Martes pennanti pacifica*	Species of Concern
Northern goshawk	*Accipiter gentilis*	Species of Concern
Unlisted Fish Species		
Dolly Varden	*Salvelinus malma*	None
Coho salmon	*Oncorhynchus kisutch*	NW[1] ~~Candidate for Listing~~
Pacific lamprey	*Lampetra tridentata*	Species of Concern
River lamprey	*Lampetra ayresi*	Species of Concern
Sockeye salmon	*Oncorhynchus nerka*	NW[1]
Chum salmon	*Oncorhynchus keta*	NW[1]
Pink salmon	*Oncorhynchus gorbuscha*	NW[1]
Steelhead trout	*Oncorhynchus mykiss*	NW[1]
Coastal cutthroat trout	*Oncorhynchus clarki clarki*	NW[1]

[1] Status reviews conclude a listing is Not Warranted at this time.

Table 2-2. Tacoma Water's customer base and water use in 1998.

Type of Customer	Number of Service Customers	Water Use in 1998 (million gallons)	Percent of Total Use (%)
Residential	77,370	8,903	39
Commercial/Industrial	4,880	11,410	51
Government	475	709	3
Wholesale	12	1,591	7
TOTAL	**82,737**[1]	**22,613**	**100**

[1] This number represents approximately 300,000 people.

Table 2-3. Historic and forecasted population of the Tacoma Water service area.

Service Area	Year			
	1990	**2000**	**2010**	**2020**
Tacoma Water Service Area-Inside City Residential	178,605	192,689	226,252	245,873
Tacoma Water Service Area-Outside City Residential	66,749	81,574	99,141	112,669
City of Tacoma UGA [1]	111,583	123,228	137,037	150,164
Pierce County UGA Serviceable	103,785	131,335	163,537	191,058
Pierce County UGA Not Serviceable	39,379	46,020	53,466	58,532
Rural Pierce County	96,370	104,643	116,995	127,144
South King County	168,786	202,145	228,771	264,645

Annual Average Growth Rate by Decade (Percent Increase)			
Service Area	**Year**		
	2000	**2010**	**2020**
Tacoma Water Service Area-Inside City Residential	0.7	1.5	0.8
Tacoma Water Service Area-Outside City Residential	1.8	1.8	1.2
City of Tacoma UGA	1.0	1.0	0.9
Pierce County UGA Serviceable	2.1	2.0	1.4
Pierce County UGA Non-Serviceable	1.4	1.4	0.9
Rural Pierce County	0.8	1.1	0.8
South King County	1.7	1.2	1.4

Source: EES, CH2M Hill 1995

[1] UGA Urban Growth Area

Table 2-4. Forecast of water use in the Tacoma Water service area and surrounding Pierce County.

Service Area	Residential Water Use (gallons per capita per day)				Commercial Water Use (gallons per employee per day)			
	1990	1995	2000	2010	1990	1995	2000	2010
Tacoma Water Service Area-Inside City Residential	88.6	87.5	87.5	87.5	145.2	110.7	110.7	110.7
Tacoma Water Service Area-Outside City Residential	100.3	98	98	98	86.9	74.1	74.1	74.1
City of Tacoma UGA	100.3	98	98	98	86.9	74.1	74.1	74.1
Pierce County UGA Serviceable	100.3	98	98	98	86.9	74.1	74.1	74.1
Pierce County UGA Not Serviceable	100.3	98	98	98	86.9	74.1	74.1	74.1
Rural Pierce County	100.3	98	98	98	86.9	74.1	74.1	74.1

Source: EES, CH2M Hill 1995

UGA = Urban Growth Area

Table 2-5. Tacoma Water's existing Conservation Program.

Public Education	Technical Assistance	System Measures	Incentives/Other Measures
Program Promotion-annual bill enclosures and advertisements	Publication and Brochures-created by Tacoma or an organization in which Tacoma participates	Leak Detection and Repair Program-annual hydrant testing, ongoing leak detection, installation of cathodic protection on water mains and main replacement program	Conservation Pricing-Seasonal including block rate structure for residential and wholesale and flat rate structure for commercial/industrial
School Outreach-elementary school theatrical group to present conservation and water quality skits	Feasibility Studies-conducted both industrial water reuse studies and residential water use studies	Reservoir Maintenance-replace leaky reservoirs, inspect reservoirs annually, install leakage return pump at McMillin Reservoir	Simpson-Tacoma Kraft-voluntary industrial process water use reduction program
Speakers Bureau-speakers/slide shows for civic groups, industry organizations, homeowners associations, neighborhood groups, and youth organizations	Purveyor and Customer Assistance-established landscape policy and customer advisory committee	Meters-meter all connections, regularly test source meters, commercial meter testing and replacement	Residential Retrofit-direct install of showerhead and faucet aerators in conjunction with City Light, showerhead exchange, toilet kits
Theme Shows and Fairs-participate in home shows such as Tacoma Home and Garden Show and Puyallup Fair; trade shows such as Washington State Plant Engineering & Maintenance Show	Bills showing water consumption history		Landscape Management-encourage conversion of manual irrigation systems to automatic, centralized irrigation systems at government facilities, consolidate plantings
Membership in local and state organizations to assist in delivery of targeted conservation messages			Recycle/Reuse-conduct water reuse studies for irrigation and industrial application in the service area
			Rebates and incentives-preparing to provide to residential and commercial/industrial customers for such items as high efficiency washers and process audits; consumption analysis for irrigation customers.

Table 2-6. Conservation Program savings since 1990.

Supply-Side Management Programs	**Water Savings (mgd)**	**Customer/Demand-Side Management Programs**	**Water Savings (mgd)**
Supply line leak detection and repairs (1990+1991)	3.27	Residential showerhead, ~~exchange program~~ aerator, and toilet kits for residential customers (ongoing since 1993)	~~0.02~~ 0.24
Transmission line leak detection and repairs (1990+1991)	0.75	~~*Watt & Water* showerhead and toilet retrofit program 1993~~	~~0.35~~
Ongoing hydrant upgrade & repair program since 1991. Bi-annual hydrant leak detection since 1983	0.10	*WashWise* high efficiency washer rebate program implemented in 1997	Market Transformation objective; savings under economic evaluation
Large commercial meter testing since 1990	~~0.41~~ 0.60	Re-use analysis at Simpson and Abatibi pulp mills 1994 + 1997	Potential alternative supply
Reservoir rehabilitation and replacement (1989 and 1990)	~~0.30~~ 1.1	Industrial audit program implemented in 1999	TBD; potential alternative supply
~~McMillin Reservoir drain system annual and ongoing since 1991~~	~~0.60~~	Simpson Tacoma-Kraft voluntary use reductions since 1992	9.0
Distribution main replacement since 1995 and 1996	TBD	State and Federal Plumbing Code since 1994	~~0.26~~ 1.1
		Voluntary reductions made by large industries	1.7
TOTAL	~~**5.43**~~ **5.82**		~~**11.37**~~ **12.04**

TBD = To be determined

Table 2-7. Conservation measures evaluated for targeted customer categories (single family, multi-family, commercial, industrial, public)[1].

Conservation Measure	Single Family	Multi-Family	Commercial/ Industrial	Public Authorities
Indoor water audit and education	x	x	x	x
Outdoor water audit and education	x	x	x	x
Combined audit and education	x	x		
Pressure-reducing valve-retrofit	x	x		
Low-flow showerheads	x	x	x	
Low-flow faucet aerator	x	x	x	x
Electronic faucets			x	x
Dual-flush toilet devices	x	x		
Toilet dams	x	x		
Toilet-flow restrictor	x	x		
Early closure toilet devices	x	x		
Toilet displacement bags/bottles	x	x	x	
Toilet leak detection with repair	x	x	x	
Ultra-low flush toilets	x	x	x	x
Tankless hot water heater-new	x	x		
Tankless hot water heater-retrofit	x	x		
Horizontal load washing machine	x	x		
Hot water line insulation	x	x		
Self-closing hose nozzle	x	x		
Faucet timer automatic shutoff	x	x		
Irrigation system rain shutoff	x	x		
Irrigation system soil shutoff	x	x		
Irrigation soaker hoses	x	x		
Drip irrigation system	x	x		
Remote irrigation				x
Gray water system	x	x		
Building leak detection			x	
Water conservation grant incentives			x	

[1]An "x" indicates an evaluation was conducted under the customer category where the "x" is located.

Table 2-8. Selected conservation programs.

Selected Conservation Programs	
Program 1	**4-Day Peak Savings (mgd)**
Indoor industrial audit–no devices	0.73
Commercial/industrial ultra-low flush toilet rebate	0.32
Parks remote irrigation	0.04
Schools remote irrigation	0.05
Program 1 Savings	**1.14**
Program 2	
Direct mail single-family self-closing hose nozzle	0.14
Direct install public schools ultra-low flush toilets	0.14
Direct mail single-family ultra-low flush toilet rebate	0.02
Direct mail single-family horizontal load washing machine rebate	0.02
Direct install public building outdoor water audits	0.10
Direct install public schools outdoor water audits	0.05
Direct install commercial/industrial low flow showerhead	0.01
Direct install public authorities electronic faucets	0.05
Direct mail single-family faucet timer automatic shutoff	0.11
Program 2 Savings	**0.64**

Table 2-9. Economic evaluation of conservation measures.

Conservation Measure	Cost per CCF Saved	Payback Period (years)	Benefit/Cost Ratio
C/I indoor water audits	$0.03	2	27.76
Public building outdoor water use evaluation	$5.49	N/A	0.12
Public schools outdoor water use evaluation	$2.08	N/A	0.33
Public parks outdoor water use evaluation	$1.05	N/A	0.65
MF irrigation audits	$15.08	N/A	0.05
Rebate for landscape technologies	$0.14	2	4.51
Public agency rebate for landscape technologies	$0.65	8	1.00
C/I ultra-low flush toilet rebate	$0.60	9	1.15
Public schools ultra-low flush toilet rebate	$0.99	N/A	0.67
SF/MF ultra-low flush toilets	$1.47	N/A	0.47
C/I low-flow showerheads	$0.40	3	1.81
Public buildings indoor water audits	$0.60	4	1.27

C/I=commercial/industrial
MF=multi-family
SF=single family
N/A=Payback not achieved
ccf=hundred cubic feet (748 gallons)

Table 2-10. Summary of operational features, components, and water demand compliances under the water withdrawal alternatives.

Alternatives	DEIS Alternative	FDWRC	SDWR	MIT/TPU Agreement	Section 1135 [2]	AWSP	HCP /ITP	Meets Future Tacoma Demand	Meets Future Water Demand of Others
No Action	**A**	Yes [1]	No	No	No	No	No	No, limited capacity	No
Proposed Action	**B**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Construct New Diversion	**C**	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

1 withdrawal of 113 cfs on a daily basis
2 under the Section 1135 Project of the federal Water Resources Development Act, up to 5,000 acre-feet of water is stored annually. Model assumes water is released to meet summer low flows during drought years, water is dumped in June during average and wet years

AWSP Additional Water Storage Project; joint U.S. Army Corps of Engineers/Tacoma Water water storage and fish restoration project at Howard Hanson Dam
DEIS Draft Environmental Impact Statement
FDWRC First Diversion Water Right Claim (withdrawals of up to 113 cfs)
HCP Habitat Conservation Plan
ITP Incidental Take Permit
MIT Muckleshoot Indian Tribe
SDWR Second Diversion Water Right (withdrawals of up to 100 cfs)
TPU Tacoma Public Utilities

Table 2-11. Proposed Tacoma Water Habitat Conservation Measures[1].

Habitat Conservation Measure[1]	Title	Description
HCM 1-01	Minimum Instream Flows under First Division Water Right	Minimum flow maintained at Auburn, gauge (stipulated in the MIT/TPU Agreement)
HCM 1-02	Seasonal Restrictions on Second Division Water Right	Minimum flow maintained at Auburn and Palmer gauges (stipulated in the MIT/TPU Agreement)
HCM 1-03	Tacoma Headworks Upstream Fish Passage Facility	Construction/operation of upstream fish passage facility at Headworks
HCM 1-04	Tacoma Headworks Downstream Fish Bypass Facility	Installation of screen and fish bypass facility at Headworks
HCM 1-05	Tacoma Headworks Large Woody Debris (LWD)/Rootwad Placement	Installation of LWD, rootwads, and boulders to enhance rearing capacity in Headworks inundation pool
HCM 2-01	HHD Downstream Fish Passage Facility	Construction/operation of downstream fish passage facility at HHD
HCM 2-02	HHD Non-Dedicated Storage and Flow Management Strategy	Provide opportunity to manage springtime water storage and release at HHD to minimize impacts to salmonids
HCM 2-03	Upper Watershed Stream, Wetland, and Reservoir Shoreline Rehabilitation Measures	Rehabilitate fish and wildlife habitat in the reservoir inundation zone and riparian areas upstream and downstream of HHD
HCM 2-04	Standing Timber Retention	Retention of 166 acres of deciduous, 48 acres of mixed, and 15 acres of conifer forest in the HHD pool inundation zone
HCM 2-05	Juvenile Salmonid Transport and Release	Transport and release of juvenile salmonids above HHD if determined to be beneficial

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.
HHD=Howard Hanson Dam

Table 2-11. Continued.

Habitat Conservation Measure	Title	Description
HCM 2-06	Low Flow Augmentation	Option to provide an additional 5,000 acre-feet of water for low flow augmentation
HCM 2-07	Side Channel Re-connection Signani Slough	Re-connect and rehabilitate 3.4 acres of off-channel habitat in Signani Slough (RM 60)
HCM 2-08	Downstream Woody Debris Management Program	Introduce woody debris into Green River downstream of Headworks
HCM 2-09	Mainstem Gravel Nourishment	Provide up to 3,900 yd^3 gravel into Green River downstream at Headworks
HCM 2-10	Headwater Stream Rehabilitation	Creation of off-channel habitat, installation of LWD/rootwads in Green River, North Fork Green River, and eight tributaries
HCM 2-11	Snowpack and Precipitation Monitoring	Install up to three snow pillows in the upper Green River basin

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

HHD = Howard Hanson Dam

Table 2-12. Estimated annual harvest acreages and volumes that would occur under each alternative.

Management Zone	Conifer Acres (Volume in MBF)			Hardwood Acres (Volume in MBF)			Total Acres (Volume in MBF)		
	Alternative			Alternative			Alternative		
	A[1]	B	C	A[4]	B[4]	C	A	B	C
Commercial	27 (1,080)	27[2] (1,080)	0	12 (240)	12 (240)	0	39 (1,320)	39 (1,320)	0
Conservation	24 (840)	24[3] (720)	0	17 (340)	17 (340)	0	41 (1,180)	41 (1,060)	0
Natural	0	0	0	0	0	0	0	0	0
Combined Total of Even-aged and Uneven-aged Harvest	**51 (1,920)**	**51 (1,800)**	**0**	**29 (580)**	**29 (580)**	**0**	**80 (2,500)**	**80 (2,380)**	**0**

[1] Based on commitments in Tacoma Water's existing Forest Land Management Plan.

[2] Tacoma Water would clearcut harvest no more than 1.5 percent of conifer in any year. Based on current ownership, this would amount to an estimated 27 acres.

[3] Tacoma Water would commercially thin no more than 2 percent of conifer in any year. Based on current ownership, this would amount to an estimated 24 acres.

[4] Tacoma Water would have no limit on the number of acres of hardwood forest that could be harvested in any year. Harvest acreage estimates are based on current acreages of hardwood forest capable of being converted to conifer forest for the benefit of fish and wildlife.

MBF = Thousand Board Feet of timber volume harvested.

Table 2-13a. Stream buffer widths for the Tacoma Green River HCP Area.

	Alternative A		Alternative B		Alternative C
DNR Stream Type	**No-Harvest Buffer Width (feet)**	**Partial-Harvest Buffer Width (feet)**	**No-Harvest Buffer Width (feet)**	**Partial Harvest Buffer Width (feet)**	**No-Harvest Buffer Width**
Type 1, Shoreline of the State, > 100 feet wide	200	0	200	0	No commercial timber harvest would occur anywhere in the HCP Area.
Types 1 and 2, > 75 feet wide	150	0	200	0	
Types 1 and 2, <75 feet wide	100	0	200	0	
Type 3, >5 feet wide	75	0	150	50	
Type 3, < 5 feet wide	50	0	150	50	
Type 4	50	0	50 to 100	0	
Type 5	25	0	25	25	

> greater than

< less than

Table 2-13b. Wetland buffer widths for the Tacoma Green River HCP Area.

Wetland Type	Wetland Size (acre)	No-Harvest Buffer Width (feet)		
		Alternative A	**Alternative B**	**Alternative C**
Type A (all)	>5.0	200	200	No commercial timber harvest would occur anywhere in the HCP Area.
Type A (all)	0.5 to 5.0	100	100	
Type A (bogs/fens only)	0.25 to 0.5	100	100	
Non-forested Wetlands (with <0.5 acre open water)				
Type B (all)	>5.0	100	100	
Type B (all)	0.25 to 5.0	50	50	
Forested Wetlands (>30 percent canopy cover)				
Type C (all)	>5.0	50	50	
Type C (all)	0.5 to 5.0	25	25	

> greater than

< less than

Table 2-14. Tacoma Water Upper Green River Watershed Habitat Conservation Measures for forest management.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-01A	Upland Forest Management Measures	Management of Tacoma lands within the HCP according to Natural, Conservation, or Commercial Zones designations
HCM 3-01B	Natural Zone	No timber harvesting except to modify fish or wildlife habitat or to remove danger trees along roads
HCM 3-01C	Conservation Zone	No even-aged harvesting in conifer-dominated stands and no harvesting (except danger tree removal along roads and fish and wildlife habitat modifications) in conifer-dominated stands older than 100 years
HCM 3-01D	Commercial Zone	Coniferous forests would be managed on an even-aged rotation of 70 years
HCM 3-01E	Hardwood Conversion	Stands in the Conservation and Commercial Zones dominated by hardwood on sites capable of producing conifers may be converted to conifers by clearcutting
HCM 3-01F	Salvage Harvesting	Salvage timber harvesting only in forested areas of the Commercial Zone and stands in the Conservation Zone under 100-years-old affected by wind-throw, insect infestation, disease, flood, or fire, according to set prescriptions
HCM 3-01G	Snags, Green Recruitment Trees and Logs	Tacoma would retain all safe snags and at least four green recruitment trees and four logs per acre, where available
HCM 3-01H	Harvest Unit Size	Even-aged harvest units would not exceed 40 acres in size
HCM 3-01I	Even-aged Harvest Unit Adjacency Rule	Even-aged harvesting would occur when the surrounding forest land is fully stocked with trees a minimum of 5-

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-14. Continued.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-01J	Harvest Restrictions on Sites with Low Productivity	Timber harvesting would occur only on lands with a Douglas-fir 50-year site index of greater than 80
HCM 3-01K	Contractor and Logger Awareness	Contractor, loggers, and forestry workers operating in the Upper HCP Area would be required to comply with relevant HCP measures
HCM 3-01L	Logging Slash Disposal	Slash disposal would not be burned unless burning is part of habitat modification
HCM 3-01M	Reforestation	All even-aged stands would be re-planted with 300-400 suitable trees per acre by the first spring following harvest
HCM 3-01N	Harvest on Unstable Slopes	Tacoma would identify potentially unstable landforms and apply general prescriptions developed by Watershed Analysis or site-specific prescriptions developed by a slope stability specialist

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-15. Tacoma Water Upper Green River Watershed Habitat Conservation measures for riparian management.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-02A	No-Harvest Riparian Buffers	Tacoma would retain no-harvest buffers along all streams and wetlands in the Upper HCP Area
HCM 3-02B	Partial Harvest Riparian Buffers	Tacoma would retain partial-harvest riparian buffers outside no-harvest buffers on Type 3 and Type 5 streams

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-16. Tacoma Water Upper Green River Watershed Habitat Conservation measures for road construction and maintenance.

Habitat Conservation Measure Title	Title	Description[1]
HCM 3-03A	Watershed Analysis	Tacoma would participate in all Watershed Analyses performed according to the Washington Forest Practices Board within the HCP area
HCM 3-03B	Road Maintenance	Tacoma would participate in the development of a Road Sediment Reduction Plan describing the priorities and schedule for road maintenance, improvement, and abandonment activities that would be implemented to reduce road sediment inputs.
HCM 3-03C	Roads Construction on Unstable Landforms	Tacoma would implement all draft and final mass wasting prescriptions specific to new road construction in WAUs where Watershed Analyses are approved or pending. In WAUs where assessments have not been completed within 2 years following issuance of the ITP, Tacoma would complete a slope stability analysis and develop site-specific prescriptions for road construction.[2]
HCM 3-03D	Roads on Side Slopes Greater Than 60 Percent	Tacoma would use full bench construction with no side-casting of excavated materials on side slopes greater than 60 percent
HCM 3-03E	Erosion Control	Tacoma would place mulch and/or grass seed on all road cuts and fills with slopes over 40 percent or near water crossings as well as in areas of severe erosion/slumping danger or above and below roads

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

[2] This commitment to complete all slope stability analyses within 2 years of ITP issuance exceeds Upper Watershed Alternative A.

Table 2-16. Continued.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-03F	Stream Crossings	When constructing roads through riparian areas, Tacoma would minimize right-of-way clearing, cross streams at right angles, minimize stream disturbances and side-casting of excavated materials, and provide for upstream and downstream passage in fish-bearing streams
HCM 3-03G	Road Closures	Tacoma would maintain a locked gate to restrict road use except where the USFS requires roads to be open
HCM 3-03H	Roadside Vegetation	Tacoma would maintain low-growing vegetation along roads to stabilize soils and to minimize erosion
HCM 3-03I	Road Abandonment	Tacoma would abandon roads in the Action Area that are no longer needed for watershed management, forestry operations, or HCP implementation, according to a specified schedule
HCM 3-03J	Culvert Improvements	Tacoma would inventory all roads in the Action Area and identify all culverts that block fish passage within 1 year of ITP issuance; plans to eliminate blockages would be made within 2 years, and all blockages would be eliminated within 5 years of issuance of an ITP

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-17. Tacoma Water Upper Green River Watershed Habitat Conservation measures for species-specific management.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-04A	Grizzly Bear Den Site Protection	Tacoma would not fell timber, yard timber, construct roads, or apply aerial pesticides within 1 mile of any known active grizzly bear den from 1 October through 31 May; and would contact the USFWS prior to any similar activities within 3 miles of a known den at other times of the year
HCM 3-04B	Grizzly Bear Sightings	Tacoma would suspend all management activities under its control in the Upper HCP Area within 1 mile of confirmed grizzly bear sightings for 21 days unless activities are necessary for the operation of the water supply project
HCM 3-04C	Grizzly Bears and Roads	Tacoma would not construct roads across non-forested blueberry and black huckleberry fields, meadows, avalanche chutes, or wetlands in the Upper HCP Area
HCM 3-04D	Grizzly Bear Visual Screening	Tacoma would retain visual screens along preferred grizzly bear habitat or along roads within 1 mile of said habitat if a grizzly bear is documented in the Green River watershed
HCM 3-04E	Grizzly Bears and Trash	Tacoma would take measures to prevent the dumping of trash that may attract grizzly bears in the upper watershed
HCM 3-04F	Grizzly Bears and Firearms	Tacoma would prohibit firearms within vehicles of contractors working for Tacoma in the Upper Action Area (except in special cases)
HCM 3-04G	Gray Wolf Den Site Protection	Tacoma would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 1 mile of any known active gray wolf den from 15 March through 15 July, and within 0.25 mile of any known active gray wolf "first" rendezvous sites from 15 May through 15 July

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-17. Continued.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-04H	Pacific Fisher Den Site Protection	Tacoma would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 0.5 mile of any known active Pacific fisher den from 1 February through 31 July
HCM 3-04I	California Wolverine Den Site Protection	Tacoma would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 0.5 mile of any known active wolverine den from 1 October through 31 May
HCM 3-04J	Canada Lynx Den Site Protection	Tacoma would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 0.25 mile of any known active Canada lynx den from 1 May through 31 July
HCM 3-04K	Seasonal Protection of Peregrine Falcon Nests	Tacoma would not fell timber, yard timber, construct roads or apply aerial pesticides within 0.5 mile, or blast within 1 mile of any known active peregrine falcon nest from 1 March through 31 July
HCM 3-04L	Long-Term Protection of Peregrine Falcon Nest Sites	Tacoma would not fell timber or alter habitat within 100 feet of any known peregrine falcon nest site or potential nest cliff greater than 75 feet in height in the Upper Action Area; and Tacoma would retain large potential perch trees within 660 feet of known peregrine nests
HCM 3-04M	Seasonal Protection of Bald Eagle Nests and Communal Winter Night Roosts	Tacoma would not fell timber, yard timber, construct roads, or alter habitat within 0.25 mile or aerial spray within 0.5 mile or blast within 1 mile of any known active bald eagle nest from 1 January through 31 August or active communal winter night roost at sensitive times of day from 15 November through 15 March

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-17. Continued.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-04N	Long-Term Protection of Bald Eagle Nests and Communal Winter Night Roosts	Tacoma would not fell timber or otherwise alter habitat within 330 feet of any known bald eagle nest or communal winter night roost in the Upper Action Area
HCM 3-04O	Seasonal Protection of Northern Spotted Owl Nests	Tacoma would not fell timber, construct roads, or apply aerial pesticides within 0.25 mile, or blast within 1 mile of the activity center of any known northern spotted owl pair from 1 March through 30 June
HCM 3-04P	Long-Term Protection of Northern Spotted Owl Nests	Tacoma would not fell timber or otherwise alter habitat within 660 feet of the activity center of any known northern spotted owl pair or resident single in the Upper Action Area
HCM 3-04Q	Seasonal Protection of Northern Goshawk Nests	Tacoma would not fell timber, yard timber, or construct roads within 0.25 mile, apply aerial pesticides within 0.5 mile, or blast within 1 mile of any known active northern goshawk nest from 1 March through 31 August
HCM 3-04R	Long-Term Protection of Northern Goshawk Nests	Tacoma would not fell timber or otherwise alter habitat within 660 feet of any known active northern goshawk nest in the Upper Action Area
HCM 3-04S	Pileated Woodpecker Nest, Roost, and Foraging Trees	Tacoma would give preference to leaving green recruitment trees with visible signs of pileated woodpecker nesting, roosting, and/or foraging when selecting snags and trees to meet other Habitat Conservation Measures
HCM 3-04T	Vaux's Swift Nest and Roost Trees	Tacoma would give preference to leaving green recruitment trees with visible signs of current Vaux's swift nesting and/or roosting and those with the potential for future use when selecting snags and trees to meet other Habitat Conservation Measures

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-17. Continued.

Habitat Conservation Measure Title[1]	Title	Description
HCM 3-04U	Larch Mountain Salamander Habitat Protection	Tacoma would not harvest timber, yard timber, construct roads, or apply aerial pesticides, herbicides, or fertilizers within forested talus fields of 1 acre or more and within 100 feet of unforested talus fields of 0.5 acre or more in size and would abandon all existing roads through unforested talus fields of 0.5 acre or more in size
HCM 3-04V	Sightings of Covered Species	Tacoma would notify the USFWS in a timely manner of any reported sightings of a spotted owl, marbled murrelet, grizzly bear, gray wolf, Pacific fisher, California wolverine, or Canada lynx in the Upper Action Area
HCM 3-04W	Seasonal Protection of Occupied Marbled Murrelet Nesting Habitat	Tacoma would not fell timber, yard timber, or construct roads within 0.25 mile, apply aerial pesticides within 0.5 mile, or blast within 1 mile of suitable marbled murrelet nesting habitat where "occupancy" has been determined or "presence" has been observed but "occupancy" is undetermined from 1 April through 15 September
HCM 3-04X	Site-Specific Protection for Northwestern Pond Turtles	Tacoma, the WDFW, and the Services would cooperatively develop site-specific protection plans for Northwestern pond turtles if the turtles are found to occur on or near the Covered Lands and it is determined the Covered Activities have the potential to impact the turtles.

[1] Refer to proposed HCP Chapter 5, Habitat Conservation Measures to be Implemented under the HCP, for details.

Table 2-18a. Summary of Tacoma Water actions under the Water Withdrawal Alternatives (with Habitat Conservation Measures [HCMs] indicated, where appropriate).

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C New Diversion
GENERAL DESCRIPTION	• No ITP. • Manage Green River operations per current requirements, similar to past practices.	• 50-year ITP for ~~31~~ 32 species. • Manage Green River operations pursuant to proposed Green River HCP.	• 50-year ITP for ~~31~~ 32 species. • Manage Green River operations pursuant to a modified Green River HCP.
DIVERSION OPERATIONS	• Divert up to a maximum of 72 mgd (113 cfs) per the First Diversion Water Right claim from existing Tacoma Headworks.	• Divert up to a maximum of 137 mgd (213 cfs) per First and Second Diversion Water Rights from expanded Tacoma Headworks.	• Divert up to a maximum of 137 mgd (213 cfs) per First and Second Diversion Water Rights, about 15 cfs (maximum) from the existing Tacoma Headworks and the remainder from a new diversion facility at approximately RM 29.2.
INSTREAM FLOW REQUIREMENTS		• Maintain minimum flows at Auburn gauge per MIT/TPU Agreement (HCM 1-01).	• Same as Alternative B.
	• Voluntary summer low-flow Restrictions on First Diversion Water Right claim.	• Seasonal restrictions on Second Diversion Water Right (HCM 1-02).	• Same as Alternative B.
		• Option to provide an additional 5,000 acre feet for low flow augmentation (HCM 2-06).	• Same as Alternative B.

Table 2-18a. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C New Diversion
KEY PROJECT FACILITIES (Associated with the Second Supply Project)	• N/A	• Expand the Tacoma Headworks diversion to accommodate Second Diversion Water Right of up to 100 cfs.	• N/A
	• N/A	• Raise the Tacoma Headworks dam by 6.5 feet.	• N/A
	• N/A	• Add fish screens to the Tacoma Headworks diversion (HCM 1-04).	• Same as Alternative B.
	• N/A	• Construct upstream fish passage facilities at the Tacoma Headworks (HCM 1-03).	• Same as Alternative B.
	• N/A	• Add downstream fish bypass facilities to the Tacoma Headworks dam (HCM 1-04).	• Same as Alternative B.
	• N/A	• Construct Pipeline No. 5.	• Construct a modified Pipeline No.5 from approximately RM 29.2 diversion to Tacoma Water service area.
	• N/A	• N/A	• Construct a 12-foot-high diversion structure at approximately RM 29.2, including upstream and downstream fish bypass facilities.

Table 2-18a. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C New Diversion
KEY PROJECT FACILITIES (Associated with the Second Supply Project) (Con't)	• N/A	• N/A	• Construct a new (screened) intake pump station and treatment plant at approximately RM 29.2.
OTHER FEATURES AND HABITAT RESTORATION MEASURES (Associated with the Second Supply Project)	• N/A	• Install large woody debris, rootwads, and boulders in the Tacoma Headworks inundation pool (HCM 1-05).	• N/A
	• N/A	• Retain 166 acres of deciduous, 48 acres of mixed, and 15 acres of conifer forest in the Howard Hanson Dam inundation zone (HCM 2-04).	• N/A
	• N/A	• Transport and release juvenile salmonids above Howard Hanson Dam if determined to be beneficial (HCM 2-05).	• Same as Alternative B.
	• N/A	• Install up to three snow pillows in the upper Green River Watershed for snowpack and precipitation monitoring (HCM 2-11).	• Same as Alternative B.

Table 2-18a. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C New Diversion
KEY PROJECT FACILITIES (Implemented by Tacoma Water as Local Sponsor for the Additional Water Storage Project)	• N/A	• Construct downstream fish passage facilities at Howard Hanson Dam (HCM 2-01).	• Same as Alternative B.
OTHER FEATURES AND HABITAT RESTORATION MEASURES (Implemented by Tacoma Water as Local Sponsor for the Additional Water Storage Project)	• N/A	• Provide opportunity to manage springtime water storage and release at Howard Hanson Dam (HCM 2-02).	• Same as Alternative B.
	• N/A	• Rehabilitate fish and wildlife habitat in the reservoir inundation zone, and in riparian areas upstream and downstream of Howard Hanson Dam (HCM 2-03).	• Same as Alternative B.
	• N/A	• Reconnect and rehabilitate 3.4 acres of off-channel habitat in Signani Slough (HCM 2-07).	• Same as Alternative B.
	• N/A	• Introduce woody debris into Green River downstream of Tacoma Headworks (HCM 2-08).	• Same as Alternative B.

Table 2-18a. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C New Diversion
OTHER FEATURES AND HABITAT RESTORATION MEASURES (Implemented by Tacoma Water as Local Sponsor for the Additional Water Storage Project) (Con't)	• N/A	• Provide up to 3,900 cubic yards of gravel into the Green River downstream of the Tacoma Headworks (HCM 2-09).	• Same as Alternative B.
	• N/A	• Create off-channel habitat and install large woody debris and rootwads in the Green River, North Fork Green River, and eight tributaries (HCM 2-10).	• Same as Alternative B.

Table 2-18b. Summary of Tacoma Water actions under the Upper Watershed Alternatives (with Habitat Conservation Measures indicated, where appropriate).

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
GENERAL DESCRIPTION	• No ITP. • Manage forestlands pursuant to existing Forest Land Management Plan, with no take of listed species.	• 50-year ITP for ~~31~~ 32 species. • Manage forestlands pursuant to proposed Green River HCP.	• 50-year ITP for ~~31~~ 32 species. • Manage forestlands pursuant to a modified Green River HCP.
TIMBER HARVESTING – COMMERCIAL ZONE			
Conifer Forest Harvest Acres and Method	• Harvest an average of 27 acres of conifer forest annually on a 70-year rotation cycle.	• Harvest no more than 1.5 percent of the coniferous forest in the zone each year (approx. 27 acres) on a 70-year rotation cycle (HCM 3-01D).	• No commercial harvesting. Conduct salvage harvesting only to maintain safety within 150 feet of roads.
Hardwood Forest Harvest Acres and Method	• Harvest 12 acres of hardwood forest annually by clearcutting and converting to conifer forest.	• Same as Alternative A (HCM 3-01E).	• No commercial harvesting. Conduct salvage harvesting only to maintain safety within 150 feet of roads.
Even-aged Harvest Restrictions	• Even-aged harvest units would be limited to 40 acres.	• Same as Alternative A (HCM 3-01H).	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Even-aged Harvest Restrictions (con't)	• Even-aged harvesting would occur only when the surrounding forest land is fully stocked with trees a minimum of 5 years old and 5 feet high.	• Same as Alternative A (HCM 3-01I).	• N/A
	• Replanting requirements would be per the FPRs.	• Even-aged hardwood harvest units would be replanted with 300-400 trees per acre by the first spring following harvest (HCM 3-01M).	• N/A
Uneven-aged Harvest Restrictions	• Uneven-aged harvest units (e.g., thinning) would be limited to 120 contiguous acres.	• Same as Alternative A (HCM 3-01 H).	• N/A
Salvage Harvesting Restrictions	• Salvage harvesting restrictions would be per the FPRs.	• Salvage harvesting would be allowed only in the Commercial Zone or within 150 feet of roads in the Natural and Conservation Zones affected by windthrow, insect infestation, disease, or fire according to set prescriptions (HCM 3-01F).	• Conduct salvage harvesting only to maintain safety within 150 feet of roads.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Other Requirements	• No harvesting or salvage of timber would occur on sites of low productivity (i.e., Douglas-fir 50-year site index of less than 80).	• Same as Alternative A (HCM 3-01J).	• N/A.
	• Retain at least six safe snags, four green recruitment trees, and at least four down logs per acre in areas that are salvage harvested. Meet or exceed current FPR's in other harvest areas.	• Retain all safe snags and at least four green recruitment trees and four down logs per acre, where available, in all harvest units. Create new snags where none are available at the time of harvest (HCM 3-01G).	• N/A
	• No comparable measure.	• Do not burn slash unless burning is part of habitat modification (HCM 3-01L).	• N/A
	• Implement slope-stability prescriptions developed through Watershed Analysis.	• Identify potentially unstable landforms and apply general prescriptions developed by Watershed Analysis or site-specific prescriptions developed by a slope stability specialist (HCM 3-01N).	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
TIMBER HARVESTING – CONSERVATION ZONE			
Conifer Forest Harvest Acres and Method	• Conduct no even-aged harvesting.	• Same as Alternative A.	• No commercial harvesting.
	• No harvesting (except salvage harvesting) would occur in conifer-dominated stands over 100 years old.	• Same as Alternative A, with additional harvesting for habitat modification purposes allowed (HCM 3-01C).	• N/A
Hardwood Forest Harvest Acres and Method	• Convert hardwood to coniferous forest by harvesting approximately 17 acres of hardwood forest annually.	• Same as Alternative A (HCM 3-01E).	• N/A
Even-aged harvest restrictions	• Adjacency requirements would be per the FPRs.	• Same as Alternative A (HCM 3-01I).	• N/A
Uneven-aged Harvest Restrictions	• Uneven-aged harvest units (e.g., thinning) would be limited to 120 contiguous acres.	• Same as Alternative A.	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Salvage Harvest Restrictions	• Salvage harvest restrictions would be per the FPRs.	• Conduct salvage harvesting only to maintain safety within 150 feet of roads.	• Conduct salvage harvesting only to maintain safety within 150 feet of roads.
Other Requirements	• No harvesting or salvage of timber would occur on sites of low productivity (i.e., Douglas-fir 50-year site index of less than 80).	• Same as Alternative A (HCM 3-01J).	• N/A
	• Retain at least six safe snags, at least four green recruitment trees, and at least four down logs per acre in areas that are salvage harvested.	• Retain all safe snags, at least four green recruitment trees and four down logs per acre, where available, in all harvest units (HCM 3-01L).	• N/A
	• Do not broadcast burn slash.	• Do not burn slash unless burning is part of habitat modification (HCM 3-01L).	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Other Requirements (con't)	• Implement slope-stability prescriptions developed through Watershed Analysis.	• Identify potentially unstable landforms and apply general prescriptions developed by Watershed Analysis or site-specific prescriptions developed by a slope stability expert (HCM 3-01N).	• N/A
TIMBER HARVESTING – NATURAL ZONE	• No harvesting of any kind would occur, except to salvage dead or damaged timber or to implement specific habitat improvement projects.	• Conduct salvage harvesting only to maintain safety within 150 feet of roads (HCM 3-01B).	• Conduct salvage harvesting only to maintain safety within within 150 feet of roads.
	• No harvesting or salvage of timber would occur on sites of low productivity (i.e., Douglas-fir 50-year site index of less than 80).	• Same as Alternative A (HCM 3-01J).	• Same as Alternative A.
	• Do not burn slash.	• Do not burn slash unless burning is part of habitat modification (HCM 3-01L).	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
RIPARIAN BUFFERS			
DNR Stream Type 1, Shoreline of the State, >100 feet	• No-Harvest Buffer: 200 feet	• No-Harvest Buffer: 200 feet	• N/A
DNR Stream Types 1 and 2, >75 feet wide	• No-Harvest Buffer: 150 feet	• No-Harvest Buffer: 200 feet	• N/A
DNR Stream Types 1 and 2, <75 feet wide	• No-Harvest Buffer: 100 feet	• No-Harvest Buffer: 200 feet	• N/A
DNR Stream Type 3, >5 feet wide	• No-Harvest Buffer: 75 feet	• No-Harvest Buffer: 150 feet Partial Harvest Buffer: 50 feet	• N/A
DNR Stream Type 3, <5 feet wide	• No-Harvest Buffer: 50 feet	• No-Harvest Buffer: 150 feet Partial Harvest Buffer: 50 feet	• N/A
DNR Stream Type 4	• No-Harvest Buffer: 25 feet	• No-Harvest Buffer: 50-100 feet	• N/A
DNR Stream Type 5	• No-Harvest Buffer: 25 feet	• No-Harvest Buffer: 25 feet Partial Harvest Buffer: 25 feet	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
WETLAND BUFFERS			
Type A (all), >5 acres	• 200 feet	• 200 feet	• N/A
Type A (all), 0.5-5 acres	• 100 feet	• 100 feet	• N/A
Type A (bogs/fens), 0.25-0.5 acres	• 100 feet	• 100 feet	• N/A
Type B (all), >5 acres	• 100 feet	• 100 feet	• N/A
Type B (all), 0.25-5 acres	• 50 feet	• 50 feet	• N/A
Type C (all), >5 acres	• 50 feet	• 50 feet	• N/A
Type C (all), 0.5-5 acres	• 25 feet	• 25 feet	• N/A

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
ROAD CONSTRUCTION AND MAINTENANCE			
Watershed Analysis	• Tacoma Water would continue its participation in Watershed Analysis in the basin, and implement the resulting prescriptions.	• Tacoma Water would participate in all Watershed Analyses in the basin performed according to the WFPB (HCM 3-03A). In WAUs where assessments have not been completed within 2 years following issuance of the ITP, Tacoma Water would complete a surface erotion slope stability analysis on lands in the HCP Area and develop and implement site-specific prescriptions (HCM 3-03A).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Road Construction	• No new roads would be constructed across unstable ~~soils~~ landforms identified through Watershed Analysis.	• Tacoma Water would implement all draft and final mass wasting prescriptions specific to new road construction in WAUs where Watershed Analyses are approved or pending.	• Same as Alternative B.
	• Tacoma Water would use full bench construction with no side casting of excavated material on side slopes of greater than 60 percent.	• Same as Alternative A (HCM3-03D).	• Same as Alternative A.
	• When constructing roads through riparian areas, Tacoma Water would minimize right-of-way clearing, cross streams at right angles, minimize disturbances to natural streamflows, and minimize side casting during construction.	• Same as Alternative A, with additional requirement to provide for upstream and downstream passage in fish-bearing streams (HCM3-03F).	• Same as Alternative B.
	• No net increase in the miles of roads in the Natural Zone.	• Same as Alternative A.	• Same as Alternative A.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Road Maintenance and Erosion Control	• Place mulch and/or grass seed on road cuts and fills with slopes over 40 percent, at water crossings, and in areas of severe erosion/slumping danger above and below roads.	• Same as Alternative A (HCM 3-03E).	• Same as Alternative A.
	• Maintain low-growing vegetation along roads to stabilize soils and minimize erosion.	• Same as Alternative A (HCM 3-03H).	• Same as Alternative A.
Culvert Improvements	• No comparable measure.	• Inventory all roads in the HCP Area and identify all culverts that block fish passage within 1 year of issuance of the ITP. Plans to eliminate blockages would me made within 2 years, and all blockages would be eliminated within 5 years of issuance of the ITP (HCM 3-03J).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Road Use	• Maintain a locked gate to restrict road use except where the USFS requires roads to be open . Roads controlled by Tacoma Water would be closed to heavy truck traffic (e.g., log hauling) when a potential exists for extraordinary damage to the road(s) and/or impacts to water quality	• Same as Alternative A (HCM 3-03G).	• Same as Alternative A.
Road Abandonment	• Roads no longer needed for watershed management or forestry operations would be abandoned.	• Same as Alternative A (HCM 3-03I).	• Same as Alternative A.
Road Sedimentation Reduction Plan	• Participate in the development and implementation of a Road Sediment Reduction Plan for lands covered by Watershed Analysis in the upper Green River Watershed, describing the priorities and schedule for road maintenance, improvement, and abandonment activities that would be implemented to reduce road sediment inputs.	• Develop and implement a Road Sediment Reduction Plan, for all HCP lands, describing the priorities and schedule for road maintenance, improvement, and abandonment activities that would be implemented to reduce road sediment inputs (HCM 3-03B).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
SPECIES-SPECIFIC PROTECTION MEASURES			
Grizzly Bear	• Tacoma Water would conduct no timber harvesting, road construction, aerial application of pesticides, or site preparation within 1 mile of a known active den site between 1 October and 30 May, or within 0.25 mile at other times of the year.	• Tacoma Water would not fell timber, yard timber, construct roads, or apply aerial pesticides within 1 mile of any known active grizzly bear den from 1 October through 31 May; and would contact the USFWS prior to any similar activities within 3 miles of a known den at other times of the year (HCM 3-04A).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would suspend all management activities under its control in the upper HCP Area within 1 mile of confirmed grizzly bear sightings for 21 days unless activities are necessary for the operation of the water supply project (HCM 3-04B).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Grizzly Bear (Con't)	• No comparable measure.	• Tacoma Water would not construct roads across non-forested blueberry and black huckleberry fields, meadows, avalanche chutes, or wetlands in the upper HCP Area (HCM 3-04C).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would retain visual screens along preferred grizzly bear habitat or along roads within 1 mile of said habitat if a grizzly bear is documented in the Green River watershed (HCM 3-04D).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would take measures to prevent the dumping of trash that may attract grizzly bears in the upper watershed (HCM 3-04E).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would prohibit firearms within vehicles of contractors working for Tacoma Water in the upper HCP Area (except in special cases) (HCM 3-04F).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Gray Wolf	• Tacoma Water would conduct no harvesting, road construction, or site preparation within one mile of an active den site between 15 March and 30 July, or within 0.25 mile at other times of the year.	• Tacoma Water would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 1 mile of any known active gray wolf den from 15 March through 15 July and within 0.25 mile of any known active gray wolf "first" rendezvous sites from 15 May through 15 July (HCM 3-04G).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 0.5 mile of any known active Pacific fisher den from 1 February through 31 July (HCM 3-04H).	• Same as Alternative B.
California Wolverine	• No comparable measure.	• Tacoma Water would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 0.5 mile of any known active wolverine den from 1 October through 31 May (HCM 3-04I).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Canada Lynx	• No comparable measure.	• Tacoma Water would not fell timber, yard timber, construct roads, blast, or apply aerial pesticides within 0.25 mile of any known active Canada lynx den from 1 May through 31 July (HCM 3-04J).	• Same as Alternative B.
Peregrine Falcon	• Tacoma Water would conduct no timber harvesting, road construction, site preparation, or aerial application of pesticides within 0.5 mile of an active nest site from 1 March to 30 July, or within 0.25 mile at other times of the year.	• Tacoma Water would not fell timber, yard timber, construct roads or apply aerial pesticides within 0.5 mile, or blast within 1 mile of any known active peregrine falcon nest from 1 March through 31 July (HCM 3-04K).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would not fell timber or alter habitat within 100 feet of any known peregrine falcon nest site or potential nest cliff greater than 75 feet in height in the upper HCP Area; and Tacoma Water would retain large potential perch trees within 660 feet of known peregrine nests (HCM 3-04L).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Bald Eagle	• Tacoma Water would conduct no harvesting, road construction, site preparation, or aerial application of pesticides within 0.5 mile of an active nest site from 1 January to 15 August, or within 0.25 mile at other times of the year. Tacoma Water would conduct no harvesting, road construction, site preparation, or aerial application of pesticides within 0.25 mile of a communal roosting site from 15 November through 15 March.	• Tacoma Water would not fell timber, yard timber, construct roads, or alter habitat within 0.25 mile or aerial spray within 0.5 mile or blast within 1 mile of any known active bald eagle nest from 1 January through 31 August or active communal winter night roost at sensitive times of day from 15 November through 15 March (HCM 3-04M).	• Same as Alternative B.
	• Tacoma Water would develop site-specific nest and roost site protection plans in accordance with FPRs.	• Tacoma Water would not fell timber or otherwise alter habitat within 330 feet of any known bald eagle nest or communal winter night roost in the upper HCP Area (HCM 3-04N).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Northern Spotted Owl	• Tacoma Water would not fell timber, construct roads or apply aerial pesticides within the 70 acres of highest quality spotted owls habitat surrounding a known activity center from 1 March through 31 August.	• Tacoma Water would not fell timber, construct roads or apply aerial pesticides within 0.25 mile, or blast within 1 mile of the activity center of any known northern spotted owl pair from 1 March through 30 June (HCM 3-04O).	• Same as Alternative B.
	• Tacoma Water would conduct no harvest that would: a) reduce the total amount of suitable habitat within 1.8 miles of a known spotted owl activity center below 40 percent, b) reduce the total amount within 0.7 mile below 50 percent, c) or disturb the best 70 acres around the activity center.	• Tacoma Water would not fell timber or otherwise alter habitat within 660 feet of the activity center of any known northern spotted owl pair or resident single in the upper HCP Area (HCM 3-04P).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Northern Goshawk	• No comparable measure.	• Tacoma Water would not fell timber, yard timber or construct roads within 0.25 mile, apply aerial pesticides within 0.5 mile, or blast within 1 mile of any known active northern goshawk nest from 1 March through 31 August (HCM 3-04Q).	• Same as Alternative B.
	• No comparable measure.	• Tacoma Water would not fell timber or otherwise alter habitat within 660 feet of any known active northern goshawk nest in the upper HCP Area (HCM 3-04R)	• Same as Alternative B.
Pileated Woodpecker	• No comparable measure.	• Tacoma Water would give preference to leaving green recruitment trees with visible signs of pileated woodpecker nesting, roosting, and/or foraging when selecting snags and trees to meet other HCMs (HCM 3-04S).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Vaux's Swift	• No comparable measure.	• Tacoma Water would give preference to leaving green recruitment trees with visible signs of current Vaux's swift nesting and/or roosting and those with the potential for future use when selecting snags and trees to meet other HCMs (HCM 3-04T).	• Same as Alternative B.
Other Species-Specific Protection Measures	• No comparable measure.	• Tacoma Water would not harvest timber, yard timber, construct roads, or apply aerial pesticides, herbicides, or fertilizers within 100 feet of unforested talus fields of 0.5 acre or more in size, and would abandon all existing roads through unforested talus fields of 0.5 acre or more in size (HCM 3-04U).	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Other Species-Specific Protection Measures (Con't)	• No comparable measure.	• Tacoma Water would notify the USFWS in a timely manner of any reported sightings of a spotted owl, marbled murrelet, grizzly bear, gray wolf, Pacific fisher, California wolverine, or Canada lynx in the upper HCP Area (HCM 3-04V).	• Same as Alternative B.
	• During the marbled murrelet nesting season, Tacoma Water would conduct no timber felling, yarding, road construction, or aerial application of pesticides within 0.25 mile and no blasting within 1 mile of habitat where "occupancy" of marbled murrelets has been determined or, within similar distances, of habitat that is suitable for murrelet nesting but has not been surveyed.	• During the marbled murrelet nesting season, Tacoma Water would conduct no timber felling, yarding, or road construction within 0.25 mile, no aerial application of pesticides within 0.5 mile, and no blasting within 1 mile of habitat where "occupancy" of marbled murrelets has been determined or where presence of marbled murrelets has been observed but "occupancy" status has not been determined.	• Same as Alternative B.

Table 2-18b. Continued.

Element	ALTERNATIVE A No Action Alternative	ALTERNATIVE B Proposed HCP Alternative	ALTERNATIVE C No Commercial Timber Harvest
Other Species-Specific Protection Measures (Con't)	• No comparable measure.	• Tacoma Water would develop site-specific plans to protect Northwestern pond turtles if they are found to exist on the Covered Lands and could be affected by one or more Covered Activities.	• Same as Alternative B.

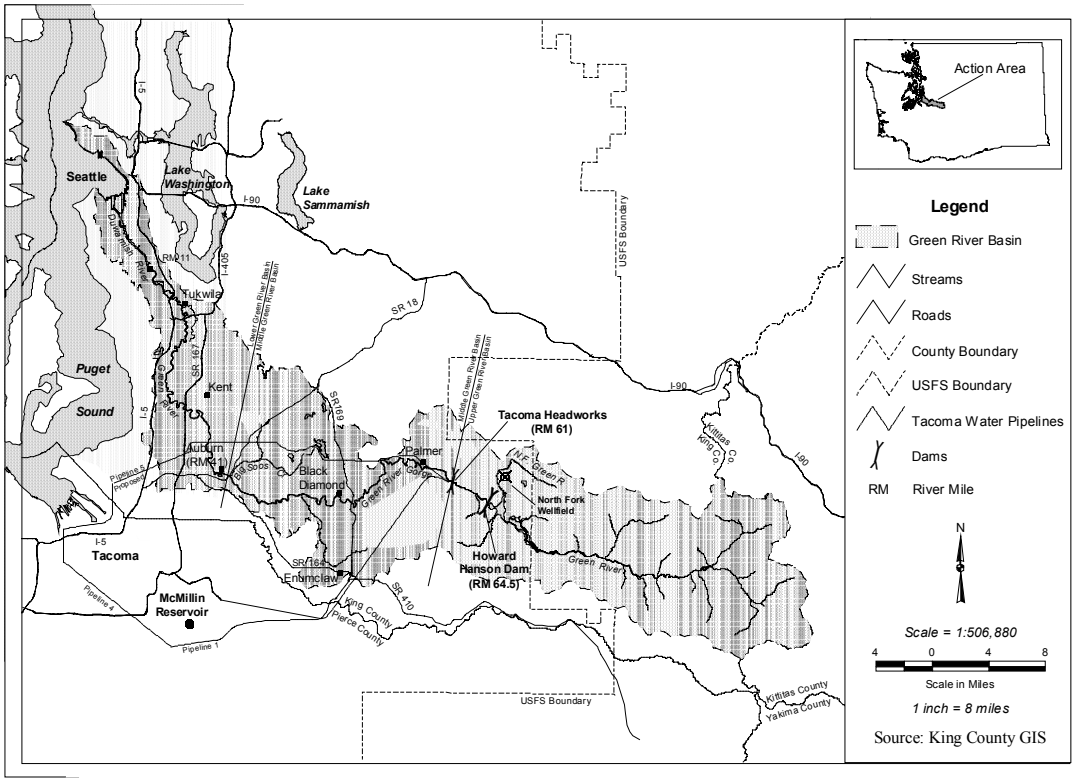


Figure 2-1. Project area and facilities.

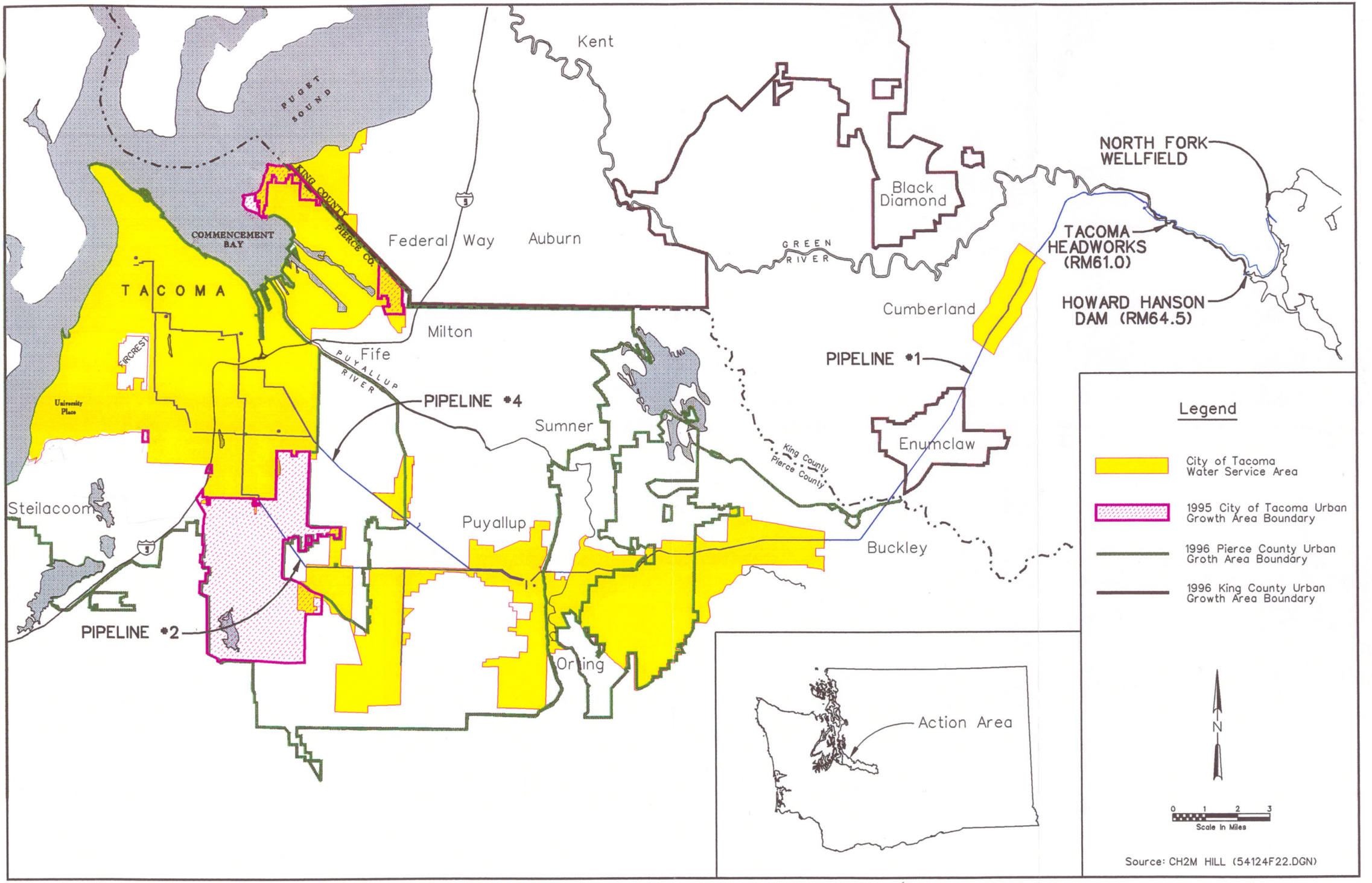
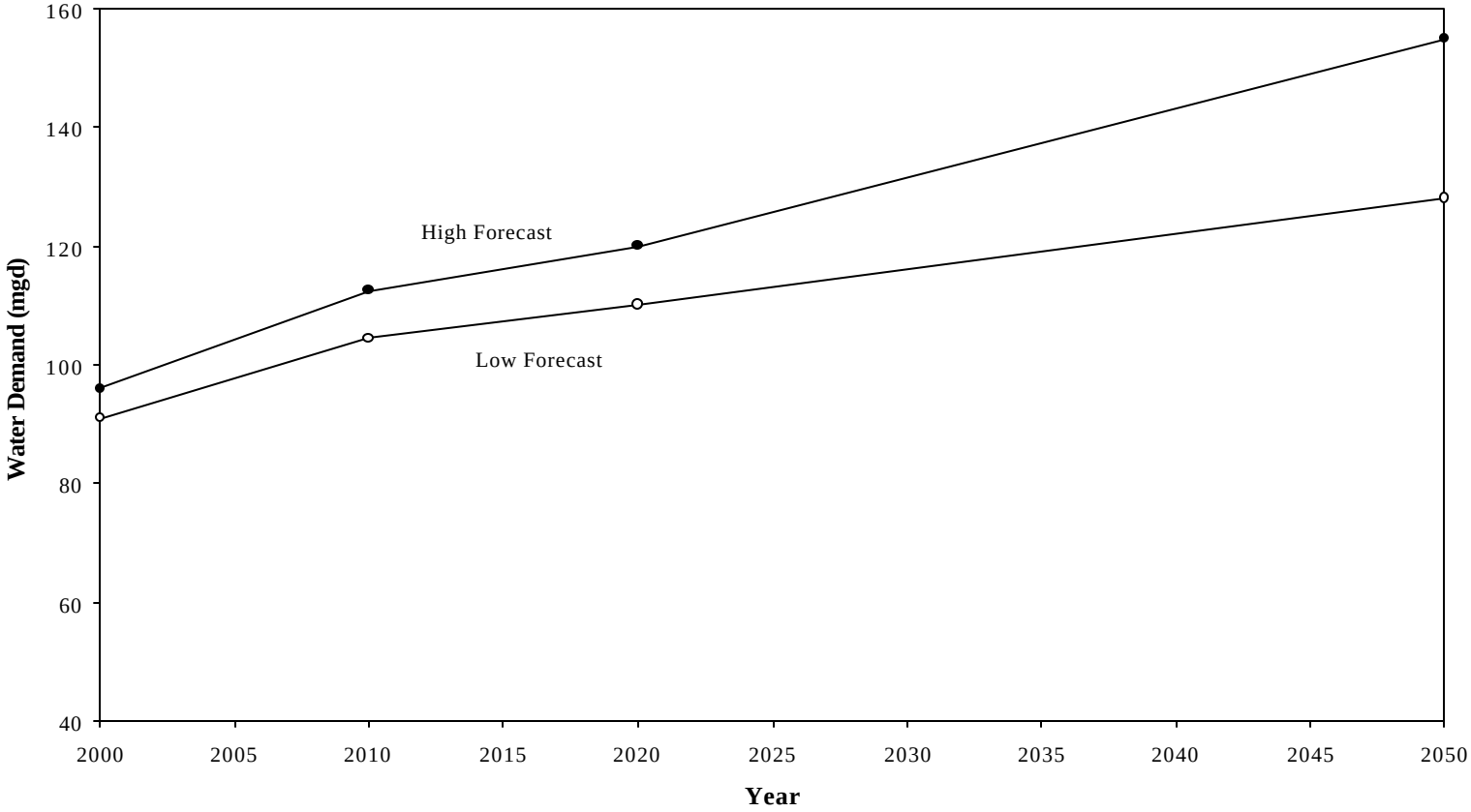


Figure 2-2. Tacoma Water geographic service areas.



Note: forecast includes committed conservation;
low forecast: conservative estimate to account for changes that would partially reduce future water demand;
high forecast: represents water demands that Tacoma Water would experience given expected growth rates and anticipated changes in service territory.

Figure 2-3. Forecasted net average day resource requirements for Tacoma Water.

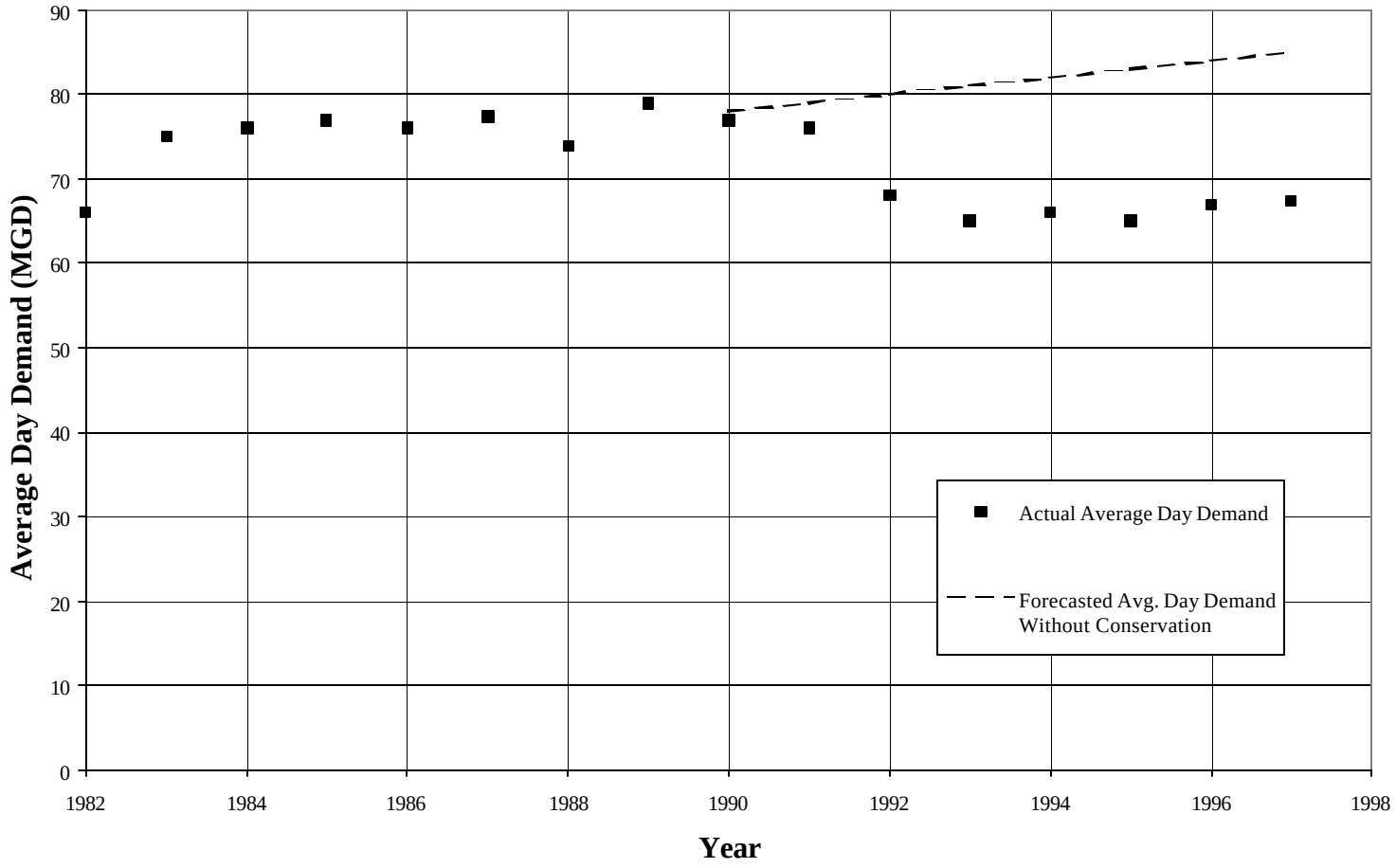
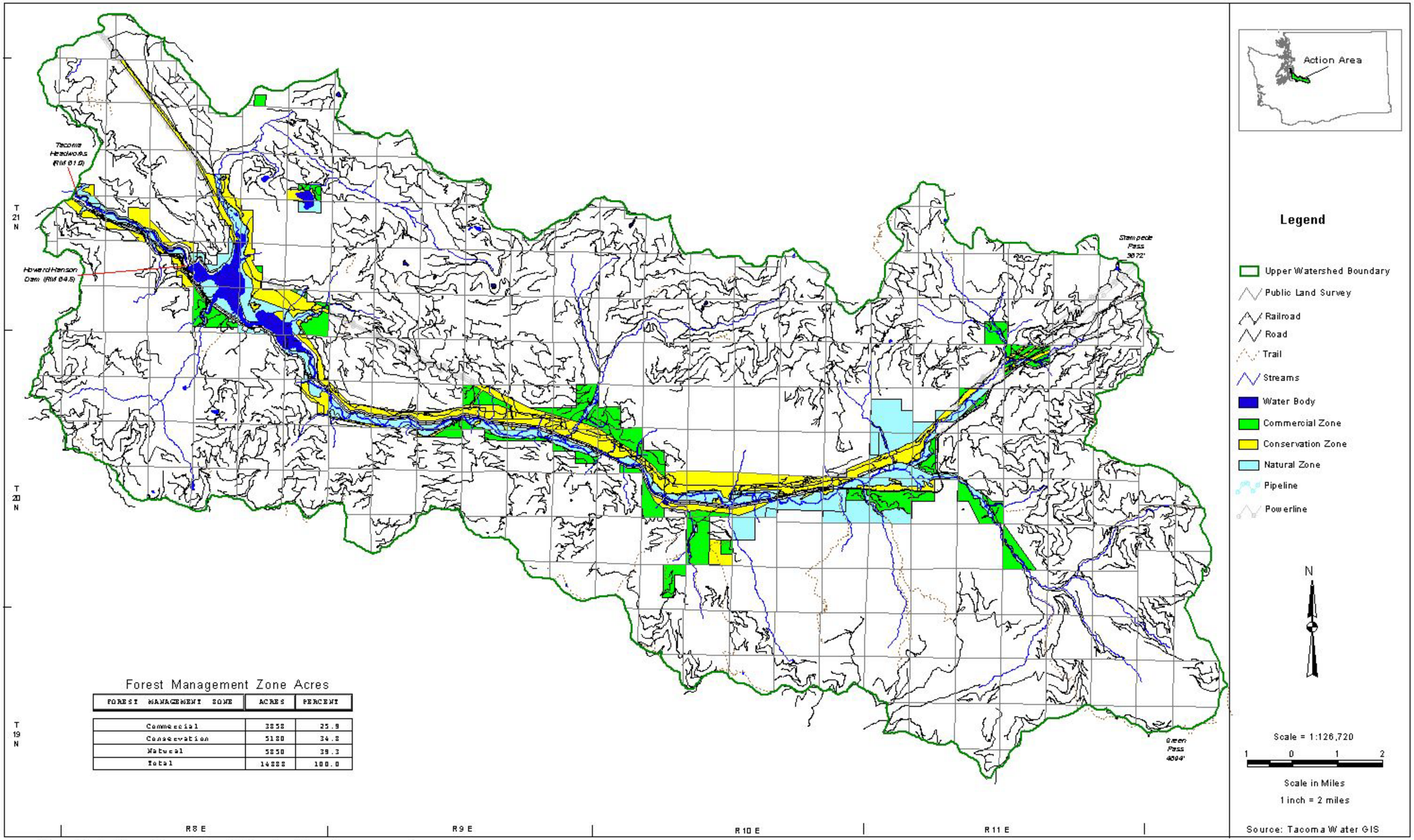


Figure 2-4. Tacoma Water historical Conservation Program performance.



Forest Management Zone Acres

FOREST MANAGEMENT ZONE	ACRES	PERCENT
Commercial	3858	25.9
Conservation	5180	34.8
Natural	5850	39.3
Total	14888	100.0

Figure 2 - 5. Upper Green River Watershed forest management zones.

3.0 Affected Environment

3.1 Introduction

This section describes current conditions of resources that may be potentially affected by implementation of the alternatives. Twelve resources are described, including:

- Environmental Setting (subsection 3.2)
- Ownership and Land Use (subsection 3.3)
- Geology and Soils (subsection 3.4)
- Air Quality (subsection 3.5)
- Surface Water Quality and Quantity (subsection 3.6)
- Vegetation (subsection 3.7)
- Fish and Aquatic Habitat (subsection 3.8)
- Wildlife (subsection 3.9)
- Recreation (subsection 3.10)
- Visual Resources (subsection 3.11)
- Social and Economic Conditions (subsection 3.12)
- Cultural Resources (subsection 3.13)

For the purpose of clarity, the description of the affected environment for each resource is divided into two separate subsections as follows:

1. *The characteristics of the resource are described in the lower and middle Green River Watershed.*

- In total, this area is defined as the area downstream of the Tacoma Headworks diversion (RM 61.0) to the upstream extent of the area of tidal influence/estuary (RM 11.0) (Figure 2-1). This area roughly corresponds to the area potentially affected by changes in Tacoma Water's diversion activities under the Water Withdrawal Alternatives, and it includes the river channel and adjacent floodplain between Howard Hanson Dam and the Tacoma Headworks diversion (up to an elevation inundated at a flow of 12,000 cfs at the USGS Auburn gauge).

- The lower Green River Watershed is defined as the 22.8 miles of river between the area of tidal influence/estuary (RM 11.0) and the confluence with Soos Creek at RM 33.8 near Auburn.

- The middle Green River Watershed lies between Soos Creek at RM 33.8 and the Tacoma Headworks diversion at RM 61.0.

2. *The characteristics of the resource are then described in terms of Tacoma Water's lands in the Upper Green River Watershed. The area potentially affected by Tacoma Water's timber management activities under the Upper Watershed Alternatives (Figure 2-1).*

- The Upper Green River Watershed extends from the Tacoma Headworks diversion at RM 61.0 to the headwaters.

- It includes 14,888 acres of forest owned by Tacoma Water.

It should also be noted that the City of Auburn is frequently used as a reference point throughout the following descriptions. Auburn is located at RM 41.0 (all River Mile locations are provided on the inside back cover of this DEIS).

3.2 Environmental Setting

A detailed description of the Green River basin and Tacoma Water's water supply operations is provided in subsection 2.3 of the proposed HCP. The following is a brief summary of the overall environmental setting.

The action area consists of: 1) Tacoma Water's lands in the Upper Green River Watershed, and 2) flows in the Green River downstream of the Tacoma Headworks diversion (RM 61.0) to the area of tidal influence (RM 11.0). The Upper Green River Watershed includes Tacoma Water's lands above the Headworks diversion and other locations where actions would take place to minimize the effects of Tacoma Water's first diversion and second diversion water withdrawals on fishery resources. These upland areas are in the Southwest Cascades Physiographic Province, generally in the Western Hemlock (*Tsuga heterophylla)* Forest Zone (Franklin and Dyrness 1984).

The *Tsuga heterophylla* Zone is characterized by a wet, mild, maritime climate with an average rainfall of about 58.5 inches, which falls primarily in the fall and winter (Franklin and Dyrness 1984). Considerably more precipitation falls as snow higher in the watershed, and average annual snowfall in the upper watershed is about 78 inches (Franklin and Dyrness 1984). Tacoma's lands in the Upper Green River Watershed are managed primarily to protect water quality, with some timber harvest activity, and are closed to public access.

Howard Hanson Dam was completed by the USACE in 1962 above the Tacoma Headworks at RM 64.5. The purpose of Howard Hanson Dam is to provide low flow augmentation and flood protection to downstream areas. Flood protection stimulated urban development in the lower Green River Watershed. Below Tacoma's Headworks, the river flows through the Green River Gorge, a State Park area that supports multiple-use recreation activities (e.g., whitewater rafting, fishing) (see subsection 3.10, Recreation). Below the Gorge, the Green River flows through riparian forestlands with surrounding agricultural land uses. The landscape along the river gradually becomes more urban in character as the river flows through the Cities of Auburn, Kent, and Tukwila, Washington. In general, the Green River has maintained an amenity value as its surrounding landscape has been urbanized; parks and open space areas are designated at many points along the Green River downstream of the Gorge.

3.3 Ownership and Land Use

The area to be covered by the proposed Action and ITP includes Tacoma Water's lands in the Upper Green River Watershed, as well as lands affected by project facilities near the Tacoma Headworks. The Action Area in the lower and middle watersheds is confined to the river channel (including the treatment facility at RM 60.3) and adjacent floodplain (up to an elevation inundated at a flow of 12,000 cfs) below the Tacoma Headworks. Both of these potentially affected areas are described in this section. All lands described in this section are within King County, Washington.

3.3.1 Lower and Middle Green River Watershed

Lands surrounding the Green River downstream of the Tacoma Headworks include both urban and rural uses. The King County Comprehensive Plan designates all lands along the Green River between the City of Auburn and the Tacoma Headworks as either Rural Residential, Parks, Agricultural (downstream of the Green River Gorge), or Forestry (along and upstream of the Green River Gorge) (King County Office of Regional Policy and Planning 1994). Land uses downstream of the City of Auburn are generally designated as Residential, Industrial, or Parks in the King County Comprehensive Plan, or are located within the urbanized areas of the Cities of Auburn, Kent, or Tukwila with similar land uses along the Green River (King County Office of Regional Policy and Planning 1994).

At RM 29.2, the approximate downstream diversion site described under Water Withdrawal Alternative C (subsection 2.2.4, Water Withdrawal Alternative C), surrounding land uses are primarily residential and open space, with an urban park (Brannan Park) west of RM 29.2, and the Auburn Golf Course and Issac Evans Park east of RM 29.2 (Figure 2-1). Although an exact location for this diversion has not been identified, the Auburn Golf Course, where a new diversion facility would likely be located under Water Withdrawal Alternative C, is designated as Green River Watershed Public and Quasi-Public Uses" in the Comprehensive Plan and Zoning Code of the City of Auburn (City of Auburn 1995).

Shoreline designations along the affected stretch of the Green River described in the *King County Shoreline Management Master Program* include Urban, Rural, Conservancy, and Natural. Under Water

Withdrawal Alternative C, this new water diversion facility could be located in the vicinity of the Auburn Regional Golf Course with a shoreline designation of Rural. Under King County Shorelines Code all shoreline designations - including Rural - may allow the development a new water diversion, subject to certain requirements (King County 1998). These requirements cover the following generalized topics:

- Disturbance of unique/fragile areas, habitat, or public use areas such as parks or monuments;
- visual impact and harmony with surroundings;
- construction and maintenance of facilities;
- rehabilitation of areas disturbed by construction or maintenance;
- non-water-related activities;
- height restrictions;
- surface water and erosion control;
- open space retention;
- parking facilities;
- water quality treatment; and
- structures in shoreline zones.

3.3.2 Upper Green River Watershed

Land ownership in the Upper Green River Watershed ~~(147,295)~~ approximately 148,000 acres is divided among several private and public entities (Figure 3-1). Major landowners include Plum Creek Timber Company (~~34~~36%), USFS (~~22~~21%), DNR (14%), Tacoma Water (10%), Giustina Resources (10%), and Weyerhaeuser Company (6%). The remaining 3 percent is comprised of small ownerships by others. All of these lands are designated as Forestry in the King County Comprehensive Plan (King County Office of Regional Policy and Planning 1994). Two linear facilities, the Burlington Northern Santa Fe Railroad, several large transmission powerlines (i.e., Bonneville Power Administration, Puget Sound Energy), follow the Green River through the upper watershed.

Tacoma Water owns 10 percent (14,888 acres) of the upper watershed, and has concentrated its holdings in lands adjacent to the Green River and the Howard Hanson Reservoir. Tacoma Water has an ongoing

policy to acquire land within 0.5 miles of the Green River and its tributaries as it becomes available. These lands are managed according to Tacoma Water's Forest Land Management Plan (Ryan 1996), and are divided into three forest management zones: Natural, Conservation, and Commercial.

- The **Natural Zone** is made up of surface waters and lowland forest adjacent to the Green River, Howard Hanson Dam reservoir, lakes, and major tributaries. This zone serves as a buffer to protect waters from sediment input and other impacts.

- The **Conservation Zone** is adjacent to and upslope of the Natural Zone and is managed for fish and wildlife habitat, which includes habitat manipulation to attract deer and elk away from areas near the water supply.
- Upslope of the Conservation Zone are lands of the **Commercial Zone**, which is under uneven- and even-aged forest management directed at producing merchantable timber at a sustainable level. Income from management of these lands is used for management of the upper watershed, including securing additional lands to be managed under Tacoma Water's Forest Land Management Plan (Ryan 1996).

Most other non-federal lands in the Upper Green River Watershed are managed for timber production, with timber harvest activities governed by the Forest Practices Rules. For two major landowners (Plum Creek Timber Company and the DNR), additional land use regulations for wildlife management purposes are provided by approved HCPs. U.S. Forest Service lands are managed under the June 1990 Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan (U.S. Forest Service 1990), as amended by the Northwest Forest Plan (U.S. Forest Service and U.S. Bureau of Land Management 1994). The Mt. Baker-Snoqualmie National Forest is managed for multiple uses, including timber harvesting, in the Upper Green River Watershed; however, acreage open to timber harvest activities has been reduced due to the Northwest Forest Plan's designation of several areas in the Green River Watershed as Adaptive Management Areas or Late-Successional Reserve.

The King County shoreline designation upstream of the Howard Hanson Dam is Conservancy. Only the Natural Environment designation is more restrictive than the Conservancy designation within the King County shoreline designation system. Preferred uses within the Conservancy designation are

"nonconsumptive of the physical and biological resources of the area." The Conservancy designation may allow for forest practices subject to certain requirements (King County 1998). These requirements cover the following generalized topics:

- shorelines;
- buffers;
- culvert design;
- roads and landings;
- cut and fill related to road construction;
- waterway crossings;
- bridges/stringer bridges;
- equipment maintenance; and
- use of chemically treated materials.

Figure 3-1. Land ownership in the Upper Watershed.

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3.4 Geology and Soils

The following is a brief description of geology and soils in the Green River basin. Unless explicitly noted, information in these sections is derived from Mullineaux (1970), Dunne and Dietrich (1978), and Snyder et al. (1973). These documents provide a detailed discussion of the geologic processes responsible for forming bedrock and soils in the Green River basin.

3.4.1 Geology

3.4.1.1 Lower and Middle Green River Watershed

Downstream of Tacoma's Headworks at RM 61.0, the Green River flows across a series of sandstone and mudstone bedrock deposits from the Tertiary known as the Puget Group. These easily erodible rock units were deposited in a large coastal plain around 50 to 60 million years ago. Deposits of the Puget Group are exposed in the Green River Gorge and in hills near the confluence of the Green and Black Rivers near the City of Tukwila, but are elsewhere overlain by younger formations (Fuerstenberg et al. 1996). The sandstones and mudstones are easily broken down into fines and do not persist as cobble- and gravel-sized particles after entering the river.

Repeated glaciation of the Puget Sound lowland during the Pleistocene resulted in the formation of a broad drift plain consisting of glacial deposits several hundred feet deep. Prior to major landscape alterations from glacial activity, the Green River flowed north from the area where the Howard Hanson Dam is now located through a valley emerging near the present community of Selleck. Since the Pleistocene, the Green River has incised a new meandering route through the drift plain to around Auburn. The channel formed a wide valley averaging 0.5 mile in width. The valley is filled with alluvial sediments, bordered by steep bluffs composed of predominantly fine-grained material (gravel, sand, and clay). Sampling of the alluvial sediments near Flaming Geyser State Park at RM 45.0 indicates that the majority originated from the resistant vocaniclastic rocks of the Upper Green River basin, rather than the easily weathered sandstones and mudstones of the Puget Group.

The Cedar River converged with the Black River, which was formerly the outlet of Lake Washington, and the combined Black and Cedar Rivers then joined the Green River, which emptied into an embayment of Puget Sound that extended up the present Duwamish/Green River Valley (Figure 3-2). In addition, around 5,000 years ago, the Osceola Mudflow swept down from the slopes of Mount Rainier through the valley of the White River. This major geological event covered the lowlands from the City of Enumclaw to approximately 4 miles north of Auburn with mudflow deposits up to 75 feet thick, well into the present lower Green River basin. The Osceola mudflow caused the White River, which had formerly flowed south into the Puyallup River, to establish a new, northerly course along the mudflow axis and into the Duwamish Valley (Figure 3-2). The combined alluvial deposits of these rivers eventually filled in the embayment to form a broad lowland characterized by meandering river channels and extensive wetlands.

The channels and routes of all these rivers in their lower reaches have undergone major alterations since settlement of the area by Euroamericans. As a result of several large floods, the effects of major log jams, and direct human intervention, the White River now flows south into the Puyallup River, and the Green River has become the major tributary to the Duwamish River (Figure 3-2).

With the lowering of Lake Washington that resulted from the creation of the Ship Canal through Lake Union, the Black River no longer carried the outflow of Lake Washington into the Duwamish River. The Cedar River was rerouted into Lake Washington to provide the flow needed to operate the Ship Canal. The Green River was also rerouted in places and largely channelized in the lower basin. These alterations have resulted in a reduction in the drainage area of the Duwamish River to about one-third its original extent and a reduction in the drainage area of the lower Green River above the Duwamish River to about one-half its original extent.

Figure 3-2. Configuration of the Duwamish basin prior to 1900 and after 1916 (after Dunne and Dietrich 1978).

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3.4.1.2 Upper Green River Watershed

From 50 to 6 million years ago during the Tertiary period, repeated volcanic activity, with intervening periods of erosion, created the Cascade Mountains in the eastern portion of the basin. These rocks are predominantly andesite flows, andesitic tuffs, and breccias with subordinate amounts of basalt and basaltic, pyroclastic, and felsitic rocks (U. S. Army Corps of Engineers 1995). Volcanic deposits cover most of the basin east of the town of Palmer. More resistant volcanic rocks are an important source of gravels and cobbles to the upper Green River channel. The watershed of the Green River above Howard Hanson Dam includes terraces formed in the underlying lava and bedrock by glacial scouring, as well as lacustrine terraces formed when a glacially impounded lake had stable water levels for extended periods.

3.4.2 Soils

3.4.2.1 Lower and Middle Green River Watershed

In the middle Green River basin from Palmer to near Auburn, soils are largely derived from unconsolidated glacial material and occur on more gradual slopes characterizing the rolling topography in this area. Soils in the Everett association, which are gravelly sandy loams formed in glacial outwash deposits, dominate the uplands surrounding the Green River floodplain. Floodplain soils in the middle basin are in the Oridia-Seattle-Woodinville association, which consists of somewhat poorly drained to very poorly drained silt loams, mucks, and peats. There are also strips of gravel and sand deposited along channels, which are typically very narrow but average nearly 1,000 feet in width (nearly one-third of the floodplain) near the confluence of Newaukum Creek.

In the lower Green River basin, soils are also in the Oridia-Seattle-Woodinville association developed from fine-textured alluvial material deposited by the Green, White, and Cedar Rivers, with organic soils in depressional areas. Soils in the lower Green River basin have high agricultural potential, although urban development has now eliminated much of the previous agricultural land use in the area.

3.4.2.2 Upper Green River Watershed

Soils in the upper Green River basin are largely derived from volcanic parent material and occur on mountainous slopes that become very steep toward the crest of the Cascade Mountains. The upper basin also includes terraces in the underlying lava and bedrock created by glacial scouring and by wave action in large Pleistocene lakes that developed between the glacial lobe and the Cascade Mountains. Many locations of bedrock outcrop also exist. The upper Green River and its tributaries have relatively narrow to nonexistent floodplains that are confined by the steep valley sides.

The potential for erosion hazard is high or severe on many soils where the slopes are greater than 35 percent (U. S. Forest Service 1996). These soils often slump or slide in rainy periods after vegetation has been removed. Soil depths range from shallow soils associated with rock outcrops and talus slopes to very deep (greater than 12 feet) valley bottom soils.

3.5 Air Quality

3.5.1 Lower and Middle Green River Watershed

Tacoma Water's actions under each of the alternatives would not affect air quality in the lower and middle Green River Watershed; accordingly, a discussion of existing air quality in this area is not provided.

3.5.2 Upper Green River Watershed

The federal Clean Air Act (CAA), including the amendments of 1977 and 1980 (42 U.S.C. 7401, et seq.), is designed to preserve air resources. Under the Act's provisions, Congress requires implementation of various methods to accomplish national air quality goals. Such methods include State Implementation Plans, deterioration prevention programs, and implementation of National Ambient Air Quality Standards. The state of Washington has an approved State Implementation Plan, which regulates, among other pollutants, emissions from prescribed burning. The State Implementation Plan also addresses particulate matter (including "PM_{10}"), visibility, and smoke management.

The Washington Smoke Management Plan ensures that forest management-related burning activities comply with the CAA (Washington Department of Natural Resources 1995). Slash burning is regulated through the Smoke Management Plan and its fuels program, administered by the DNR and Ecology. The Smoke Management Plan requires that statewide emissions from burning be reduced by 20 percent from historic levels by 31 December 1994. A further 50 percent reduction in statewide emissions is required by 31 December 2000. Currently, statewide emissions are already below the required 2000 levels (Weaver, pers. comm., 10 May 1999). Ecology considers air quality in the Upper Green River Watershed area to be in compliance with national ambient air quality standards (Weaver, pers. comm., 10 May 1999).

The three potential sources of particulate air pollution associated with forest management activities are slash burning, wildfire, and road use. Tacoma Water uses slash burning as part of its site preparation activities, usually by concentrating slash in piles and burning the piles (slash concentration burning) rather than by broadcast burning. As a result of state restrictions on burning pursuant to the Smoke Management Plan, most of Tacoma Water's slash concentration burning occurs during cooler, rainy conditions.

Road use due to timber activities contributes to dust generation and associated air quality impacts. Currently, all roads on Tacoma Water's ownership in the Upper Green River Watershed are unpaved, but experience light traffic (Plum Creek Timber Company 1996a, 1997). Only about 13 percent of the roads in the upper watershed are open to the public, which accounts, in part, for the light traffic use in this area.

3.6 Surface Water Quality and Quantity

3.6.1 Action Area Surface Water Drainage Basins

The Action Area lies within the Green River Drainage Basin (Figure 3-3). The Action Area encompasses lands adjacent to the mainstem Green River from the confluence with headwaters in the upper watershed to the estuary of the Green River in the lower watershed. The Action Area in the lower and middle watersheds is confined to the river channel and adjacent floodplain (up to an elevation inundated at a flow of 12,000 cfs).

The Action Area also contains the lower portions of six WAUs that are tributary to the Green River (Table 3-1). Watershed Administrative Units in the lower and middle watershed include the Cumberland

and Newaukum WAUs. The upper watershed contains the North Fork Green, Smay, Lester, and Sunday Creek WAUs.

3.6.2 Water Quality Standards and Criteria

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) to protect uses of water beneficial to wildlife and humans. The following is a discussion of these standards for the Action Area. Clean Water Act Section 303(d) listings for impaired waterbodies are also discussed.

3.6.2.1 Lower and Middle Green River Watershed

Water Quality Standards for Surface Waters of the State of Washington (Chapter 173-201A WAC), classify the Green River as Class "AA" (extraordinary) upstream of RM 42.9 (approximately Flaming Geyser Recreation Area), Class "A" (excellent) between approximately the lower end of Flaming Geyser Recreation Area and the Duwamish River confluence (RM 42.9 to 11.0), and Class "B" (good) within the Duwamish River (WAC 173-201A-130). These specific classifications are meant to define present and potential uses of these waters and do not necessarily define natural conditions. For example, WAC 173-201A-030 states that Class B waters shall meet or exceed the requirements for most beneficial uses (beneficial uses, as described in WAC 173-201A-030, include but are not limited to agricultural and industrial water supply, stock watering, fish and shellfish habitat, wildlife habitat, and secondary contact recreation). Class A waters shall meet or exceed the requirements for all or substantially all uses (identical to those listed for Class B waters, but in addition including domestic water supply and primary contact recreation). Class AA waters shall markedly and uniformly exceed the requirements for all or substantially all beneficial uses (identical to those listed for Class A waters). These classifications indicate that the Green River has sufficient water quality to support current uses of the river. However, several areas (primarily below Auburn) have been identified where water quality may be limiting to beneficial uses of the river during certain times of the year (U. S. Army Corps of Engineers 1995), as discussed below.

Figure 3-3. Major surface waters and drainage systems in the Action Area.

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Table 3-1. Watershed Administrative Units encompassing the Action Area.

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Different water quality criteria apply to Class AA, Class A, and Class B waters to ensure that the various beneficial uses of these waters are protected. Table 3-2 presents the criteria, as established in WAC 173-201A-030, that apply to Class AA, A, and B waters. These state standards must be maintained as designated by Chapter 173-201A WAC.

3.6.2.2 Upper Green River Watershed

In regard to Tacoma Water ownership in the upper watershed, water quality standards affected by forest practices are addressed by the Washington Forest Practices Board Manual, which states that "whereas Ecology is solely responsible for establishing water quality standards for waters of the state, both the Forest Practices Board and Ecology shall jointly regulate water quality issues related to silviculture in the State of Washington (RCW 90.48.420)." As a result, WAC 173-202, Washington Forest Practices Rules to protect Water Quality, was jointly developed and adopted by the Forest Practices Board and Ecology so that compliance with Forest Practices Rules would in turn achieve compliance with water pollution control laws.

Water quality standards are also maintained through the state's riparian policy, which is aimed at providing adequate physical components to maintain functions necessary to water quality, fish, and wildlife. Forest Practices Rules require that Riparian Management Zones (RMZs) of specified widths must be maintained along each side of DNR Type 1, 2, and 3 streams during timber harvest operations. Leave-tree requirements for RMZs have also been established for DNR Type 1 through 3 waters. Established RMZs are required to provide adequate stream shade, as defined in WAC 222-30-040. On Tacoma-owned lands in the upper watershed, RMZ widths are generally greater than those required under Forest Practices Rules. The Forest Land Management Plan establishes wider RMZs for the purpose of enhancing state-required water quality protection measures (Ryan 1996).

Table 3-2. Water quality standards applicable to the Green River (WAC 173-201A-030).

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Table 3-2. Continued.

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To protect Tacoma's water supply, discharges of waste into the upper Green River basin are prohibited by the state. Tacoma Water restricts public access into this area. Furthermore, adult anadromous salmon do not presently have access to the Upper Green River Watershed. Most salmon die after spawning, and while salmon carcasses contribute nutrients important to ecosystem functions (Cederholm et al. 1999), in the past there has been concern about the potential effect of nutrient loading on water quality in municipal watersheds (Manning et al. 1996). Tacoma Water believes that reintroduction of anadromous fish to the upper watershed does not pose a risk to drinking water quality and public health at the proposed levels described in the Additional Water Storage Project Technical Appendices to the Draft EIS (HCP subsection 5.1, Habitat Conservation Measures). Tacoma has also allowed the transport of adult steelhead into the Upper Green River Watershed since 1992.

Sediment input to the river resulting from high-flow events is known to occur and sometimes causes turbidity increases at the Tacoma Headworks diversion (RM 61.0). Tacoma Water restricts withdrawals when turbidity is in excess of 5 NTUs. Water quality in the Green River below the Headworks is affected by a range of impacts including agriculture, forestry practices, stormwater runoff from urbanized areas, and contaminated sediments and groundwater from industrialized areas and landfills (U.S. Army Corps of Engineers 1998).

Specific water quality data for temperature, dissolved oxygen, turbidity, fecal coliform bacteria, and metals and toxics levels in the Green River are discussed below. These characterizations are based on a 1985 study commissioned by King County Metro (Metro), as reported by the USACE (1995, 1998) and on more recent monitoring by Ecology and Metro.

3.6.2.3 Section 303(d) Listings

Section 303(d) of the 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 for submittal to the U. S. Environmental Protection Agency (EPA) for its review and approval.

In 1998, Ecology prepared a proposed list of water quality limited waterbodies for the state. To date this list has not received final approval by the EPA. Segments of the Green River on the 303(d) list that could be affected by each of the alternatives include: 1) the Duwamish River between RM 0.0 and 11.0 (waterbody segment WA-09-1010), listed as limited for fecal coliform bacteria, pH, and dissolved oxygen, 2) the Green River between RM 11.0 and 42.9 (waterbody segment WA-09-1020), listed as limited for mercury, fecal coliform bacteria, and temperature, and 3) the Green River between RM 42.9 and 64.5 (waterbody segment WA-09-1030), listed as limited for temperature (Washington Department of Ecology 1998).

3.6.3 Temperature

3.6.3.1 Lower and Middle Green River Watershed

Summer water temperatures in the Green River increase progressively as the water travels downstream. Low-flow releases from Howard Hanson Dam during the summer conservation period are made through a 48-inch bypass intake located about 35 feet above the bottom of the pool. The 48-inch bypass pipe is located below the level of typical reservoir stratification. As a result of drawing water from the lower, colder stratum, releases from Howard Hanson Dam during the early summer are usually below the temperature of water flowing into Howard Hanson Reservoir. Later in the summer and in early fall, as cooler water is depleted and warmer surface water is released, temperatures are higher than would be expected under a natural, unimpounded flow regime (U. S. Army Corps of Engineers 1998). These artificially higher temperatures can adversely affect salmon spawning behavior and may accelerate maturation of developing salmon eggs.

High temperatures in the lower and middle Green River probably result from solar heating of the river during summer low-flow periods. The factors responsible for this warming include extensive paved areas in the lower Green River basin that reduce groundwater recharge and subsequent discharge of cool groundwater into the river, low summer flows, and lack of shade along the lower river (U. S. Army Corps of Engineers 1998).

Caldwell (1994) studied temperatures between Howard Hanson Dam and the confluence with the Duwamish River. Between Howard Hanson Dam and the Tacoma Headworks, summer water temperatures averaged 57°F (13.9°C) to 65°F (18.3°C). Caldwell (1994) found water temperatures at the Tacoma Headworks, 3.5 river miles below the dam, to be independent of Howard Hanson Dam outfall temperatures.

Between the lower end of the Green River Gorge and the City of Tukwila, maximum temperatures between 72.5°F (22.5°C) and 75.2°F (24°C) were observed in the summer months. These reported temperatures exceed the state criterion and caused the middle Green River (waterbody segments WA-09-1020 and -1030) to be placed on the state's 303(d) list for temperature.

Metro and Ecology have also measured numerous instances of high water temperatures in the lower Green/Duwamish River, particularly at water quality stations located immediately upstream of the Duwamish River.

Water temperatures above 60°F (15.5°C) are limiting for coldwater-adapted fish, such as salmon and steelhead and also contribute to low dissolved oxygen, another potentially limiting water quality parameter. Elevated temperatures may also result in algae blooms, a particular concern in the lower Green River and in the Duwamish River. It is also thought that high water temperatures affect the movement of migrating adult salmonids, particularly during August and early September (Caldwell 1994).

3.6.3.2 Upper Green River Watershed

Based on data reported by the USACE (1995), water temperatures in the Green River above Howard Hanson Dam were found to be generally below 60°F (16°C). However, inflows into the Howard Hanson Reservoir did exceed 60°F (16°C) during the summer in most years. Such periods were generally brief and did not appear to greatly affect reservoir temperatures. Temperatures in the lower levels of the reservoir during the summer were found to be between 50°F (10°C) and 55°F (12.8°C), which was 15°F (8.3°C) below surface temperatures during the same time period. Surface temperatures fluctuate more than deeper-layer temperatures, and reservoir stratification was generally weaker than in natural lakes (U. S.

Army Corps of Engineers 1998). A more thorough assessment of temperature conditions in the Green River can be found in the Howard Hanson Additional Water Storage Project Draft Project Feasibility Study Report and Environmental Impact Statement, Appendix D3, Section 1 (U. S. Army Corps of Engineers 1998).

3.6.4 Dissolved Oxygen

Dissolved oxygen can be severely limiting to aquatic organisms, and species differ in their abilities to tolerate low dissolved oxygen levels. Since dissolved oxygen levels in clean waters are inversely related to temperature, low dissolved oxygen levels have the highest potential to occur during periods of high temperatures.

3.6.4.1 Lower and Middle Green River Watershed

In the lower and middle Green River, levels of dissolved oxygen are generally satisfactory to support fisheries resources. Samples collected by Metro in the lower Green River show a few occasions where dissolved oxygen levels were measured below the state Class A criterion (U. S. Army Corps of Engineers 1995). However, these violations of the state criterion were not frequent enough to warrant listing the lower Green River as water quality-limited for dissolved oxygen. Low dissolved oxygen can impair successful migration by fish and may affect reproductive success, especially during periods when eggs and hatchlings are within the gravel strata.

3.6.4.2 Upper Green River Watershed

In the Green River above Howard Hanson Dam, dissolved oxygen levels were found to be relatively high and stable (U. S. Army Corps of Engineers 1995), consistent with the generally cool temperatures recorded in this reach. The low level of stratification in the Howard Hanson Dam reservoir allows dissolved oxygen to disperse to the bottom layers, and the reservoir is oligotrophic with no substantial algae blooms or macrophytes that might decay and result in low dissolved oxygen. There have been no recorded observations in the Green River or in the Howard Hanson Reservoir where dissolved oxygen has fallen

below the standard for Class AA waters (9.5 mg/L), although there has been little sampling in these waters to date.

3.6.5 Turbidity

3.6.5.1 Lower and Middle Green River Watershed

In the lower and middle Green River, turbidity is not generally limiting to fish, although it may limit other uses such as water supply and recreation. Turbidity is of greatest concern during flood events and when Howard Hanson Reservoir levels are low, both of which can result in river water at the Tacoma Headworks being too turbid for use by Tacoma Water. When this occurs, Tacoma Water uses water from the North Fork Wellfield located in the upper North Fork Green River basin until turbidity levels fall to acceptable levels. A detailed discussion of turbidity effects from operation of Howard Hanson Dam can be found in Appendix D3, Section 2 of the Howard Hanson Additional Water Storage Project Draft Project Feasibility Study Report and Environmental Impact Statement (U. S. Army Corps of Engineers 1998).

3.6.5.2 Upper Green River Watershed

Turbidity is the only water quality parameter that has seasonally exceeded Class AA standards in the Green River above Howard Hanson Dam (U. S. Army Corps of Engineers 1995). Periods of high turbidity are generally associated with winter storms and snowmelt. Evaluation of fine sediment production in the Green River by Plum Creek Timber Company (1996a) shows that sediment production increased from the period 1958-1967 to 1968-1978, but decreased from 1968-1978 to 1979-1995. Plum Creek Timber Company (1996a) found that mass wasting was the largest source of fine sediment to the river. Timber harvest and road construction increased dramatically in several subwatersheds of the Upper Green River Watershed in the late 1960s and early 1970s. Large runoff events in association with these management activities are a likely cause of higher sediment production in the 1968 to 1978 period. With recovery of vegetation and improved forest management practices, sediment production in the Green River Watershed has since been declining.

The USFS has estimated that 824 miles of road access exists in the upper Green River basin, of which approximately 34.5 miles are decommissioned roads (U.S. Forest Service 1996). Roads, especially older roads, can contribute substantial quantities of sediment to streams and to the upper Green River. Additionally, roads on steep slopes can cause mass wasting events, which may cause large debris flows into streambeds. Suspended sediments in upper basin streams eventually enter the Howard Hanson Reservoir. According to the USACE, studies have shown no net accretion of sediment in the reservoir, but it is likely that large, heavy particles settle in the reservoir while small particles are carried downstream of Howard Hanson Dam (U.S. Army Corps of Engineers 1998).

3.6.6 Fecal Coliform

3.6.6.1 Lower and Middle Green River Watershed

Water quality standards for fecal coliform are frequently exceeded in parts of the lower and middle Green River and its tributaries. The state water quality standard established for fecal coliform was exceeded 204 times during the period from July 1987 to January 1992 in the lower Green/Duwamish River, including tributaries (U. S. Army Corps of Engineers 1995). More recent monitoring between 1991 and 1997 conducted by Metro and Ecology have documented enough failures of the fecal coliform standard to place the lower and middle Green River (overlapped by waterbody segment WA-09-1020) on the state's 303(d) list. Livestock access to streams is thought to be the primary cause of high fecal coliform levels, and exceedances are most common during significant storm events when storm runoff washes fecal material from agricultural lands. In addition, the functional lifespans of the septic systems for some of the early developments along the river have been exceeded. As a result, failing septic systems may be contributing to the elevated coliform levels measured between Auburn and Kent (U. S. Army Corps of Engineers 1995).

3.6.6.2 Upper Green River Watershed

Human fecal coliform sources in the Green River basin above Howard Hanson Dam are minor because of restricted development in this portion of the watershed. Animal fecal coliform sources in the basin above Howard Hanson Dam are limited to wildlife populations in the immediate vicinity of the mainstem and

tributaries. Tacoma Water's Forest Land Management Plan manages lands to attract elk and deer away from areas near waterbodies to reduce potential fecal coliform input from those sources (Ryan 1996).

3.6.7 Metals and Toxics

3.6.7.1 Lower and Middle Green River Watershed

Ecology has measured levels of mercury, copper, lead, and zinc above state-established standards in the Duwamish River (U.S. Army Corps of Engineers 1995). However, concentrations of most of these metals have not exceeded state standards frequently enough to warrant placement on the state's 303(d) list for 1998.

The metal of most concern in the Green River is mercury. King County and Ecology have reported mercury at levels above state standards in the lower Green River. These sampling results have put the lower Green River (waterbody segment WA-09-1020) on the state's 303(d) list for mercury. One source of mercury was the Renton Treatment Plant, which discharged wastewater into the Black River/Springbrook Creek until 1987. An additional source of metals into the river may be leachate from the now closed Kent Highlands Landfill.

Toxic contaminants have been identified in bottom sediments and surface water in the lower Green River and especially in the Duwamish River (U. S. Army Corps of Engineers 1995). Chemical testing of bottom sediments in the lower 5 miles of the Duwamish River revealed contamination by oil and grease, sulfides, pesticides, and polychlorinated biphenyls. More recently, Ecology cited excursions beyond criteria in sediment for polychlorinated biphenyls and polyaromatic hydrocarbons. Potential contamination sources are common along industrialized sections of the Duwamish River, which is currently being addressed as part of the EPA's Elliott Bay Toxics Action Plan as well as other programs addressing remediation and source control for toxic contaminants. Runoff from agricultural and other developed areas are also thought to be sources of toxic contaminants in the lower Green River (Duwamish River and Elliott Bay Water Quality Assessment Team 1999).

3.6.7.2 Upper Green River Watershed

In the upper Green River above Howard Hanson Dam, heavy metals such as arsenic, lead, and zinc have been identified in preliminary results from sediment and tissue samples from resident fish taken at Twin Camps Creek, which were collected as part of the U. S. Geological Survey's (USGS) National Water Quality Assessment Program (U.S. Army Corps of Engineers 1998). The Puget Sound Basin, including the Green River basin, is one of 15 water quality study units initiated in 1994 under the National Water Quality Assessment Program. The source of these heavy metals is unclear as there has been limited resource development in the area besides timber management.

3.7 Vegetation

The following is a brief discussion of the plant communities within the Action Area. Expanded discussions are provided in subsection 5.9.1 of the Howard Hanson Additional Water Storage Project Draft Project Feasibility Study Report and Environmental Impact Statement, in Section 1.4 of Appendix F of that same report (U.S. Army Corps of Engineers 1998), and in the Draft HCP for Green River Water Supply Operations and Watershed Protection (Tacoma Water Habitat Conservation Plan 1998).

3.7.1 Plant Communities in the Lower Green River Watershed

The lower Green River Watershed, as defined for purposes of Tacoma Water's HCP, consists of the 22.8 miles of river between the estuary at the mouth of the river and the confluence with Soos Creek near the City of Auburn. Most of the lower Green River basin below Auburn is within a low-lying valley bottom and has little remaining natural vegetation due to urbanization and agricultural changes to the landscape. Existing cover types are mostly pasture, cropland, and urbanized areas. Prior to alteration by Euroamericans, the floodplain of the lower Green River was characterized by extensive wetlands. The low-lying topography, fine textured soils, and frequent flooding supported large wetland systems (U.S. Army Corps of Engineers 1995). Diking and channelization of the river and filling and draining of floodplain areas in the lower basin have eliminated the majority of these wetland plant communities. The Action Area in the lower watershed is confined to the river channel and adjacent floodplain (up to the elevation inundated at a flow of 12,000 cfs), and generally includes only limited vegetated areas, if any, comprised of grasses, shrubs, and deciduous trees.

3.7.2 Plant Communities in the Middle Green River Watershed

The middle Green River basin (i.e., between Soos Creek at RM 33.8 and the Tacoma Headworks at RM 61.0) occurs within the Western Hemlock Forest Zone (Franklin and Dyrness 1984). Dominant tree species in the Western Hemlock Zone include western hemlock (*Tsuga heterophylla*), western redcedar (*Thuja plicata*), and Douglas-fir (*Pseudotsuga menziesii*). Natural stands in this forest zone, if undisturbed, eventually develop "old-growth" characteristics, which include dominant trees greater than 3 feet in diameter and 200 feet in height, multiple age and size classes of trees ranging from large dominants to seedlings, large standing dead trees (snags), and heavy accumulations of logs on the forest floor (Franklin et al. 1981). Existing forested areas in the middle basin are dominated by second-growth Douglas-fir.

Further downstream, cover types characterized by pasture and cropland become more common. Other than a narrow riparian zone, few wetlands occur in the narrow Green River floodplain between Howard Hanson Dam and the lower end of the approximate 13-mile-long Green River Gorge (approximately RM 45.6). Below the Gorge, riparian deciduous forest dominated by black cottonwood (*Populus trichocarpa*) and red alder (*Alnus rubra*) occurs in patches on the floodplain, most of which likely pre-date the operation of Howard Hanson Dam when flood control was initiated. The mosaic of successional stages of riparian forest reflects the previous flood history of the river.

Like the lower watershed, the Action Area in the middle watershed is confined to the river channel and adjacent floodplain (up to the elevation inundated at a flow of 12,000 cfs). Outside of the Gorge, the middle watershed Action Area includes limited areas of shrub and deciduous tree vegetation growing adjacent to the river channel and within several backwater channels.

3.7.3 Plant Communities in the Upper Green River Watershed

The upper Green River basin also occurs within the Western Hemlock Forest Zone. Hardwood forests are commonly restricted to moist, early successional sites, where red alder often dominates, and big-leaf maple (*Acer macrophyllum*) is common. Forested riparian areas along streams in the upper Green River basin are typically dominated by red alder and/or black cottonwood.

Disturbance has had a major impact on forest patterns in the upper Green River basin due primarily to extensive timber harvest and past wild fires. Timber harvest activities have resulted in the predominance of second-growth, even-aged coniferous stands. There is also a large area of hardwood dominated by red alder with an understory of western hemlock and western redcedar present. The majority of the stands are 30 to 90 years old and, until about 30 years ago, regenerated naturally. More recently harvested areas have been planted with Douglas-fir.

The Action Area in the upper watershed is comprised of lands owned by Tacoma Water, including the Howard Hanson Dam Reservoir, upper watershed restoration/rehabilitation sites, Howard Hanson Dam downstream fish passage facility, and the river channel and adjacent floodplain of the Tacoma Headworks inundation pool. Tacoma currently owns 14,888 acres of land in the upper watershed; 3,244 acres on Tacoma's ownership are non-forested, and 11,644 acres are forested. The distribution of age classes of coniferous and hardwood-dominated stands currently managed by Tacoma Water are shown in Table 3-3.

3.7.4 Plant Species of Special Interest

Table 3-4 lists those plant species with federal status and all state threatened or endangered species that could potentially occur in King County. Habitat information is presented in this table along with a general assessment of the potential for each species to occur in the Action Area.

One federally endangered species, ~~swamp~~ marsh sandwort (*Arenaria paludicola*), is listed by the Washington Natural Heritage Program (WNHP) as being historically collected in King County (Washington Natural Heritage Program 1999) (Appendix A, Plant and Animal Database Searches). The WNHP lists this species as being possibly extinct or extirpated in the State of Washington. The WNHP also identifies one federally threatened plant species and three federal plant species of concern as occurring in King County (Table 3-4). Golden Indian paintbrush (*Castilleja levisecta*) is listed as a federal threatened species and endangered species by the State of Washington. Tall bugbane (*Cimicifuga elata*) is a federal plant species of concern and a state threatened species. White-top aster (*Aster curtus*) and stalked moonwort (*Botrychium pedunculosum*) are federal plant species of concern and state sensitive species. Two additional plants, water lobelia (*Lobelia dortmanna*) and choris' bog-orchid (*Platanthera chorisiana*), are listed as state threatened species but have no federal status (Washington Natural Heritage Program 1999).

The WNHP maintains a database system that contains information on the occurrences of rare, threatened, and endangered plants and high quality plant communities within the State of Washington. A March 1999 search of this database produced no documented occurrences of plants in these categories within 5 miles of the Action Area (Appendix A, Plant and Animal Database Searches). White-top aster was documented to occur 7 miles north of the middle Green River basin.

The USFWS listed tall bugbane (a federal species of concern) as the only federal-listed or plant species of concern that may be present in the Action Area (Appendix A, Plant and Animal Database Searches).

3.8 Fish and Aquatic Habitat

It is assumed that, historically, fish habitat within the Green River basin has been excellent for anadromous salmon and trout, resident trout, and other coldwater native species (U.S. Army Corps of Engineers 1996). Currently chinook, coho, chum, pink and sockeye salmon, steelhead, and coastal cutthroat trout are found at various times of the year in the Green River. Native resident salmonids include rainbow and cutthroat trout and mountain whitefish. Other native resident fish species are also present, including lamprey and various minnow, sculpin, and sucker species.

The Green/Duwamish River basin lies within the southernmost portion of the North Cascades ecoregion in the Puget Sound basin (U.S. Army Corps of Engineers 1996). This ecoregion (an area with distinct climate, wildlife, and plant populations) is an important producer of fish and wildlife resources. Anadromous fish species historically had access to the upper basin above the Tacoma Headworks diversion. However, anadromous fish access to the upper Green River is now blocked by Howard Hanson Dam at RM 64.5 (completed in 1962) and Tacoma's Headworks diversion at RM 61.0 (completed in 1912).

Table 3-3. Forest age class distribution on Tacoma-owned lands within the Upper Green River Watershed.

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Table 3-4. Plant species with federal or state threatened or endangered status that occur in King County, Washington, and their likelihood of occurrence within the Action Area.

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Table 3-4. Continued.

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The middle Green River basin includes the 13-mile-long Green River Gorge (subsection 3.1, Introduction). The middle Green River basin and lower Green/Duwamish basin lie within the Puget Lowland ecoregion, which is characterized by open hills and flat lacustrine and glacial deposits. This region once contained extensive wetlands; however, the lower portion of the basin was historically developed for agricultural use. Much of the forested areas were cleared for pastureland, and riparian zones were restricted by levees. Much of the lower basin has since been developed as urban areas and includes the cities of Auburn and Kent (U.S. Army Corps of Engineers 1996). The Duwamish River historically consisted of extensive saltwater and brackish marshes.

The lower Green/Duwamish River served as a transportation corridor for anadromous fish and was probably extensively used by juvenile salmonids (Grette and Salo 1986). Tidewater fish that likely used the estuary of the Duwamish River include smelt (*Osmeridae*), sole (*Pleuronectidae*), sanddab (*Bothidae*), goby (*Gobiidae*), sculpin (*Cottidae*), Pacific sandlance (*Ammodytes hexaperterus*), and tube-snout (*Aulorhynchus flavidus*) (Grette and Salo 1986).

3.8.1 Fish Species of Special Interest

Tacoma Water is seeking ITP coverage for 11 anadromous fish species. Several of these species exhibit resident freshwater phases. Nine species were selected to be discussed in detail because of their status as fishes of primary concern, as USFS-sensitive species, or as species proposed for listing under the ESA (Appendix A, Plant and Animal Database Searches). The anadromous salmonids include chinook, coho, chum, pink, and sockeye salmon, and steelhead, coastal cutthroat, and bull trout/Dolly Varden. Resident salmonids that would be covered by the ITP include rainbow, cutthroat trout, and bull trout/Dolly Varden. Pacific salmon and four species of western North American trout are members of the genus Oncorhynchus, while Dolly Varden and bull trout belong to the char genus Salvelinus. Dolly Varden and bull trout are char native to Washington state. The WDFW management policy does not distinguish between Dolly Varden and bull trout, and for the purposes of the ESA considers Washington's native char populations to be predominantly bull trout (Washington Department of Wildlife 1992) (Appendix A, Plant and Animal Database Searches).

Two other anadromous species that would be covered by the ITP are Pacific and river lamprey (*Lampetra tridentatus, L. ayresi*). Chinook salmon were listed as threatened in the Puget Sound Evolutionary Significant Unit (ESU) by NMFS on 9 March 1998 (63 FR 11482)(Table 3-5). Bull trout/Dolly Varden were proposed for listing as a threatened species by the USFWS within the Puget Sound Distinct Population Segment (DPS) on 10 June 1998 (63 FR 31693) and were listed as threatened in the Puget Sound DPS on 1 November 1999 (64 FR 58909). Other than those on the federal list, none of the fish species present in the Green River drainage are currently listed as endangered, threatened, or sensitive by the State of Washington (WAC-232-12-011)(Table 3-5). Detailed life history information for each of the 11 anadromous fish species can be found in Appendix A of the proposed HCP.

3.8.1.1 Species Listed as Threatened under the ESA

Chinook Salmon *(Oncorhynchus tshawytscha)*

Life History and Habitat Requirements

Most chinook salmon present in the Green River are summer/fall run fish (Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes 1994). Adult chinook salmon migrate upstream the Green River from the Puget Sound from late June through November (Grette and Salo 1986). Owing to their body size, the presence of deep holding water and sufficient discharge are important to allow upstream passage through the lower and middle reach of the river. The upstream migration of chinook salmon in the lower Green River may be delayed by warm water temperatures and low dissolved oxygen concentrations in the late summer and early fall (Fujioka 1970; Williams et al. 1975), which are most likely to occur under low flow conditions.

Chinook salmon spawn in the Green River from early September through mid-November (Grette and Salo 1986). Caldwell and Hirschey (1989) report that chinook salmon in the Green River typically spawn in large gravels and cobbles at depths greater than 1 feet, and in water velocities ranging from about 2 to 3 feet per second (fps). The length of incubation in the Green River varies depending on location of redds and water temperature conditions, but is generally completed by the end of February. Chinook salmon fry usually emerge from gravels 2 to 3 weeks after hatching (Wydoski and Whitney 1979).

Table 3-5. Federal and state status of fish species present in Green River Watershed.

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Most juvenile chinook salmon in the Green River have an ocean-type life history, meaning that they migrate to the ocean as fry 3 to 4 months following emergence from spawning gravels (Lister and Genoe 1970; Healey 1991). Consequently, the fry outmigration period for chinook salmon in the Green River extends from February through June. However, some chinook salmon juveniles in the Green River may migrate to the ocean later during the year (e.g., late summer and fall), or during the following spring following a 1-year period of freshwater residency. Ocean-type chinook salmon reside in estuaries for longer periods as fry than juveniles with stream-type life histories (Myers et al. 1998).

The peak movement of subyearling chinook planted in the upper watershed during 1991 into Howard Hanson Reservoir was observed in late May and early June (Dilley and Wunderlich 1992). The peak outmigration period for chinook smolts migrating out of the reservoir was between late April and early June, based upon studies conducted in 1992 (Dilley and Wunderlich 1993). The period of peak fry outmigration in the middle Green River was observed from 7 April through 17 April (Dunstan 1955). Recent juvenile surveys conducted in the middle Green River found that chinook salmon peaked in early April; chinook salmon fry were observed to be present in this section of the river from 25 February through 25 June (Jeanes and Hilgert 1999). Age-1+ chinook were also captured during juvenile salmonid surveys in the middle Green River (Jeanes and Hilgert 1999). The origin of age-1+ chinook is unknown, but they may represent fish over-wintering in the Green River, or fish originating upstream from Howard Hanson Dam.

Studies performed in the Duwamish estuary indicate that peak chinook fry abundance in the Duwamish estuary occurs during late May (Bostick 1955; Weitkamp and Campbell 1979). Meyer et al. (1980) found the greatest abundance of juvenile chinook during early May, although chinook persisted in beach and purse seine catches through July, indicating that juvenile chinook display an extended period of residency in the Duwamish estuary.

Most chinook salmon in the Puget Sound mature after 2 to 4 years of ocean residency, although the length of saltwater life can range from 1 to 6 years along the west coast (Myers et al. 1998). A small portion of males may mature early as "jacks" and return to fresh water after several months of ocean residency. Most chinook salmon originating from the Green River mature at age-4 (62%) and age-3 (26%), with a minority of fish maturing at age-2 (1%) and age-5 (11%) (Washington Department of Fisheries et al. 1993).

Current Distribution

Preferred spawning areas for chinook salmon in the Green River include the main river channel from Kent (RM 24.0) to the Tacoma Headworks diversion (RM 61.0). Spawning chinook salmon also utilize the lower portions of Newaukum and Big Soos Creeks (Williams et al. 1975; King County Planning Division 1978). Due to their ocean-type life history, most juvenile chinook salmon migrate out of the Green River as fry within a few months of emergence from gravels. Consequently, the mainstem sections of the river function primarily as a transportation corridor for these fish. The side channels present in the middle section of the Green River may provide important rearing habitat areas to chinook fry prior to their outmigration into the Puget Sound (Coccoli 1996; Jeanes and Hilgert 1999). Juvenile chinook salmon are also present in the Upper Green River Watershed as a result of outplanting programs conducted by the Muckleshoot Indian Tribe since 1987 (U.S. Army Corps of Engineers 1998, Appendix F1). These fish are presently found in the tributaries where they are released, as well as in the mainstem upper Green River. Like the middle and lower sections of the river, the upper Green River functions mainly as a transportation corridor for outmigrating chinook fry.

Stock Status

The Green River summer/fall chinook salmon stock is part of the Puget Sound ESU, which includes 28 distinct stocks of chinook salmon (Myers et al. 1998). Overall, abundance of chinook salmon in this ESU has declined substantially, and both long- and short-term abundance are predominantly downward. These factors have led to the listing of this ESU as proposed threatened under the ESA (50 CFR Parts 222, 226 and 227).

Chinook salmon within the Duwamish/Green River basin originate from both native and hatchery fish. The stock is of mixed origin, as natural production is currently supplemented by hatchery releases from the Green River Hatchery located on Soos Creek. Genetic analysis is currently underway to determine if the chinook spawning in Newaukum Creek are a separate stock from those spawning in the Green River (Washington Department of Fish and Wildlife et al. 1994). Coded-wire tag recoveries indicate that some hatchery strays are spawning naturally in the Green River and Newaukum Creek (Washington Department

of Fish and Wildlife et al. 1994). The hatchery stock of chinook salmon is currently believed to have descended from the wild run (Grette and Salo 1986). The majority of hatchery releases of chinook salmon in the Puget Sound ESU have originated from the Green River Hatchery, or broodstocks derived from this hatchery (Myers et al. 1998; Fed. Reg. 63[45]:11482-11520).

Escapement of summer/fall chinook salmon in the mainstem Green River averaged 7,600 from 1987 through 1992, with a trend toward increasing escapement during this period (Washington Department of Fish and Wildlife et al. 1994). The WDFW has classified the Green River stock as "healthy" based on high levels of escapement and increasing population trends (Washington Department of Fish and Wildlife et al. 1994). However, a declining population trend was observed in the Green River from 1987 to 1996, as was the case for most river drainages within the Puget Sound ESU during this period (Myers et al. 1998).

It is unknown whether a spring chinook population is present in the Green River (Grette and Salo 1986). A small run may have been present prior to the separation of the Green and White Rivers in 1906; however, little information is available (Grette and Salo 1986). There is currently no hatchery production of spring chinook in the Green River.

Bull Trout/Dolly Varden *(Salvelinus confluentus)*

Life History and Habitat Requirements

Bull trout/Dolly Varden in the Puget Sound region possess four life history strategies: resident, fluvial, adfluvial, and anadromous (Washington Department of Wildlife 1992; Washington Department of Fish and Wildlife 1998). Resident bull trout/Dolly Varden complete their life cycles in tributaries that possess cold water and relatively pristine habitat conditions (Washington Department of Wildlife 1992). Fluvial forms spawn and rear in small tributaries, but migrate to large rivers as adults. Adfluvial forms have a life history similar to fluvial fish, but migrate to lakes or reservoirs as adults. Finally, anadromous forms spawn and rear in freshwater rivers and streams, but migrate to the ocean as adults. The anadromous form of bull trout/Dolly Varden is the least understood and documented of these four life history forms (U.S. Fish and Wildlife Service 1998a). Adult fish have been occasionally seen in lower sections of Puget Sound rivers (including the Cedar, White, and Green Rivers), and are presumed to be anadromous forms (Washington

Department of Fish and Wildlife 1998). Anadromous char (bull trout and Dolly Varden) migrate to sea in the spring and return in late summer and early fall (Wydoski and Whitney 1979).

Spawning in most native char populations occurs in September and October, although it may occur in August at elevations above 4,000 feet in the Cascades and as late as November in coastal streams (Goetz 1989; Craig 1997). Most anadromous populations spawn only every second year while resident char may spawn every year (Armstrong and Morrow 1980; U.S. Fish and Wildlife Service 1998a). Spawning sites are characterized by low-gradient, uniform flow and a gravel substrate between 0.25 to 2.0 inches in diameter (Wydoski and Whitney 1979; Fraley and Shepard 1989). Groundwater influence and proximity to cover are also reported as important factors in spawning site selection (Fraley and Shepard 1989). Studies conducted throughout the species' range indicate that spawning occurs in water from 0.75 to 2 feet deep (Wydoski and Whitney 1979; Fraley and Shepard 1989) and often occurs in reaches fed by streams, or near other sources of cold groundwater (Pratt 1992).

Bull trout/Dolly Varden require a long period of time from egg deposition until emergence. Embryos incubate for approximately 100 to 145 days, and hatch in late winter or early spring (Weaver and White 1985). Rieman and McIntyre (1993) indicate that optimum incubation temperatures are between 36°F (2°C) and 39°F (4°C). The alevins remain in the streambed, absorbing the yolk sac, for an additional 65 to 90 days (Pratt 1992). Emergence from the streambed occurs in late winter/early spring (Pratt 1992). High fine sediment levels in spawning substrates reduce embryo survival, but the extent to which they affect bull trout/Dolly Varden populations is not entirely known (Rieman and McIntyre 1993).

Fry are usually found in shallow, slow backwater side channels and eddies, in close proximity to instream cover (Pratt 1984). Young-of-the-year bull trout/Dolly Varden are found primarily in lateral stream habitats such as side channel areas and along stream margins, similar to that reported for other species of salmonids (Fraley and Shepard 1989). Juveniles are primarily bottom dwellers and are found among interstitial spaces in the substrate (~~Thompson and Tufts 1967;~~ Fraley and Shepard 1989; Pratt 1992). Sub-adults are often found in deeper stream pools or in lakes in deep water with temperatures less than 59°F (15°C) (Pratt 1992). Bull trout/Dolly Varden juveniles typically spend 2 to 3 years rearing in tributary streams before migrating downstream to mainstem river sections (fluvial forms), lakes (adfluvial forms), or the sea (anadromous forms)(Goetz 1989; Washington Department of Wildlife 1992; McPhail

and Baxter 1996). Most fish become sexually mature between 4 and 6 years of age (Goetz 1989; Washington Department of Wildlife 1992).

Limiting factors to this species include warm water temperatures that exceed temperatures tolerated by spawning adults (about 50°F [10°C]) and rearing juveniles (about 59°F [15°C]), lack of spawning and rearing habitat, and a high percentage of fine sediment in spawning gravels (U.S. Fish and Wildlife Service 1998a). Because of their close association with stream bottoms, native char are sensitive to changes in streambed conditions (Fraley and Shepard 1989; U.S. Fish and Wildlife Service 1998a). Bull trout/Dolly Varden readily interbreed with non-native brook trout (*Salvelinus fontinalis*), which can seriously impact bull trout/Dolly Varden populations due to genetic introgression. Brook trout may also exclude bull trout/Dolly Varden from native habitats (U.S. Fish and Wildlife Service 1998a). Native char are easily caught and are highly susceptible to fishing pressure; therefore, any increase in the accessibility of a population to fishing pressure may negatively impact a population (Fraley and Shepard 1989).

Current Distribution

Bull trout/Dolly Varden populations are located in the upper Cedar River and White River drainages, which are adjacent to the Green River Watershed (Washington Department of Fish and Wildlife 1998). However, information on the presence and distribution of bull trout/Dolly Varden in the Green River is very limited (Washington Department of Fish and Wildlife 1998). A single bull trout was reported in Soos Creek in 1956. No supporting information regarding this sighting is available (Beak Consultants Incorporated 1996). A single bull trout was also observed at the mouth of the Duwamish River in the spring of 1994 (Warner, pers. comm., 1998). Native char have been captured in the Green River as far upstream as RM 40.0 (Watson and Toth 1995). Bull trout/Dolly Varden have not been found in the Green River Watershed above Howard Hanson Dam (Washington Department of Fish and Wildlife 1998).

Stock Status

Bull trout/Dolly Varden within the Puget Sound DPS were proposed for listing as a threatened species by the USFWS in 1998 (Fed. Reg. 63[111]:31693-31710). This proposed listing was due to factors including declining population numbers, widespread habitat degradation caused by forest management and urban

growth, the high vulnerability of this species to fishing and poaching, genetic introgression and competition with brook trout, and population fragmentation caused by dams and diversions. The status of bull trout/Dolly Varden in the Green River is considered as "unknown" due to a lack of information on this species in this drainage (Washington Department of Fish and Wildlife 1998). The occasional fish that have been observed in the lower Green River in recent years may be strays from other river systems (Washington Department of Fish and Wildlife 1998).

3.8.1.2 Proposed and Candidate Species for Federal Listing

Coho Salmon *(Oncorhynchus kisutch)*

Life History and Habitat Requirements

Coho salmon in the Green River are typical of Puget Sound stocks with regard to their life histories; 18 months in fresh water followed by 18 months in salt water (or up to 3 years) (Grette and Salo 1986). Green River coho migrate upstream from early August through mid-January (Grette and Salo 1986). As with chinook salmon, coho require both deep holding cover for resting and sufficient discharge (water depths of 0.6 feet) to permit upstream movement (Laufle et al. 1986).

Coho spawning takes place in the mainstem sections and tributaries of the Green River from late September through mid-January (Grette and Salo 1986). Incubation periods for coho salmon last from 35 to 101 days (Laufle et al. 1986; Sandercock 1991). After hatching, larvae typically spend 3 to 4 weeks (depending on depth of burial, percentage of fine sediments, and water temperatures) absorbing the yolk sac in gravels before they emerge in early March to mid-May (McMahon 1983; Laufle et al. 1986; Sandercock 1991). Newly emerged coho (e.g., yolk sac fry) were found in the middle Green River on 25 February 1999 (Jeanes and Hilgert 1999). Coho fry continued to be present through May, with peak relative abundance occurring in mid-April (Jeanes and Hilgert 1999).

Juvenile coho salmon rear in fresh water for approximately 15 months prior to migrating downstream to the ocean, but may extend their rearing time for up to 2 years (Sandercock 1991). Newly emerged fry usually congregate in schools in pools of their natal stream. As juveniles grow, they move into more riffle

habitat and aggressively defend their territory, resulting in displacement of excess juveniles downstream to less favorable habitats (Lister and Genoe 1970). Aggressive behavior may be an important factor maintaining the numbers of juveniles within the carrying capacity of the stream and distributing juveniles more widely downstream (Chapman 1962; Sabo 1995). Once territories are established, individuals may rear in selected areas of the stream feeding on drifting benthic organisms and terrestrial insects until the following spring (Hart 1973; Cederholm and Scarlett 1981). Complex woody debris structures and side channels are important habitat elements for juvenile coho salmon, particularly during the summer low-flow period on the Green River (Grette and Salo 1986; Jeanes and Hilgert 1999).

The peak outmigration of coho smolts in the lower and middle Green River occurs between late April and early June (Bostick 1955; Dunstan 1955). Weitkamp and Campbell (1979) and Meyer et al. (1980) observed the greatest abundance of coho smolts in the Duwamish estuary during late May. Meyer et al. (1980) noted that by early June coho smolts appeared to move quickly through the estuary, and that few coho were present in the estuary after 4 June. Observations of peak coho smolt movement in the Duwamish estuary may occur up to several weeks following peak movement through the lower Green River. The peak downstream movement of coho yearlings planted in the Upper Green River Watershed into Howard Hanson Reservoir was observed during May and early June (Dilley and Wunderlich 1992).

Current Distribution

Coho spawn in all available tributaries and in the mainstem Green River. Mainstem spawning is heaviest in the braided channel reaches near Burns Creek, in the Green River Gorge, and immediately downstream of the Tacoma Headworks. Major spawning tributaries include Newaukum, Big Soos, Crisp, Burns, Springbrook, and Hill Creeks (Grette and Salo 1986). Juvenile coho salmon are found in mainstem sections of the Green River below Howard Hanson Dam, and in tributaries that are accessible to adult spawners. Juveniles are also present in the upper Green River drainage as a result of an outplanting program conducted by the Muckleshoot Indian Tribe since 1983 (U.S. Army Corps of Engineers 1998, Appendix F1). These fish, which are mainly derived from Green River hatchery stock, are congregated in the tributaries where they are planted as well as in the mainstem of the upper Green River.

Stock Status

Coho salmon of the Green River system are divided into two stocks, Soos and Newaukum Creeks, by geographic separation and differences in spawning timing. This designation is tentative due to the lack of biological characteristics (Washington Department of Fish and Wildlife et al. 1994). Both stocks are of mixed origin and contain both native and non-native coho. Currently, approximately 3 million yearling coho are released annually from hatcheries on Soos and Crisp Creeks. The Newaukum Creek stock is considered "depressed," and the Soos Creek stock is currently considered "healthy" (Washington Department of Fish and Wildlife et al. 1994).

3.8.1.3 Other Species of Special Interest

Sockeye Salmon *(Oncorhynchus nerka)*

Life History and Habitat Requirements

Sockeye salmon exhibit the greatest variety of life history patterns of all the Pacific salmon, and characteristically make more use of lacustrine (lake) habitat than other salmon species. Life history patterns of sockeye include land-locked sockeye, lake-type sockeye, and river- or sea-type sockeye. The land-locked type, called kokanee, mature, spawn, and die in fresh water without a period of marine residency (Gustafson et al. 1997). Lake-rearing sockeye juveniles typically spend 1 to 3 years in lacustrine habitats before migrating to sea (Burgner 1991). Lake-rearing stocks represent the most common and typical life history. Sockeye that rear in rivers for 1 to 2 years (river-type sockeye) are less common than the lake-type sockeye, and hence little is known about them. The Green River is among several in the Puget Sound known to possess river-type sockeye (Gustafson et al. 1997).

Sockeye salmon enter Puget Sound rivers from mid-June through August. Spawning takes place in late September to late December and occasionally into January (Gustafson et al. 1997). Peak emergence for similar river systems occurs from early March to mid-May. Areas containing upwelling of oxygenated water through sand and gravel are important for spawning (Burgner 1991). Length of sockeye egg incubation is

temperature dependent, but is generally longer than the incubation period for other salmon species (Burgner 1991). After emergence, juvenile sockeye will migrate to nursery lakes for rearing, or in the case of river-type sockeye, utilize river and estuarine habitat for rearing, or migrate directly to the sea (Burgner 1991). Maturity in sockeye salmon ranges from 3 to 8 years (Gustafson et al. 1997). Sockeye typically spend 1 to 4 years in the ocean before returning to fresh water to spawn.

Current Distribution

Adult sockeye salmon have been observed spawning in the Green River below the Tacoma Headworks diversion (Warner, pers. comm., 1998). It is unknown whether these are strays from Lake Washington, or are native river-type sockeye. Peak counts of sockeye spawners in the Green River have ranged from 1 to 16 fish during 14 years of surveys that occurred between 1954 and 1990. These fish were observed from mid-September to mid-November (Gustafson et al. 1997). Due to lack of nursery-lake habitat, juvenile sockeye in the Green River rear in side-channels, sloughs, or travel to the lower estuary to rear (Gustafson et al. 1997).

Stock Status

The origin of sockeye salmon in the Green River remains uncertain. At least 392,050 sockeye salmon fry derived from the Green River, Quinault Lake, and unspecified Alaska stocks were released into the Green River between 1925 and 1931 (Washington Department of Fish and Game undated report, cited in Gustafson et al. 1997). The Green River stock is not considered part of an ESU at this time due to insufficient information. Protection under the ESA may be necessary in the future if Green River sockeye runs are found to be a distinct population.

Chum Salmon *(Oncorhynchus keta)*

Life History and Habitat Requirements

Chum salmon migration into the Green River begins in early September and continues through December (Salo 1991). Spawning in the Green River takes place from early November through mid-January.

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). Egg and embryo incubation in the Green River takes place from November to mid-April (Salo 1991). Success and health of the emergent fry are also dependent on dissolved oxygen, gravel composition, spawner density, stream discharge, and genetic characteristics (Salo 1991).

Juvenile chum salmon have an ocean-type early life history, rearing in fresh water for only a few days to weeks before migrating downstream to salt water (Grette and Salo 1986; Johnson et al. 1997). Chum fry that migrate to sea within several days after emergence exhibit little growth, but fry that rear for longer periods may exhibit an increase in length up to 22 percent in less than 4 weeks (Hale et al. 1985).

Downstream movement in the Green River occurs from mid-February through late May, but varies annually. Dunstan (1955) identified an initial small surge of chum fry in late February, but believed the peak of chum fry outmigration occurred between 20 March and 3 April. Chum fry were present in juvenile surveys conducted in the middle Green River from February through June, peaking in relative abundance in mid-April, 1998 (Jeanes and Hilgert 1999). Observations of chum fry abundance in the Duwamish estuary also indicate movement from the Green River, but peak movement in the estuary may be several days or weeks following peak movement in the river. Juvenile chum salmon, like ocean-type chinook, have a long period of estuarine residence, which is the most critical phase of their life history and often determines the size of subsequent adult returns. The highest abundance of chum fry in the Duwamish estuary has been observed from late April through mid-May (Bostick 1955; Weitkamp and Campbell 1979; Meyer et al. 1980), although they have been observed in the estuary from February through July (Warner, pers. comm., 1998).

Current Distribution

The major chum salmon spawning areas in the Green River are the braided section of the mainstem below the Gorge and most major tributaries (Grette and Salo 1986). Dunstan (1955) reported that most chum seemed to be produced in Burns and Newaukum Creeks rather than in the mainstem river. While their

capture process could not differentiate between fry produced in side channels, tributaries, and mainstem habitats, spawning surveys during the 1950s identified large numbers of chum spawning in Burns Creek. Muckleshoot Indian Tribal biologists surveyed the Green River from 1996 to 1998 and reported significant numbers of chum spawning in side channels in the middle and lower Green River reaches (Warner, pers. comm., 1998). Due to their ocean-type life history, chum fry utilize the middle and lower Green River and tributaries mainly as a transportation corridor. Juvenile chum may remain in the brackish water habitat of the Duwamish estuary for several days to 3 months, moving offshore as food resources decline in the summer (Meyer et al. 1981; Grette and Salo 1986).

Stock Status

Two chum salmon stocks are recognized in the Green River system (Washington Department of Fish and Wildlife et al. 1994). The Crisp (Keta) Creek fall chum stock originated from releases of Quilcene and Hood Canal stocks at the Keta Creek Hatchery in the early 1980s, and is considered "healthy" (Washington Department of Fish and Wildlife et al. 1994). The Duwamish/Green stock may be a remnant native stock, but its status is considered "unknown" (Washington Department of Fish and Wildlife et al. 1994). Green River chum salmon, along with chum stocks from the Puget Sound and as far west as the Elwha River, were placed into the Puget Sound/Strait of Georgia ESU by NMFS (Johnson et al. 1997). The average chum harvest from 1988 to 1992 for this ESU was estimated as 1.2 million fish, equating to a total abundance of 1.5 million fish (Johnson et al. 1997). Current levels of chum abundance for this ESU are at or near historical levels, and do not warrant protection under the ESA at this time (50 CFR Parts 226 and 227).

Pink Salmon *(Oncorhynchus gorbuscha)*

Life History and Habitat Requirements

Pink salmon in the Puget Sound migrate into fresh water to spawn after spending approximately 18 months at sea (Heard 1991). These fish are distinct from other Pacific salmon by having a 2-year life cycle. Adult pink salmon in the south Puget Sound region generally enter fresh water during July and August, and spawn

from early August through late October (Washington Department of Fish and Wildlife et al. 1994). Most pink salmon spawn in the lower reaches of rivers and streams, and a large percentage of pink salmon populations spawn within intertidal zones (Hard et al. 1996). Pink salmon prefer to spawn in riffles with clean gravel, relatively shallow water, and with moderate to fast currents (Heard 1991). Substrate preference is for coarse gravel and sand, with a few large cobbles and very little silt. Incubation of eggs and embryos in gravel interstices lasts between 5 and 8 months (Heard 1991). Pink salmon eggs hatch in late February, and the young emerge from the gravel in April and May depending on water temperatures. Pink salmon fry spend less time on average in fresh water than other Pacific salmon species (Hard et al. 1996), migrating downstream to the ocean shortly after emergence. Upon arrival in estuarine habitat, young pink salmon tend to remain close to nearshore nursery areas until September (Emmett et al. 1991).

Current Distribution

There is currently little information on the distribution of pink salmon in the Green River. Most pink salmon likely spawn in the Duwamish River and in lower sections of the Green River, since the lower reaches of rivers and streams are the most common spawning areas used by this species (Heard 1991). This species has a difficult time passing through high-gradient areas and potential barriers compared to other salmon species due to its small size (Heard 1991). For this reason, this species probably does not migrate above the Gorge section of the Green River to spawn. Pink salmon fry outmigrate to the ocean soon after emerging from gravels, and the river channel is probably used only as a migration corridor by these fish. These fry probably remain in the Duwamish estuary and Elliott Bay until the early fall.

Stock Status

Pink salmon are uncommon in the Green River (Washington Department of Fish and Wildlife et al. 1994). Prior to the 1930s, odd-year pink salmon were observed to be present in small numbers in this river (Grette and Salo 1986). Stray pink salmon are now observed on occasion in the Green River, but these incidents do not suggest that a self-sustaining run is present (Grette and Salo 1986). The NMFS has identified two ESUs for pink salmon in Washington and southern British Columbia, an even-year ESU and an odd-year ESU (Hard et al. 1996). Most Washington pink salmon stocks are odd-year fish, although a single

even-year run exists in the Snohomish River (Hard et al. 1996). The total average escapement (1959 to 1993) of 14 odd-year pink salmon stocks occurring in Washington is 888,804 fish (Hard et al. 1996). The NMFS has determined that neither of these two ESUs are warranted for protection at this time under the ESA.

Steelhead Trout *(Oncorhynchus mykiss)*

Life History and Habitat Requirements

Both summer and winter races of steelhead trout are present in the Green River (Grette and Salo 1986; Washington Department of Fish and Wildlife et al. 1994). Steelhead entering the Green River from May through October are considered summer steelhead; while moving into the Green River from December through May steelhead are considered to be winter fish (Grette and Salo 1986; Washington Department of Fish and Wildlife et al. 1994). Native winter steelhead spawn from mid-March through June, while summer steelhead spawn primarily from February through March (Grette and Salo 1986; Washington Department of Fish and Wildlife et al. 1994). Hatchery-origin winter steelhead (Chamber Creek stock) spawn earlier in the season than do their wild counterparts, often completing spawning by mid-March, and are not thought to interbreed with wild winter steelhead (Washington Department of Fish and Wildlife et al. 1994).

The greatest number of steelhead redds counted during WDFW surveys in the Green River between 1994 and 1996 were observed in late April (Washington Department of Fish and Wildlife, unpublished data). Caldwell and Hirschey (1989) observed steelhead spawning in the Green River in velocities ranging from approximately 2.0 to 4.0 fps, and depths ranging from 1.6 to 3.7 feet. Caldwell and Hirschey (1989) also report that steelhead preferred spawning substrates composed of predominantly large gravels and small cobbles. The incubation period of steelhead eggs and embryos varies with water temperature, with fry emergence occurring 40 to 80 days after spawning (Busby et al. 1996). Emergence of steelhead fry is usually competed by mid-August in the Green River (Grette and Salo 1986).

Most winter and summer juvenile steelhead rear in fresh water for 1 to 5 years before migrating to the ocean, with a majority of juveniles outmigrating following 2 or 3 years of freshwater residency (Busby et

al. 1996). In the Green River, most juvenile steelhead migrate after 2 years of rearing in fresh water (Meigs and Pautzke 1941). Everest and Chapman (1972) found age-0 steelhead residing over cobbles in water velocities of less than 0.5 fps and depths of 0.5 to 1 feet. Juvenile steelhead will utilize stream margins and submerged rootwads, logs and woody debris, large substrate such as boulders, and deep pools to provide shelter and cover while rearing in freshwater habitats (Bustard and Narver 1975; Busby et al. 1996).

The downstream migration of steelhead smolts in western Washington occurs from April through June, with peak migration generally occurring in mid-April (Wydoski and Whitney 1979). Most steelhead smolts in the Green River outmigrate during April and May (Pautzke and Meigs 1940; Jeanes and Hilgert 1999). Most steelhead reside in the ocean for 2 to 3 years before returning to fresh water to spawn (Busby et al. 1996). Steelhead are capable of repeat (i.e., multiple-year) spawning, which accounts for 4 to 14 percent of total spawning runs (Wydoski and Whitney 1979).

Current Distribution

Winter steelhead spawn in the Green River from approximately RM 26.0 to RM 61.0. Summer steelhead primarily spawn in the mainstream and lower tributary areas from the Tacoma Headworks (RM 61.0) downstream to the upper Gorge (RM 58.0) (King County Planning Division 1978). An anonymous Washington Department of Game (WDG) report in 1945 (as cited in U.S. Army Corps of Engineers 1998) states that historically, at least 90 percent of steelhead spawning and rearing area in the Green River drainage were located above the Tacoma Headworks diversion at RM 61.0.

Juvenile steelhead are found throughout the mainstem sections of the lower and middle Green River, as well as in all tributaries accessible to spawners. Steelhead smolts in Puget Sound rivers have been reported to move quickly through estuaries, rearing and feeding primarily in the mainstem section of rivers before migrating to the ocean (Emmett et al. 1991; Seattle Regional Water Authority 1998). Steelhead represent a small fraction (1%) of the juvenile salmonids found in the Duwamish estuary (Meyer et al. 1980). Hatchery-raised juveniles (summer-race fish) have been planted in the Upper Green River Watershed since 1982 (U.S. Army Corps of Engineers 1998, Appendix F1). Beginning in 1992, between 70 and 133 adult winter steelhead have been captured on an annual basis at a temporary trap-and-haul facility at Tacoma's Headworks and released upstream of Howard Hanson Dam (U.S. Army Corps of Engineers 1998). Juvenile steelhead are consequently found in the mainstem channel and tributaries of upper Green River.

Stock Status

The Green River system supports both summer and winter stocks of steelhead (Washington Department of Fish and Wildlife et al. 1994). Summer steelhead are non-native in origin, and were first introduced in 1965 from the Skamania Hatchery. About 70,000 summer steelhead smolts are currently released into the Green River on an annual basis. This stock is managed to provide a recreational fishery, and is currently considered to be "healthy" (Washington Department of Fish and Wildlife et al. 1994).

Winter steelhead trout are native to the Green River drainage. In addition to the naturally reproducing native winter steelhead, approximately 100,000 hatchery-origin smolts from the Chambers Creek stock are planted annually in the Green River drainage. These fish are not thought to interbreed with the native stock due to differences in spawning timing (Washington Department of Fish and Wildlife et al. 1994). However, the juveniles of all stocks of steelhead in the Green River share a common life-history and habitat requirements (i.e., they rear in fresh water for 2 to 3 years), and likely compete for food and space.

Coastal Cutthroat Trout *(Oncorhynchus clarki clarki)*

Life History and Habitat Requirements

Coastal cutthroat trout have a life history pattern similar to that of steelhead, with coastal cutthroat generally spawning and rearing in smaller tributaries than steelhead. The upstream migration of adult cutthroat trout spawners in the Green River occurs from July through early February (Caldwell 1994), with peak migration occurring in October and November (Grette and Salo 1986). Spawning in the Green River occurs mainly from March through early May, which is slightly earlier than native winter run steelhead in this river (Grette and Salo 1986). The preferred spawning substrate of coastal cutthroat trout is small- to medium-sized gravel. They prefer to spawn at depths ranging from 0.5 to 1.5 feet, and near pools where escape cover is present (Trotter 1997). Emergence of cutthroat fry occurs from March to mid-July, depending on spawning date and water temperature conditions (Trotter 1997).

Juvenile cutthroat prefer low-velocity, lateral habitats in streams, seeking pools and other slow water habitats with root wads and large wood for cover (Trotter 1997). Often coho fry are present in the same

habitat, and the larger coho will drive the cutthroat into riffles, where they will remain until fall and winter (Sabo 1995).

Like steelhead trout, cutthroat trout juveniles rear in fresh water from 2 to 4 years. The seaward migration of cutthroat smolts peaks in mid-May (Trotter 1997). During the marine phase of their life cycle, juvenile and adult coastal cutthroat trout appear to utilize waters near the shore, usually in areas relatively near their natal streams (Moyle 1976; Johnston 1982; Trotter 1997). Cutthroat trout that have migrated into the Puget Sound will feed and migrate along beaches, often in waters less than 10 feet deep (Johnston 1982). Many stocks are thought to stay within estuarine habitats for their entire marine life (Leider 1997).

Most cutthroat trout mature and return to fresh water the same year they migrate to sea. Like steelhead, adult coastal cutthroat trout are repeat spawners, although coastal cutthroat trout recover quickly to pre-spawning condition (Trotter 1997). They may live to an age of 7 or 8 years, spawning three to five times during their life (Trotter 1997). By definition coastal cutthroat trout are anadromous. However, they generally remain inshore or in areas of reduced salinity while in salt water and will rarely, if ever, overwinter in salt water (Behnke 1992; Trotter 1997). Due to their short ocean residency time, coastal cutthroat trout are usually smaller than other anadromous salmonids.

Current Distribution

Coastal cutthroat trout typically spawn in the lower gradient reaches of small tributaries (Trotter 1997). This appears to be an adaptation to isolate their nursery/rearing ground from other, more competitive species such as steelhead and coho salmon (Stolz and Schnell 1991). Although the distribution of coastal cutthroat trout has not been well studied in the lower and middle Green River, they would be expected to spawn and rear in all accessible tributaries.

Cutthroat trout fry and juveniles were captured in lateral habitats of the mainstem Green River during juvenile salmonid surveys conducted in 1998 (Jeanes and Hilgert 1999). The numbers of cutthroat were found to be small and the distribution of this species limited compared to other salmonid species, including steelhead trout, chinook salmon, and coho salmon. Resident cutthroat trout are found in the mainstem and most tributaries of the upper Green River (U.S. Forest Service 1996). Coastal cutthroat trout were

assumed to migrate into the upper Green River before the construction of Tacoma's Headworks Diversion in 1912. It is not known whether the cutthroat trout currently present in the upper Green River are derived from sea-run fish.

Stock Status

A small population of coastal cutthroat is present in the Green River, although little is known about its status (Grette and Salo 1986). The historical and present abundance and distribution of coastal cutthroat trout in the Puget Sound region is not well known, as data for this species are scarce (Johnson et al. 1999). Reports based on anecdotal information suggest a low abundance of coastal cutthroat trout in the southern Puget Sound. This species is thought to be abundant and well distributed in the northern Puget Sound region, especially in the Skagit and Stillaguamish River basins (Johnson et al. 1999). Existing data are insufficient to determine trends in coastal cutthroat trout populations in this region, although abundance has been observed to be increasing in some drainages (Stillaguamish and Snohomish) while declining in others (Skagit River).

The anadromous form of coastal cutthroat trout has been declining in some streams (Johnson et al. 1999). The impact of hatchery stocks of fish on this species in the Puget Sound ESU is thought to be low, since most streams in this region are considered to be dominated by wild production of native fish (Johnson et al. 1999). In April 1999, NMFS determined that cutthroat trout in the Puget Sound ESU were not presently in danger of extinction, and are not likely to become endangered in the future (Federal Register 64[64]16397-16414). Consequently, the listing of coastal cutthroat trout in the Puget Sound ESU under the ESA was not found to be warranted.

Pacific Lamprey *(Lampetra tridentata)* **and River Lamprey** *(Lampetra ayresi)*

Life History and Habitat Requirements

Pacific and river lamprey have similar life history patterns, and occur in most major rivers in Washington (Wydoski and Whitney 1979). The adults of both species are parasitic on fish, and migrate to fresh water to spawn. Less is known about the abundance of river lamprey than is known about Pacific lamprey populations.

Both lamprey species are anadromous, living in the ocean as adults and then migrating to fresh water to spawn and rear. However, reports of the presence of river lamprey in collections made above dams suggest that some river lamprey may spend their entire life in fresh water (Johnson 1986).

Adult river lamprey are substantially smaller in size than Pacific lamprey and migrate from the ocean to fresh water in the fall, overwinter, and spawn in the spring (Close et al. 1995). Adult Pacific lamprey migrate upstream in late spring and early summer in search of spawning areas where both sexes construct a shallow nest in stream gravels (Morrow 1980). Flowing water (1.6 to 3.3 fps) is preferred for spawning (Close et al. 1995). Most river lamprey are thought to spawn in small tributary streams, with spawning occurring in April and May (Moyle 1976). The adults of both species die after they spawn.

The larval form of Pacific and river lamprey, termed ammocoetes, are blind, toothless, and feed on algae and other small organisms. The ammocoetes (larvae) of these two species are morphologically similar, making positive distinction between the two difficult (Johnson 1986). Lamprey ammocoetes, after swimming up from their nests, are washed downstream where they burrow into mud or sand to feed by filtering organic matter and algae (Moyle 1976). Such an extended freshwater residence makes them especially vulnerable to degraded stream and water quality conditions.

Larval lamprey will transform to juveniles from July through October (Close et al. 1995). River lamprey ammocoetes begin to transform into the adult stage when they are as small as 4.6 inches in total length, and become parasitic soon after this transformation (Wydoski and Whitney 1979). It is during this transition that they become ready for a parasitic lifestyle by developing teeth, tongue, eyes, and the ability to adapt to salt water. After metamorphosis, juvenile lamprey may remain in fresh water up to 10 months before passively migrating with the current downstream to the ocean. The ammocoetes of Pacific lamprey generally remain in fresh water for 5 or 6 years, moving from site to site (Wydoski and Whitney 1979). Adult Pacific lamprey may remain in salt water for up to 3.5 years (Close et al. 1995).

Current Distribution

Little information exists regarding the distribution and abundance of Pacific and river lamprey in the Green River. Pacific lamprey are common in the Green River downstream of the Tacoma Headworks.

Numerous Pacific and a few river lamprey were observed during side channel surveys in the middle Green River conducted by R2 Resource Consultants in 1998. The relative abundance of Pacific lamprey ammocoetes was greater than other lamprey species encountered during electrofishing surveys conducted on the middle Green River (RM 35.0 to 45.0). Pacific lamprey were captured in each habitat type surveyed (i.e., gravel bar pools, mainstem sloughs, mainstem margins, backbar channels, abandoned channels, and wallbase channels) (Jeanes and Hilgert 1999). Lamprey should be found throughout the lower and middle reaches of the Green River as far upstream as Howard Hanson Dam, which presently is a barrier to the upstream migration of these two lamprey species.

Stock Status

Lamprey have shown severe population declines in the Pacific Northwest (Close et al. 1995). Lamprey have similar freshwater habitat requirements as the Pacific salmon and, therefore, they face the same habitat problems affecting salmonid abundance and distribution. In particular, elevated water temperatures (greater than 68°F [20°C]) and increased sediment in spawning gravels are two major habitat factors attributing to lamprey population decline (Close et al. 1995). The NMFS has not initiated a status review of Pacific lamprey in the Pacific Northwest.

3.8.2 Fish Habitat Conditions

3.8.2.1 Historic Influences on Fish Habitat Conditions

Changes to aquatic habitat in the Green River basin over the last 150 years have been substantial due to urbanization, rural development, and land-management practices including agriculture and timber harvest. Many physical changes to the hydrology, sediment supply and transport characteristics, floodplains, and stream channels have occurred, as have other direct and indirect impacts to fish and their habitat.

Diversion of White/Black/Cedar Rivers

Significant changes to the hydrology of the lower Green River basin have occurred due to flood control measures. In particular, two major tributaries were re-routed to other drainages. The White River, which contributed more than 50 percent of the total flow to the lower Green River, was diverted naturally to the Puyallup River in 1906 as a result of major log jams, several large floods, and direct human intervention (subsection 3.4.1.1, Geology, Lower and Middle Green River Watershed) (Figure 3-2). A permanent diversion structure was subsequently constructed and completed in 1911 that forced the flows of the White River to join with the lower Puyallup River. The Black River, which enters at RM 11.0, was reduced to a small fraction of its former flow in 1916 by construction of the Ship Canal/Ballard Locks and associated lowering of the water level in Lake Washington, along with diversion of the Cedar River into the lake to provide flows for the locks.

The combined diversions of the White and Black Rivers reduced summer flows to roughly 30 percent or less of their historical magnitude within the lower Green River basin. Sediment supply to the lower basin was also reduced sharply. The diversions enabled salt water from the estuary to move farther upstream than before, to roughly RM 10.0 under low summer flows and high tides; a salt wedge is usually found up to RM 7.0 (Dawson and Tilley 1972).

Migration routes of anadromous species were influenced dramatically in the White and Cedar Rivers and in the other Lake Washington tributaries as the returning fish searched for the water of their natal streams. As a result of the separation of the these rivers, fish in the Green River remain physically isolated from the White and Cedar/Lake Washington stocks. This has greatly restricted the interchange of fish among these drainages, which has likely reduced genetic diversity, as well as resulted in the isolation of resident fish populations including bull trout/Dolly Varden.

Consumptive Water Use

The City of Tacoma began diverting water from the Green River in 1913 with the completion of the Tacoma Headworks diversion at RM 61.0, at a maximum rate of 113 cfs (72 mgd). Fish passage facilities

were not provided, and anadromous fish consequently could not access habitat in the upper basin. In some years, the amount of water needed for diversion during the summer and early fall could exceed the amount originating naturally upstream of the Tacoma Headworks. Tacoma's First Diversion Water Right claim, which provides for water withdrawals of up to 113 cfs, is not constrained by Washington State minimum instream flow requirements. In recent years, Tacoma Water has attempted to work cooperatively to minimize impacts of water withdrawals on fisheries and on other instream resources; however, Tacoma diverted water from the mainstem Green River under the First Diversion Water Right claim for more than 50 years without flow augmentation.

The Howard Hanson Dam was completed by the USACE in 1962 to provide flood control to the Green River valley and to provide 24,200 acre-feet of water storage for summer low flow augmentation. Tacoma's Second Diversion Water Right was originally limited only by state-imposed minimum instream flows at the USGS gauge at Palmer. Additional constraints on the use of the Second Diversion Water Right and constraints on the First Diversion Water Right claim were developed as part of the 1995 MIT/TPU Agreement.

Construction and Operation of Howard Hanson Dam

Howard Hanson Dam was completed by the USACE at RM 64.5 in 1962 for flood control purposes, with King County as the local sponsor. The facility was designed to provide flood protection up to the 500-year event and to limit flood flows downstream to 12,000 cfs at Auburn; flood control operations are subject to congressional mandate. The reservoir is kept as low as possible during the flood season and is essentially a run-of-the-river facility until the river reaches flood stage, at which time flows in excess of the 12,000 cfs limit are impounded and later released. The original authorization of Howard Hanson Dam also provided for storage of 24,200 acre-feet of water for summer low flow augmentation.

During the winter, Howard Hanson Reservoir is held nearly empty between storm events. In late spring, inflow is reduced, and the reservoir allowed to partially fill to provide a summer conservation pool for low flow augmentation. In the past, spring refill operations dramatically reduced flows in the middle and lower river for several weeks between April and June, the timing depending on hydrologic conditions in the mountains and on USACE operating procedures. As a result, winter and spring flood flows below the dam

have been reduced over pre-Howard Hanson Dam conditions. Conversely, summer flows have increased over conditions immediately prior to construction of Howard Hanson Dam. The increased flow was instituted as a benefit of the original construction of the Howard Hanson Dam project.

Howard Hanson Dam has interrupted the flow of gravel and cobbles from the upper to the middle and lower basins and has curtailed channel-forming flows, effectively rendering the channel geomorphically inactive throughout most of its length below the dam. Between June and October, water releases influence water temperatures up to 6 miles downstream of the dam. Outflow is colder than inflow in early summer, and then becomes warmer than inflow water throughout the remainder of the summer.

Timber Harvest

Logging is associated with direct and indirect impacts to the Green River aquatic ecosystem, including increased fine turbidity and sediment loading; altered hydrology; removal of riparian wood that provides shade, leaf litter, bank stability, and large woody debris (LWD) to streams; and destruction of tributary habitat by construction and operation of splash dams. Important sources of sediments induced by logging activities include roads and landslides.

Clearcutting of large areas has influenced flood flows within the upper valley by means of increased areas of land susceptible to rain-on-snow events. Initial clearing by settlers was associated with limited logging within primarily the lower and middle Green River basins. Large-scale logging began circa 1880 to 1910 in the lower and middle Green River basin and rapidly moved upstream into the upper basin between 1910 and 1930. Private lands were logged extensively in the 1960s and 1970s. Most old-growth timber has been logged, with isolated patches remaining in the most inaccessible portions of the upper basin; more than 80 percent of the upper basin forest contains trees that are less than 100 years old. Forest practices prior to the 1970s did not consider riparian zone protection or Best Management Practices (Watson and Toth 1995).

Logging has extended to the highest portions of the upper basin in recent years. Essentially all of the middle basin has been harvested at least once, including areas within the riparian zones.

Land ownership in the upper Green River basin alternates in the characteristic square-mile checkerboard pattern found elsewhere in Washington, where alternating squares are owned by the USFS or private timber companies. Plans are underway regarding a land exchange between the USFS and the Plum Creek Timber Company. A legislative land exchange (I-90 Land Exchange) between the USFS and the Plum Creek Timber Company is underway. The USFS proposes to exchange public land draining mostly below Sunday Creek (RM 86.2) for land around Kelly Butte owned by Plum Creek Timber Company (U.S. Forest Service 1998). Plum Creek Timber Company and Weyerhaeuser plan to continue to harvest within the upper basin.

Agriculture

Agriculture-related changes occurred well before the effects of urbanization. Conversion of the floodplain to agricultural land has resulted in disconnection of side-channel habitat; destabilization of stream banks by cattle; runoff of fertilizer, pesticides, and fecal coliform bacteria into the river; and preclusion of riparian succession. The first documented land clearing was in 1851; livestock were introduced shortly thereafter. Initially crop production was for local consumption, but eventually as more land was cleared, production was increased for commercial sales outside of the area. Much of the early flood control activities were designed to increase the agricultural use of the Green River floodplain, both for crops and livestock.

Urbanization

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 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

areas and reduced floodplain storage;

- increased fishing pressure as the 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 heavy metals, petrochemicals and related byproducts, herbicides and pesticides, other organic compounds, and nutrients. Pollutants are concentrated in estuary sediments and impact organisms living in or on that medium.

The lower Green River basin has undergone extensive urbanization, while the middle basin is currently in the process of conversion from agricultural to urban land use. The upper watershed has not experienced urbanization. The City of Seattle was sufficiently large by the early 1900s to have influenced the lower Green/Duwamish River channel structurally. Water quality impacts from the City occurred primarily within the estuarine area. Growth continued gradually throughout the region, but in the 1970s growth in the region accelerated greatly, with a significant amount of the lower Green River basin becoming developed. Over 97 percent of the lower Green/Duwamish estuary has been filled and developed. Industry is the primary land use downstream of the Black River confluence at RM 11.0.

Roads and Railroads

The first road in King County was built in the lower Green River basin in 1854; railroad construction began circa 1867, primarily in support of logging activities. Since then, the construction of roads and railroads has resulted in channelization of portions of the lower and middle and upper Green River. Channelization is associated with loss of habitat structure, increased flow velocities, and narrowing of the active floodplain. Water quality has been influenced by spills and runoff of hydrocarbon, other organic compounds, and metal pollutants from road surfaces. Some side tributaries throughout the system have had accessibility blocked to spawning fish by installation of impassable culverts. The railroad line in the upper Green River basin was inactivated in 1983, although the Burlington Northern Santa Fe Railway recently upgraded and reactivated the line in 1996 to help alleviate congestion on other mainlines. As many as eight trains per day are expected to use the upgraded line.

Diking, Leveeing, Draining, Dredging, Channel Clearing, and Filling

The lower and middle Green River basin channels have undergone extensive physical transformation to provide for navigation, flood control, and land development. The result has been straightening and confinement of the river to a single channel without riparian vegetation (important for both habitat and water quality) and instream habitat structure.

Removal of woody debris from the stream channel was first performed in the mid-1850s to facilitate navigation. Drainage of wetland areas began in the lower and middle Green River basins circa 1858 to provide land for agriculture and settling. As the region's population grew, floodplain pumping was initiated; the Black River pumping station was installed in 1971 to pump stormwater from the floodplain into the Green River mainstem.

As part of the dredging and filling activities, the lower Green/Duwamish River delta was straightened and channelized. The majority of the estuary was filled by the mid-1940s. The East Duwamish Waterway was dredged initially in 1895, and the material used for Harbor Island fill. Dredging was completed in both the East and West Waterways in 1917, with the material used to fill intertidal flat areas of the Duwamish River. Extensive filling of the intertidal area also occurred during the hydraulic sluicing of Beacon Hill. Dredging of the lower river continues, where the depth of the channel is maintained at approximately 12 feet.
Large scale levees were built beginning in the early 1900s to help prevent the floodplains of the lower Green River from flooding. Periodic levee construction and maintenance activities continue to the present to protect higher density population areas and specific residential areas. Bank protection measures have resulted in restricting or preventing active channel meandering and migration across the floodplain. A recent survey of the middle Green River below Flaming Geyser State Park determined that levees and streambank revetments on one or both banks accounted for between 10 and 30 percent of the length of three contiguous reaches above about RM 38.0, and between 60 and 80 percent of the length of three contiguous reaches running between RM 25.0 and RM 38.0 (Perkins 1993).

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 (Washington Department of Fish and Wildlife 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, 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).

There are several hatchery facilities located and operating within the Green River system, and another is planned as part of the MIT/TPU Agreement. The state of Washington opened the Green River Hatchery on Soos Creek in 1902; it produced chinook and coho salmon primarily, and chum salmon secondarily. The majority of fish reared at the hatchery have been released within the Green River drainage, although the stock has been used to supplement stocks in other basins, including the Stillaguamish, Snohomish, Lake Washington, Nisqually, and many coastal systems. The Keta Creek Hatchery, located on Crisp Creek, was opened originally by the state in 1969 and later expanded and operated by the Muckleshoot Indian Tribe circa 1981. The facility has produced chinook, coho, and chum salmon, and steelhead trout. A state steelhead trout rearing pond facility is located near Palmer. A pond complex has also been operated for chinook salmon supplementation at Icy Creek, located within the Green River Gorge.

Past donor stock for fall or spring chinook released within the Duwamish River system has included fish originating from hatcheries located in British Columbia and on the Deschutes River, Hoh River, Skagit River, Skykomish River, Sol Duc River, Cowlitz River, Issaquah Creek, and other locations (National Marine Fisheries Service 1998). Chinook and coho salmon, and steelhead trout juveniles have been planted periodically upstream of Howard Hanson Dam since 1982. Adult steelhead have been released to spawn upstream of Howard Hanson Dam since 1992.

Fishing Harvest

Salmon originating from the Green River 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. Sport and Tribal fisheries have also caught large numbers of returning adult salmon within the Duwamish/Green River. Fishing harvest rates for salmon populations in the Green/Duwamish River peaked in the 1980s. The Muckleshoot Indian Tribe and WDFW have ~~has~~ recently curtailed ~~Tribal~~ fishing to promote increased escapement.

3.8.2.2 Current Fish Habitat Conditions

The partitioning of the Green River into the lower, middle, and upper watersheds reflects divisions of the system by both natural and human influences. Prior to construction of the Tacoma Headworks and Howard Hanson Dam, the upper Green River basin was distinguished from below by natural geologic features (i.e., the Gorge). With the exception of the impounded reservoir area, physical features of fish habitat have been influenced primarily by timber harvest and transportation activities. However, the artificial geographic division imposed by water withdrawal and flood management facilities is approximately coincidental with the geologic division and, thus, is useful in the context of evaluating Tacoma Water activities. The greatest influence on anadromous fish in the upper basin has been the construction of Tacoma's Headworks diversion and Howard Hanson Dam, which have disconnected the upper watershed from the middle and lower Green River.

The division between the middle and lower Green River Watersheds (Highway 18/Big Soos Creek) approximates the division between the lower gradient, extensive Duwamish geologic deposits in the lower basin, and the intermediate gradient reaches upstream. The geographic division also roughly separates highly urbanized reaches downstream and lesser-developed reaches upstream. The middle watershed includes the physically (and biologically) distinct canyon reach and a transition reach that is still adjusting to changes in flow and sediment supply caused by the construction of the Tacoma Headworks, Howard Hanson Dam, and diversion of the White River.

The fisheries in the lower watershed have been influenced most by urban development, although construction of the Tacoma Headworks and Howard Hanson Dam has also affected fisheries in the lower watershed. Fisheries in the middle watershed, however, have been influenced most directly by the construction of Howard Hanson Dam and Tacoma water withdrawals. Specific aspects of fish habitat in the Green River system that have been influenced most adversely are summarized below.

<u>Lower and Middle Watershed</u>

Spawning Habitat

The construction of Tacoma's Headworks did not seriously impair the movement of gravel in the Green River from the upper watershed to the middle and lower watersheds. The construction of Howard Hanson Dam, however, did reduce the supply of gravel to the middle and lower Green River Watersheds, and as a consequence, the availability of spawning habitat has become reduced in quantity for some distance downstream of the dam. The availability of gravels suitable for spawning salmonids in the canyon reach has been reduced, and there is some evidence that the effects of Howard Hanson Dam on gravel supply extend down to Newaukum Creek (RM 41.2), which is now the most upstream, significant source of spawning gravel to the middle river. Bank revetment construction may have helped accelerate the process by working to straighten and confine the channel, thereby increasing its sediment transport capacity. Gravel recruitment in the middle and lower reaches has also been reduced by construction of bank revetments, which has reduced channel meandering. It has been proposed that gravel depletion effects will continue to migrate farther downstream over time (Fuerstenberg et al. 1996).

Flood operations and flow withdrawal/augmentation have also influenced spawning habitat availability for spring spawners by controlling when and how much spawning gravel is covered by water downstream of the Tacoma Headworks. Specifically, springtime refilling of Howard Hanson Dam has been linked with dewatering of steelhead redds that are constructed prior to the sudden reduction in flow associated with refill (Watson and Toth 1995).

Summer Flows

Anadromous fish migrating upstream to the cold headwater tributaries of the White and Green Rivers pass through the lower 34 miles of the Green River during their upstream migration. Historically, there may have been sufficient amounts of water, but with the diversion of the White and Black Rivers, and growing, large water demands of the region, instream flows in the mainstem middle and lower Green River were reduced. Apparent declines in summer stream flow have also been identified for the Soos and Newaukum basins, likely in response to increased urbanization, groundwater withdrawals, and changes in precipitation (Culhane et al. 1995).

Prior to mainstem flow augmentation, summer water demands frequently exceeded availability, and flows in the lower basin were at times so low that early arriving adult chinook salmon attempting to migrate upstream were instead trapped lower in the river reaches where water temperatures and water quality can be adverse. Low summer flows may also influence juvenile steelhead and coho survival in both the mainstem and tributaries because of elevated summer temperatures, poor water quality, and reduced rearing habitat.

Side Channel and Tributary Habitat

Rearing habitat quantity and quality is particularly limited in the lower Green River due to urbanization, channelization, and flood control measures. Side channel habitat may have been historically an important component of juvenile salmonid rearing habitat within both the middle and lower Green River Watersheds, providing rearing habitat and refuge from high flows. The quality and quantity of side channel habitats have been diminished not only because of the changes in flow regime identified above, but also because of changes in the Green River sediment transport regime that may result in effective side channel disconnection from the mainstem.

As a partial consequence of loss of side channel habitat, tributary habitat has become much more important to anadromous salmonids than historically when more habitat was available elsewhere. Development in the Big Soos Creek and Newaukum Creek drainages in particular have had, and will continue to have, a significant influence on present salmonid rearing success.

Large Woody Debris/Riparian Vegetation

Large woody debris is an important component of salmonid habitat because it provides habitat space (pools) and structure (cover) and habitat for aquatic invertebrates, helps retain local deposits of spawning gravel in reaches where sediment transport capacity exceeds supply rates, contributes to bank stability, and can be integral to channel migration processes in alluvial reaches. Removal of in-channel LWD has occurred throughout much of the Green River basin as a result of timber harvest prior to 1975, flood control, and navigational improvement activities.

Recruitment of new LWD to the river throughout the basin has been limited by past timber harvest within the riparian zone, by physical blockage at Howard Hanson Dam, by physical clearing during development and bank protection work, and by reduced migration of the channel into wooded areas that could potentially provide material to the channel. Clearing and harvest of the riparian zone have influenced bank stability (which has been subsequently achieved artificially) and input of organic detrital matter, and reduced or removed shade such that summer water temperatures are likely elevated over pre-development values. Paving over of the riparian zone has led to rapid surface runoff and decreased floodplain storage of water.

Estuarine Habitat

Estuarine habitat has been the most severely compromised of all fish habitat types in the Green River system. Practically all of the original intertidal flats, wetlands, and swamps in the lower basin have been drained and lost to development, resulting in a severe loss of physical habitat space and biological production. The natural ability of the estuarine system to counter water quality problems has also been lost as a result.

Sediments in the bed of the present estuary and Elliott Bay are contaminated with toxic compounds (subsection 3.6, Surface Water Quality and Quantity). In addition, the extent of saltwater influence has moved upstream to roughly the confluence with the Black River because of the White and Black River diversions. The loss of habitat and food production, coupled with poor water quality, has likely reduced survival of anadromous and other species that rely on estuarine habitat for at least part of their life history (Blomberg et al. 1988).

Fish Passage Past Howard Hanson Dam and the Tacoma Headworks Diversion

Tacoma's Headworks Diversion and Howard Hanson Dam have blocked the upstream passage of anadromous fish into the Upper Green River Watershed. The anadromous runs are thought to have been an important source of selected trace elements and nutrients to the ecosystem of the upper Green River. These dams also interrupted upstream-downstream migrations of resident salmonids and other fish species. Although limited trap-and-haul operations have been instituted, studies of downstream migrant survival through the Howard Hanson Dam facility have documented low survival of fish from the upper Green River basin due to poor passage conditions at the dam (Dilley and Wunderlich 1992, 1993).

Upper Green River Watershed

Fish habitat in the Upper Green River Watershed is influenced by a number of factors, including withdrawal of groundwater from the North Fork Wellfield by Tacoma Water, forest management activities including logging and road building, operation of Howard Hanson Dam, and use and maintenance of a railroad right-of-way. This watershed presently has very limited residential use, and public access to the watershed is prohibited except for forest and watershed management purposes and access for a few landowners.

The capacity of freshwater streams to produce salmonid fishes is often determined by the quality and quantity of habitat conditions for critical life history stages of the important species (Salo and Cundy 1987; Fausch et al. 1990; Meehan 1991). Forest management practices in the Upper Green River Watershed have impacted fish habitat by: 1) introducing fine or coarse sediment to the stream channel by road or hillslope erosion, or by landslides; 2) reducing the capacity of riparian zones to recruit LWD to the stream,

to stabilize streambanks with a root network, to provide adequate riparian shade, to contribute fine litter to the stream, or to filter fine sediment from surface runoff; and 3) altering peak stream flows and potentially increasing bank erosion or scour depths of spawning gravels (U.S. Forest Service 1996; Plum Creek Timber Company 1996a).

Fine Sediment

Fine sediments enter stream networks naturally through bank erosion, soil creep, and mass wasting events. Forest practices can influence delivery rates of fine sediment by affecting erosion from road surfaces and harvest units, and by increasing the rate of mass wasting (Beschta 1978; Sullivan and Duncan 1980; Reid and Dunne 1984; Bilby 1985). Fine sediments (less than 0.85 mm) can have detrimental effects on salmonid spawning success if sediment is deposited on redds during the spawning and incubation period (Chapman 1988; Tappel and Bjornn 1983). Peterson et al. (1992) concluded that survival and development of embryos and growth of alevins can be reduced if fine sediment size fractions exceed approximately 12 percent by weight of the total sample volume. Spawning habitat is generally considered degraded if sediment levels in the streambed exceed 17 percent (Washington Forest Practices Board 1997). Fine sediments are typically transported through forest streams during peak flow events. Sediment deposition, if any, occurs in low-gradient stream areas (less than 1%) or in estuaries. Low-gradient and mainstem spawners such as fall chinook, chum, or pink salmon may be most affected by increases in fine sediment levels.

Fine sediments can seasonally collect in pools, low-gradient reaches, and along margins of channels throughout the stream network (Peterson et al. 1992; Lisle and Hilton 1992). Such sedimentation can reduce summer and winter rearing capacities by filling pools, embedding stream substrates, and decreasing food production capabilities. All salmonid species would be affected to some extent by such sedimentation if annual flushing flows were insufficient to keep channel substrates clean of fines. Sources of fine sediment in the Upper Green River Watershed include road use and road construction, mass wasting caused by logging and roads, natural landslides, and streambank erosion.

Coarse Sediment

Coarse sediments enter the stream network naturally through bank erosion and mass wasting. Catastrophic landscape events such as floods and debris torrents may extensively redistribute sediment in the channel network. Forest practices can influence delivery and distribution of coarse sediment in streams by altering the frequency and severity of these natural processes (Eisbacher and Clague 1984; Coho and Burges 1994; Benda et al. 1998; Fetherston et al. 1995). Forest practices may reduce hillslope stability through inappropriate road construction techniques and timber harvest on steep slopes, which cause reduced root strength.

Moderate rates of coarse sediment delivery are necessary to maintain fish habitat elements such as spawning gravels, deformable bed thickness capable of creating deep pools, and multiple channels providing off-channel habitat. However, excessive coarse sediment inputs can reduce the fish production capacity of a stream by filling pools, changing bed elevations, and otherwise altering stream channels and water courses. Dry reaches can occur where summer low flows are inadequate to fill increased interstitial spaces in coarse sediment deposits. Coarse sediment volumes sufficient to bury channel obstructions (LWD, boulders) will reduce the hydraulic value of the obstructions.

Most coarse sediments enter and are transported in streams during peak flows and major storm events. The most devastating effect on fish resources in streams generally occurs when the stream bed is mobile during catastrophic events, such as debris flows or dam-break floods (Eisbacher and Clague 1984; Coho and Burges 1991; Benda et al. 1992). Fish production in streams subject to debris torrents and dam-break floods can vary widely from year to year in response to the dynamic nature of the stream channel and unstable habitat conditions.

Summer Flows

The operation of Tacoma's North Fork Wellfield can result in reduced flows in the North Fork Green River during the summer. Periodic low flows of the North Fork Green River may reduce the quality of habitat conditions for juvenile steelhead trout, chinook salmon, and coho salmon, which are currently outplanted in the upper watershed, as well as resident fish species including rainbow and cutthroat trout. Reduced river flows may also result in elevated water temperatures in this tributary.

Peak Flows

Two types of peak streamflow events can affect fish habitat: 1) seasonal peak flows that occur every winter in response to rain and snowmelt, and 2) exceptional peak flows that produce floods with a recurrence interval of once every several years or more. Seasonal peak flows do not normally produce significant changes in stream channel structure, but they can potentially cause redd scour or generic bed mobility. Such scour would be important for salmonid species with embryos incubating in the gravel during winter (Lisle 1981).

Conversely, floods are generally regarded as channel-forming events (Leopold et al. 1964). Floods may move large amounts of bedload and LWD, producing fundamental changes in channel structure. They typically occur in association with exceptional storm events that often trigger shallow-rapid landslides, debris torrents, dam-break floods, or exceptionally rapid bankcutting, depending on storm characteristics and channel type (Benda et al. 1998; Fetherston et al. 1995). In the Action Area, such floods have most recently occurred in conjunction with major storms in January 1990, November 1995, and February 1996. Both types of peak flow events may be detrimental to fish production (Peterson et al. 1992).

Channels have different capacities to handle peak flow changes depending on cross-sectional profiles, catchment area, the amount of hydrologically mature vegetation in the drainage, and the amount of energy-dissipating features (e.g., flow obstructions or bed complexity) in the channel (Dunne and Leopold 1978; Beschta et al. 1987). Recently harvested (i.e., hydrologically immature) vegetation tends to increase surface runoff (Helvey 1980; Harr 1983; Kattlemann et al. 1983); winter rain-on-snow events can also be increased by harvesting (Harr 1986). However, the anticipated effects of peak flow increases on stream channels have not been demonstrated during Watershed Analyses performed in western Oregon and Washington (Washington Forest Practices Board 1997). Although the effects of forest management on fish habitat are often most visible after a severe storm/flood event, the actual habitat changes are typically caused by coarse sediment and LWD movement rather than by management-induced changes in streamflow (Washington Department of Natural Resources 1995).

Large Woody Debris

Large woody debris in streams provides channel structure, helps trap and stabilize coarse gravel deposits, creates sites for scour pool development, provides overhead and stream velocity cover for fish, and influences streambank characteristics (Campbell 1986; Bisson et al. 1987; Beschta et al. 1987; Bilby and Ward 1991). Besides providing fish habitat, LWD enhances channel stability and contributes to overall channel structural diversity (Bisson et al. 1987; Sullivan et al. 1987). Large woody debris enters streams naturally through treefall in the riparian zone, via mass wasting events, and by undercutting of streambanks.

Forest practices can influence delivery of LWD by harvest of riparian trees (Gregory et al. 1987) and by altering the frequency and severity of floods and mass wasting (Benda et al. 1998; Fetherston et al. 1995). Historically, removal of in-channel wood through stream-cleaning projects, use of splash dams, and increases in natural rates of dam-break floods also tended to reduce the quantity and distribution of LWD in streams (Sedell and Swanson 1984).

Large woody debris is an important component in the development of pool habitat. Pool habitat is critical to both summer and winter rearing for salmonid fish. The importance of pool habitat varies by species, stream gradient, and season (Campbell and Neuner 1985). Pools provide good feeding opportunities for fish, as well as adequate stream depths for cover from avian and terrestrial predators. The amount of rearing space is often considered the most limiting factor to salmonid production in flowing waters (Chapman 1966; Reeves et al. 1989). Good habitat conditions occur when pool frequencies are between 20 and 50 percent by area (Raleigh et al. 1984; Reeves et al. 1989; Reeves et al. 1991; Peterson et al. 1992). Pool areas below 10 percent are generally regarded as poor rearing habitat conditions and tend to limit salmonid productive capacities (Raleigh et al. 1984; Reeves et al. 1989).

Harvest of riparian trees during past logging and road building has led to reduced wood supplies in the upper Green River drainage. Activities contributing to low LWD levels in the mainstem and tributaries include timber harvest, mass wasting, and decomposition due to wet riparian conditions.

Riparian Canopy

Riparian forests provide a forest canopy that can shade streams and effectively moderate both peak stream temperatures and daily fluctuations in stream temperature (Beschta et al. 1987; Sullivan et al. 1990). Since fish are cold-blooded species, stream temperatures may constitute an important control of salmonid production, metabolism, growth, survival, behavior, and habitat utilization. Optimum stream temperatures for salmonid fishes generally range between 50°F and 66°F (10°C and 19°C), with growth decreasing above 68°F (20°C) because of increased metabolic rates (Bell 1973). Lethal temperature levels over sustained periods vary between 73°F and 79°F (23°C and 26°C), depending on the species and degree of temperature acclimation (Bjornn and Reiser 1991).

Bull trout/Dolly Varden, which have not been found but which potentially reside in the Upper Green River Watershed, have lower thermal optima than other salmonid fishes potentially residing in the Action Area and generally occupy cold headwater streams. Juvenile bull trout/Dolly Varden have been reported to prefer water temperatures between 46°F and 50°F (8°C and 10°C) (Bonneau and Scarnecchia 1996). Adverse effects are generally reported as stream temperatures begin to exceed 59°F (15°C) for extended periods (Beamish 1980; Shepard 1985).

Stream temperature is primarily determined by air temperature, elevation, channel morphology, canopy closure, and topography (Caldwell et al. 1991). Timber harvesting can affect stream temperatures by increasing the exposure of the water surface to sunlight and by altering microclimatic conditions in the riparian area (Adams and Sullivan 1989; Brosofske et al. 1997). Timber harvest may also indirectly affect stream temperature by changing the frequency of channel-altering events such as debris torrents and by altering the hydrologic regime (e.g., by creating wetlands). Shade removal can lead to increases in peak water temperature during the day and reduced minimum temperatures at night (Beschta et al. 1987).

Conversely, studies on forest streams in western Washington have shown that for any given stream, water temperatures may primarily respond to factors such as elevation, channel morphology, groundwater effects, or the presence of wetlands, with riparian shade frequently acting as a relatively unimportant determinant of stream temperature (Caldwell et al. 1991; Earle 1998). In general, the relationship between air temperature, shade, groundwater, and other factors affecting instream temperatures is complex and is unique to each individual stream.

3.9 Wildlife

An estimated 460 species of mammals, birds, amphibians, and reptiles inhabit western Oregon and Washington (Brown 1985), in addition to thousands of species of invertebrates. At least 272 species could be present in the Action Area. The USFWS, under the authority of the ESA, has identified species considered threatened or endangered because of low population numbers or other significant threats to their survival (U.S. Fish and Wildlife Service 1994), as well as candidate species being considered for formal listing (U.S. Federal Register, 28 February 1996). The USFWS has identified seven wildlife species that are currently considered threatened or endangered, are candidates for listing, or are proposed for listing in or near the Action Area (Table 3-6) (Appendix A, Plant and Animal Database Searches).

There are an additional 12~~1~~ wildlife species considered by the USFWS to be Species of Concern ~~and one species considered Proposed Threatened~~ (Table 3-6) (Appendix A, Plant and Animal Database Searches). The USFWS also lists three species of bats and one insect as Species of Concern that would not be covered by the ITP (long-eared myotis, long-legged myotis, Pacific Townsend's big-eared bat, Hatch's click beetle).

The WDFW maintains a priority habitats and species list of those species identified within the state of Washington because of population status, sensitivity to habitat alteration, and/or recreational, commercial or tribal importance (Appendix A, Plant and Animal Database Searches) (Washington Department of Fish and Wildlife 1999). Based on distribution information from this list, seven wildlife species having a threatened, endangered, or candidate status have been documented to occur in or near the Action Area (Table 3-6) (Appendix A, Plant and Animal Database Searches).

The WDFW's Priority Habitats and Species Database is used by agency and private cooperators as a central repository for distribution and abundance records of federal and state species of concern. Information from a search of the database was used along with habitat coverage for the Action Area to indicate occurrence potential for terrestrial species in the Action Area (Appendix A, Plant and Animal Database Searches) (Washington Department of Fish and Wildlife 1999).

Table 3-6. Wildlife species to be covered under Tacoma Water's Green River HCP.

PLACEHOLDER

3.9.1 Wildlife Habitats and Communities within the Boundaries of Tacoma Water's Green River Action Area

Tacoma Water's Action Area extends approximately 75 miles from the estuary of the Green River (i.e., area of tidal influence at RM 11.0) to nearly the crest of the Cascade Mountains (subsection 3.1, Introduction). Within this area are a wide range of climates, plant communities, and land uses that create a diversity of habitats and wildlife communities. The following is a description of the wildlife communities that exist in and near the Action Area within the lower, middle, and upper portions of the Green River Watershed.

3.9.1.1 Lower Green River Watershed

The lower Green River Watershed, as defined for purposes of Tacoma Water's HCP, consists of the 22.8 miles of river between the estuary and the confluence with Soos Creek near the City of Auburn. The Action Area in the lower watershed is confined to the river channel and adjacent floodplain (up to the elevation inundated at a flow of 12,000 cfs), and generally includes limited vegetated areas, if any, comprised of grasses, shrubs, and deciduous trees (subsection 3.7, Vegetation). Wildlife populations within the Action Area in the lower reaches of the river are therefore limited to those that use the wetted area of the river on a daily or seasonal basis, such as reptiles, amphibians, waterfowl, and streamside mammals that hunt or seek cover in the river.

The lower Green River reach of the river is almost entirely confined by levees and revetments to protect adjacent urban and suburban areas from flooding. The river has very little natural floodplain along this reach, and riparian vegetation is limited to a narrow band of native and exotic trees (mostly hardwoods), shrubs, and grasses directly adjacent to the river, or is lacking altogether in the more industrialized sections (subsection 3.7, Vegetation). Channelization of the river has left few slack-water areas favored by aquatic and riparian wildlife, and steep, abrupt banks that offer little riparian habitat for ground-dwelling wildlife. Lands beyond the stream bank are developed as industrial, commercial, urban residential, suburban residential, and agricultural areas. Few natural wildlife habitats exist in these areas outside municipal parks. Human activity is variable, but generally high throughout this portion of the Green River.

Wildlife found along the lower Green River are typical of urban and suburban environments of western Washington. They include meadow and woodland song birds, waterfowl such as the Canada goose (*Branta canadensis*), native and exotic rodents, and small carnivores such as the raccoon (*Procyon lotor*). Somewhat atypical of urban/suburban environments is the presence of several active nests of the bald eagle (*Haliaeetus leucocephalus*) and the great blue heron (*Ardea herodias*). Both species are known to nest throughout developed areas of the Puget Sound lowlands where trees of sufficient size remain and human activity is moderate to low, such as in large, forested parks. A number of active nests of both species are documented within the lower Green River drainage.

3.9.1.2 Middle Green River Watershed

The middle Green River lies between Soos Creek (RM 33.8) and Tacoma's Headworks diversion at RM 61.0 (subsection 3.1, Introduction). This 27.2-mile reach of the river includes the approximately 13-mile-long Green River Gorge, a steep-walled canyon cut up to several hundred feet deep through sandstone and mudstone. Like the lower watershed, the Action Area in the middle watershed is also confined to the river channel and adjacent floodplain (up to the elevation inundated at a flow of 12,000 cfs). Outside of the Gorge, the middle watershed Action Area includes limited areas of shrub and deciduous tree vegetation growing adjacent to the river channel and within several backwater channels. Wildlife populations within the Action Area in the middle reaches are therefore limited to those that use the wetted area, such as reptiles, amphibians, waterfowl, and streamside mammals that hunt or seek cover in the river. Above the Gorge, the river follows a moderately confined channel through second-growth forest and rural residential development. Below the Gorge the river gradient drops and the channel becomes meandering, supporting at least 48 known side channels. Adjacent land uses below the Gorge are forestry, agricultural, and rural residential.

Streamside habitat above the Green River Gorge is mostly second-growth coniferous and mixed conifer-hardwood forest typical of the Western Hemlock Forest Zone (Franklin and Dyrness 1987). Dominant tree species are western hemlock (*Tsuga heterophyla*), western redcedar (*Thuja plicata*), Douglas-fir (*Pseudotsuga menziesii*), red alder (*Alnus rubra*), black cottonwood (*Populus trichocarpa*), and big-leaf maple (*Acer macrophyllum*). Trees reach up to 150 feet in height and 30 inches in diameter at breast height (dbh), although most are considerably smaller. Understory vegetation is dense and composed of salmonberry (*Rubus spectabilis*), sword fern (*Polystihcum minutum*), vine maple (*Acer circinatum*), and

several other shrubs, ferns, and herbaceous species. Residential lawns occur throughout this area beyond the narrow riparian corridor.

Habitat within the Gorge is exposed rock or steep, open-canopy forest of Douglas-fir, western hemlock, and western redcedar. Human development is rare within the Gorge due to the steep terrain, and human disturbance is rare except for recreational boating on the river.

Below the Gorge, the middle Green River corridor supports several wetlands, including those dominated by emergent plants, shrubs, and hardwood forest of black cottonwood and red alder. Agricultural pastures and residential development also occur in this area.

Wildlife communities along the middle Green River are variable, ranging from those associated with native coniferous forest within and upstream of the Gorge to those found in wetlands, farms, and suburban developments below the Gorge. Most native forest, wetland, and riparian wildlife of western Washington are capable of being present in this portion of the river at some time during the year, except those associated with large tracts of mature or old-growth forest like the northern spotted owl *(Strix occidentalis caurina*), and those particularly sensitive to human disturbance like the gray wolf (*Canis lupus*). Nests of the bald eagle and osprey (*Pandion haliaetus*) are documented along this stretch of the river, and sightings of coyote (*Canis latrans*), black bear (*Ursus americanus*), and cougar (*Felis concolor*) are common. Black-tailed deer (*Odocoileus hemionus*) and elk (*Cervus elaphus*) are both common, particularly above the Gorge.

3.9.1.3 Upper Green River Watershed

The Action Area in the Upper Green River Watershed (above Tacoma's Headworks) consists of 14,888 acres of Tacoma-owned forest that is interrupted only by the Headworks diversion, Howard Hanson Dam (and Reservoir), the abandoned Lester town site, the Burlington Northern Santa Fe Railroad corridor, several powerline corridors and a network of forest roads. Under Tacoma ownership, 3,244 acres in the upper watershed are non-forested. Forest stands range in age from recent clearcuts to residual old-growth, and in composition from pure red alder and cottonwood (along streams and in recently disturbed areas) to pure coniferous forest in managed uplands (Table 3-3). Large natural openings in the forest are rare, and are limited to rock outcrops and cliffs near the top of the watershed. Several hundred acres of man-made

openings are maintained in native and non-native grasses and shrubs as powerline rights-of-way. A number of small lakes and wetlands are present, and a well-developed riparian community exists along the Green River and its major tributaries upstream of Howard Hanson Reservoir.

Brown (1985) estimates there are 272 species of vertebrates native to the coniferous forest ecosystem along the west slope of the Cascade Mountains in Washington. Most, if not all 272 of these species occur in the Upper Green River Watershed, although some are extremely rare and/or occasional visitors to the area. Species associated with high elevations and/or cliffs (e.g., mountain goat, wolverine and peregrine falcon) are not likely to be present in the Action Area because it is concentrated at low to moderate elevations along the Green River and contains very few cliffs. The watershed supports an elk herd of up to 200 wintering animals (Washington Department of Fish and Wildlife 1999), and black-tailed deer are abundant. Large carnivores such as the black bear and cougar are common, and recent sightings of grizzly bears (*Ursus arctos*), gray wolves, wolverine (*Gulo gulo*), and fisher (*Martes pennanti*) in the vicinity suggest these species may also be present (see HCP Appendix A, Life Histories of Fish and Wildlife Species). Several northern spotted owl activity centers have been documented in the upper watershed, and northern spotted owls are known to be present in the managed forests of the Action Area. Recent surveys have confirmed "occupancy" by the marbled murrelet (*Brachryamphus marmoratus*) on USFS-managed lands adjacent to Tacoma Water's ownership, but HCP lands do not support suitable habitat for these species.

3.9.2 Wildlife Species Covered by Tacoma Water's HCP

Tacoma Water's HCP and its alternatives would cover 21 species of wildlife native to western Washington (Table 3-6). These species and their life histories are described in detail in Tacoma Water's proposed HCP (HCP subsection 4.4.3 and HCP Appendix A). One of these species (the gray wolf) is federally listed as endangered, four are federally listed as threatened (bald eagle, marbled murrelet, northern spotted owl, ~~and~~ grizzly bear, and the Canada lynx), one is a candidate for federal listing, the Oregon spotted frog (*Rana pretiosa*), and one, the peregrine falcon (*Falco peregrinus*), was recently de-listed by the USFWS. All but two of the others, the common loon (*Gavia immer*) and the pileated woodpecker (*Dryocopus pileatus*), are federal species of concern. The loon and pileated woodpecker have no federal status at this time.

Ten of the species that would be covered by Tacoma Water's HCP, the gray wolf, peregrine falcon, marbled murrelet, grizzly bear, Canada lynx (*Lynx canadensis*), Oregon spotted frog, Cascade torrent salamander (*Rhyacotriton cascadae*), Northwestern pond turtle (*Clemmys marmorata*), California wolverine, and Pacific fisher, do not presently occupy the Action Area. These 10 species would be covered in the HCP in the event that conservation measures in the region result in their presence in the Action Area in the future. Four of the other 11 species that would be covered by the HCP are known to be present in or directly adjacent to the Action Area; these are the bald eagle, northern spotted owl, common loon, and pileated woodpecker. The rest of the other 11 species are thought to be present even though no specific surveys have been conducted for the HCP; these are the Cascades frog (*Rana cascadae*), Van Dyke's salamander (*Plethodon vandykei*), Larch Mountain salamander (*Plethodon larselli*), tailed frog (*Ascaphus truei*), northern goshawk (*Accipiter gentilis*), olive-sided flycatcher (*Contopus borealis*), and Vaux's swift (*Chaetura vauxi*).

3.10 Recreation

The area to be covered by the proposed HCP and ITP includes Tacoma Water's lands in the Upper Green River Watershed, as well as lands affected by project facilities near the Tacoma Headworks (subsection 3.1, Introduction). In addition to the areas to be covered by the proposed HCP and ITP, areas potentially affected by the proposed HCP and by other alternatives also include the Green River lands downstream of the Headworks in the lower and middle Green River Watershed (subsection 3.1, Introduction). Both of these potentially affected areas are described in this subsection.

3.10.1 Lower and Middle Green River Watershed

Flows in the Green River downstream of the Tacoma Headworks would be affected by diversion operations under each alternative; therefore, existing use of this downstream area for water-dependent recreation activities is relevant to this analysis. The Green River Gorge State Park Area and other downstream areas support a wide variety of recreation uses; the primary water-dependent and other recreation uses are described in this section (Figure 3-4). The Green River does not have federal status under the Wild and Scenic Rivers system (i.e., listed for "recreation" values).

3.10.1.1 Water Use Recreation

Whitewater Rafting/Kayaking

The Green River Gorge State Park Area, which extends from Kanaskat-Palmer Recreation Area (RM 56.0) to Flaming Geyser Recreation Area (RM 42.9), is located downstream of the Tacoma Headworks (Figure 3-4). The State Park Area is extensively used by experienced whitewater rafters and kayakers, and the river is also run by commercial outfitters. The Green River through the Gorge is a challenging river with Class IV rapids. The Green River is one of approximately 10 commercially run rivers in Washington State that contain Class IV or better rapids (Best, pers. comm., 1 July 1999). The full Gorge run is approximately 9 river miles long, extending from Kanaskat-Palmer Recreation Area to Flaming Geyser Recreation Area (i.e., the full length of the State Park Area). The topography of the Gorge generally limits put-in (start point) and take-out (end point) access to these developed areas, but whitewater users can also put-in at the Tacoma Headworks above Kanaskat-Palmer, or near the old Franklin townsite about midway through the run. No access fees are charged in the Green River Gorge State Park Area.

Figure 3-4. Recreation sites.

PLACEHOLDER

Recreation use of the Green River by whitewater rafters and kayakers is based primarily on the availability of sufficient flows, as defined below. Whitewater use, especially by the most experienced rafters and kayakers, can occur whenever sufficient flows are present in the Green River Gorge, regardless of season (Sumption, pers. comm., 8 April 1999). However, because of various factors including natural river hydrology and the USACE operations of Howard Hanson Dam, the typical season for whitewater use is currently during late fall, winter, and early spring months when higher flows tend to occur. During other parts of the year, flows are usually not sufficient to support whitewater use (Sumption, pers. comm., 8 April 1999). The range of flows that are generally acceptable for whitewater rafting are from 1,300 cfs to 4,000 cfs, and flows generally acceptable for kayaking are from 1,000 cfs to 3,000 cfs (Sumption, pers. comm., 25 March 1999).

The number of whitewater rafters and kayakers using the Green River varies depending on flows. When sufficient flows are present through the Green River Gorge State Park Area, whitewater use will typically include about 30 individual kayakers and about 30 rafts (Sumption, pers. comm., 8 July 1999). The composition of these users typically changes depending on flow levels. For example, expert rafters and kayakers may only run the Green River at the high end of the flow range, while less skilled boaters generally prefer the low end of the flow range.

Canoeing and Swimming

Canoeing, swimming, and inner-tubing are popular summer activities downstream of the Green River Gorge State Park Area when flows are low (Washington State Parks and Recreation Commission 1997; King County Department of Planning and Community Development 1977). The most popular areas for inner-tubing and swimming are in and around Flaming Geyser Recreation Area and in several downstream parks where public access is provided (Figure 3-4). Between the cities of Auburn and Kent, including the potential new downstream diversion site as described under Water Withdrawal Alternative C, the river has been described as having an extremely high recreation value (King County Department of Planning and Community Development 1977). As opposed to whitewater rafting and kayaking, inner-tubing and swimming are likely to be more dependent on air temperature than on instream flows.

Fishing

Fishing is a popular recreation use in the Green River, and occurs essentially along its entire length downstream of the Tacoma Headworks wherever access is available. Steelhead fishing is especially popular, as the Green River is usually one of the top 10 steelhead rivers in Washington (Washington State Parks and Recreation Commission 1997). The primary steelhead season is from mid-December to mid-February, and recent creel census information indicates that about 57,900 angler hours of effort (1 November to 15 March) resulted in the capture of about 1,450 winter steelhead (Cropp, pers. comm., 22 April 1999). Summer is also popular for fishing, and 1975 creel census information indicated that about 41,600 angler hours of effort (1 June to 31 October) resulted in the capture of about 1,500 summer steelhead, 700 trout, and 150 whitefish (Cropp, pers. comm., 22 April 1999).

3.10.1.2 Other Recreation

The Green River is the focus of much non-water-use recreation activity downstream of the Green River Gorge. King County maintains several day-use park areas in the rural section of the river between Flaming Geyser Recreation Area and the City of Auburn, including Whitney Bridge Park, Metzler Park, Neely Bridge Park, and Auburn Narrows Park (King County Department of Parks and Recreation 1997). These facilities provide picnic areas and access to the river (e.g., for fishing, canoe launching), but are not developed for high-intensity use.

The City of Auburn has also developed parks along the Green River, notably Brannan Park and Issac Evans Park. Brannan Park is intensively developed, with lighted ballfields and soccer fields. Adjacent to Issac Evans Park is the 18-hole Auburn Golf Course, the City of Auburn's municipal (i.e., public) course. All three of these facilities are near RM 29.2, the potential site of a downstream diversion facility described under Water Withdrawal Alternative C. Developed parks in the City of Kent along the Green River include North Green River Park, Horsehead Bend, and the 27-hole Riverbend Golf Complex, the City of Kent's municipal course.

There are several other parks downstream of the City of Kent, most of which are small, neighborhood parks surrounded by residential and industrial development. Notable in this area is the expanded development of bicycle/walking trail facilities along the Green River. As the river has lost much of its natural

amenity value in this urbanized area, the river levee has become more important as a linear facility for recreational trail use and for alternative transportation (i.e., bicycling).

3.10.2 Upper Green River Watershed

Little recreational use occurs in the Green River Watershed above the Tacoma Headworks. The 14,888-acre Tacoma Water ownership is closed to public access and, therefore, experiences no recreational use. Public lands (32,500 acres) in the 147,295-acre upper watershed are largely those of the Mt. Baker-Snoqualmie National Forest. While the USFS allows access from the east over Stampede Pass into the upper watershed, its management objectives are generally consistent with Tacoma Water's goal of protecting the public water supply (U. S. Forest Service 1990).

In 1984, the USFS and Tacoma Water entered into a Memorandum of Understanding regarding management of National Forest lands in the upper watershed. Management objectives contained in the Mt. Baker-Snoqualmie National Forest Land and Resource Management Plan (U.S. Forest Service 1990) generally limit recreational use within the Upper Green River Watershed to dispersed recreational activities (e.g., deer and elk hunting); trail use and other development is very limited. Additionally, no formal recreational uses occur on DNR or private lands adjacent to Tacoma's ownership (Weiss, pers. comm., 29 April 1999; Raedeke Associates 1995), although some National Forest trails cross Tacoma Water and Plum Creek Timber Company ownerships in the upper watershed.

3.11 Visual Resources

3.11.1 Lower and Middle Green River Watershed

The Green River below the Tacoma Headworks is an important visual resource; several parks and other land uses have been developed to take advantage of the river's scenic value (Figure 3-5). Key vantage locations along the Green River include the following:

Green River Gorge State Park Area

Because the steep walls of the Green River Gorge limit visibility, the visual resources of the Green River are enjoyed primarily from the river itself (i.e., by whitewater rafters, kayakers). Visual enjoyment of the

river from land is generally limited to Kanaskat-Palmer Recreation Area above the Green River Gorge, and Flaming Geyser Recreation Area below the Green River Gorge.

Flaming Geyser Recreation Area to Auburn

Visual enjoyment of the Green River from surrounding lands is very limited along this reach because of the extent of riparian forest vegetation and few access improvements. However, the river corridor, with its natural vegetation, retains a high visual quality, which is enjoyed from the river itself by floaters and canoers.

City of Auburn to City of Kent

Although more developed than upstream areas, this section of the Green River continues to support a high visual quality. The river can be viewed from most surrounding areas, especially from several developed parks and open space areas, and from the scenic Green River Road, which follows the east bank of the river. In addition, the visual quality of the river is enjoyed from the river itself by recreational users (e.g., floaters, swimmers).

Downstream of the City of Kent

From the City of Kent downstream to the area of tidal influence (RM 11.0), there is almost no instream use of the Green River. Although the river corridor becomes more urbanized downstream of Kent and the City of Tukwila, enjoyment of the river's visual quality continues to be locally important, and several parks and open space areas front the river in this reach.

Figure 3-5. Vantage points in the lower and middle Green River Watershed.

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3.11.2 Upper Green River Watershed

Tacoma Water's lands in the Upper Green River Watershed generally follow the river and are, therefore, visible from vantage points higher in the watershed. However, public access to lands in the upper watershed is limited. Tacoma Water's property itself is closed to public access, and public use of DNR and other private timberlands in the upper watershed is generally restricted. U.S. Forest Service lands of the Mt. Baker-Snoqualmie National Forest are managed in a manner consistent with Tacoma Water's water quality goals; National Forest recreational use in the upper watershed is generally limited to dispersed activities such as hunting. Some National Forest trails exist in the upper watershed; however, trail use is low (U.S. Forest Service 1990). Accordingly, although Tacoma Water's lands may be visible, no key vantage points have been identified because the sparse public use of the upper watershed limits the area's visual sensitivity.

3.12 Social and Economic Conditions

For this affected environment, the Action Area can best be categorized by social conditions in the areas surrounding the lower and middle Green River Watershed (i.e., recreational opportunities), and economic conditions in the Upper Green River Watershed (i.e., Tacoma timber harvest and watershed management). More detailed information on these resources is included in subsections 3.3, Ownership and Land Use; 3.9, Wildlife; and 3.10, Recreation.

Other important social and economic conditions related to the Proposed Action are the growth and demand characteristics of Tacoma Water's Service Area. As background for the alternative descriptions, this information is provided above in subsection 2.2.1, Background and Identification of Water Withdrawal Alternatives.

Under the GMA, growth projected for the state by the state's Office of Fiscal Management is allocated to the counties, which then develop plans to address the projected population increase and the associated needs for services. Cities may also prepare plans under the GMA. Plans developed under the Act then guide both zoning and development permits within the jurisdictional boundaries of the plans. In the case of Tacoma's service area, GMA plans have been developed by Pierce County, the City of Tacoma, King County, the City of Seattle, and a number of other cities in King County. These plans forecast and direct urban growth with Tacoma Water's service area (subsection 1.6.5, Growth Management Act).

3.12.1 Lower and Middle Green River Watershed

The middle and lower reaches of the Green River support a variety of social opportunities and economically important recreational activities. These include camping and water-based recreation, kayaking and rafting, fishing, and general nature appreciation activities, including bird watching and hiking.

The Green River Gorge State Park Area, a popular regional recreational area, is located along the middle reach of the Green River (subsection 3.10, Recreation). Kanaskat-Palmer Recreation Area and Flaming Geyser Recreation Area are both located along the river in the Green River Gorge State Park Area. In addition, a number of undeveloped city, state, and county park properties are located along the middle reach of the Green River. The proximity of the Green River to the urbanized areas of Tacoma and Seattle provide for frequent and extensive use of these parks in all seasons.

Sport fishing has historically been of importance on the Green River (subsection 3.10, Recreation). The proximity of the Green River to the urbanized area makes it particularly popular among local anglers. The river has historically produced trout and salmon, but is probably most well known for steelhead fishing, which is supported by the hatchery production of steelhead juveniles by the WDFW.

3.12.2 Upper Green River Watershed

Tacoma Water manages its forestlands in the Upper Green River Watershed with one professional forester according to its Forest Land Management Plan (Ryan 1996). Pursuant to the Forest Land Management Plan (Ryan 1996), timber harvest is limited to a maximum of 80 acres per year. This timber is offered for sale to domestic sawmills in the Puget Sound region at times when the timber stumpage market is at or near its optimum price. Over the last 10 years (~~1988 to 1998~~ 1990 to 1999) Tacoma Water has made ~~22~~ 24 sales totaling ~~154~~ 84 acres and ~~4,499,000~~ 2,682,000 board feet of timber. These timber sales have returned a total net revenue to Tacoma Water of ~~$1,224,181~~ $763,010. This revenue is deposited into the Watershed Assurance Fund B for later use in land acquisition, forest management, and watershed improvements.

The timber sale program provides employment to contract loggers and log truck drivers in the watershed and sawmill workers outside the watershed. Timber sales also provide work in the watershed for contract tree planters, tree thinners, and other forest workers through the life of the newly regenerated forest.

Tacoma Water employs four Watershed Inspectors in the watershed who patrol on a daily basis to assure the protection of water quality. This activity is required by the Safe Drinking Water Act and related State regulations. In addition, three Water Control Station Operators operate and maintain Tacoma's Headworks treatment building and the associated Tacoma Headworks Diversion.

The USACE employs two to three people as operators at Howard Hanson Dam. These operators maintain the facilities at the dam and make operational adjustments as required.

3.13 Cultural Resources

The entire Action Area between the area of tidal influence/estuary at RM 11.0 and the headwaters in the Upper Green River Watershed has been extensively reviewed in prior analyses for various Green River projects. Several of these projects have analyzed cultural resources within the Green River area. Consequently, the following documents have been reviewed and summarized by the Services, and are relied upon for the NEPA cultural resources overview and analyses conducted by the Services for Tacoma Water's ITP application. These documents provide an adequate review of potential cultural resources located within the Action Area, including the landscape under each alternative, and are hereby incorporated by reference.

- Additional Water Storage Project, Final Feasibility Study Report and Final EIS (U.S. Army Corps of Engineers 1998). Lists chronology of events in the Green/Duwamish River Basin between 1850 and 1997, beginning with the Oregon Donation Land Act and ending with the USACE reconnaissance report for the Green/Duwamish Ecosystem Restoration Study.

- Additional Water Storage Project, Final Feasibility Study Report and Final EIS, Appendix I, Agency Coordination Documents and Public Review Comments and Responses (U.S. Army Corps of Engineers 1998). Response to the comments of the Muckleshoot Indian Tribe on the USACE feasibility study for the Additional Water Storage Project of the Howard Hanson Dam.

- Additional Water Storage Project, Draft Feasibility Report and EIS - Howard Hanson Dam (U.S. Army Corps of Engineers 1998). Summarizes treaties and agreements with the Muckleshoot and Suquamish Indian Tribes, which have co-management responsibilities with the state of Washington for fisheries resources in the Green/Duwamish River system. Reviews pre-history of the area, citing archaeological surveys identifying over 20 hunter/gatherer and hunter/gatherer/fisher sites in the Upper Green River Watershed, near the confluence of the Green River and the North Fork of the Green River, and near the Howard Hanson Dam.

- Draft Reconnaissance Report - Green River/Duwamish River Ecosystem Restoration General Investigation (U.S. Army Corps of Engineers 1997). Outlines chronology of events in the Green/Duwamish River Basin since 1850 and describes current land use and population centers. The basin includes the territory of three tribes, including the present-day Muckleshoot Indian Tribe. Permanent winter villages of the Muckleshoots have been located on the Green, White, Stuck, and Puyallup Rivers and their tributaries. Currently, the Muckleshoot and Suquamish Tribes share the management of fisheries resources in this area with the state of Washington.

- Green/Duwamish River Basin - General Investigation, Ecosystem Restoration Study Reconnaissance Phase (U.S. Army Corps of Engineers 1997). Summarizes early evidences of human settlement in the Green/Duwamish River Basin, which include prehistoric campsites, specialized resource procurement sites, village sites, and early historic period sites. Describes historic and contemporary contributions of Native American tribes, including the Duwamish, Suquamish, and present-day Muckleshoot tribes. Provides chronology of events in the area from 1850 to 1997. A short discussion of population, land use, and recreation in the basin serves as an overview of modern cultural resources.

- Cultural Resources Survey of the Additional Water Storage Project Area - Howard Hanson Dam, King County, Washington (Larson Anthropological/Archaeological Services

1996). Report on a pedestrian reconnaissance in June and July 1995 of 900 acres proposed for additional water storage above the Howard A. Hanson Dam. Descriptions of ethnography/ethnohistory, previous cultural resource studies, field survey methods, and individuals and agencies contacted. One hunter/fisher/gatherer resource, a single cryptocrystalline silica flake, was identified, in addition to four historic archaeological sites (a lumber mill and portions of several homesteads) and a 1950s refuse disposal area adjacent to a logging railroad grade. The four historic sites were evaluated for potential listing on the National Register of Historic Places, but it was determined that none were eligible.

- Final Supplemental Environmental Impact Statement for the Second Supply Project (Pipeline No. 5) (Tacoma Water 1994a). Statement that mitigation measures are planned to ensure that potentially affected cultural resources are identified and given proper consideration.

- Draft Supplemental Environmental Impact Statement for the Second Supply Project (Pipeline No. 5) (Tacoma Water 1994b). Summary of mitigation for historic and cultural resources associated with the Tacoma Water Pipeline No. 5.

- Final Environmental Impact Statement - Pipeline No. 5 (City of Tacoma and King County 1988). Comments by the Muckleshoot Indian Tribe to the proposal for Pipeline No. 5, addressing impacts on fish, soils, water quality, flora and fauna, and land and shoreline use. Includes responses.

- Draft Environmental Impact Statement, Volume 1 - Pipeline No. 5 (City of Tacoma and King County 1987a). Brief description of a literature search and field survey of cultural resources for the proposed Tacoma Water Pipeline No. 5, identifying two prehistoric and 10 historic sites within the pipeline corridor. Provides discussion of impacts on cultural resources as a result of the project and its alternatives.

- Draft Environmental Impact Statement, Volume 3 - Pipeline No. 5 (City of Tacoma and King County 1987b). Description of a literature search and field survey of cultural resources of a 100-foot-wide right-of-way for the Tacoma Water Pipeline No. 5 from the Tacoma Water Diversion Headworks on the Green River to Tacoma, Washington. Two prehistoric and 10 historic sites were identified by the survey. The two prehistoric sites, one a lithic scatter and one a pit, represent use by native peoples; the remaining sites represent Euroamerican use of the area since the 1880s.

- Tacoma Water Division Water System Plan, Volume I (City of Tacoma and Economic and Engineering Services, Inc. 1987a). A figure illustrating the designated water supply area for the Tacoma Water System Plan, with a comment stating that the proposed plan will not result in an alteration of a significant archaeological or historical site, structure, object, or building.

- Tacoma Water Division Watershed Management and Water Treatment Plan, Volume II (City of Tacoma and Economic and Engineering Services, Inc. 1987b). Brief description of a cultural resource study contracted for by the USFS in 1978. The report described the geography, geology, history of the watershed, native use of natural resources, and occupancy of the watershed by the Muckleshoot Indian Tribe and other groups. It identified two sites in the watershed area as showing a complex pattern of existence among the Green River Basin native groups.

- Archaeological Reconnaissance of Howard Hanson Dam Project - Technical Report (U.S. Army Corps of Engineers 1985). Report on an intensive archaeological reconnaissance of the Howard A. Hanson Dam Resource conducted in June 1985, including a description of the area's geomorphology, flora, and fauna; historic and ethnographic overviews; and a description of field techniques. The survey identified 14 prehistoric and three historic cultural resource sites and discussed their significance.

- City of Tacoma Department of Public Utilities, Water Division Water System Plan, Volume I (Economic and Engineering Services, Inc. 1980a). States the intent of the Water Division to establish a long-term settlement of tribal and state fisheries issues.

- City of Tacoma Department of Public Utilities, Water Division Water System Plan, Volume II - Final Environmental Impact Statement (Economic and Engineering Services, Inc. 1980b). Brief description of the water consumption needs of Pierce and King Counties, including fishing interests of the Muckleshoot Indian Tribe. Provides a discussion of impacts to fisheries resources as a result of the proposed second diversion pipeline.

Table 3-1. Watershed Administrative Units encompassing the Action Area in the Upper Watershed.

Watershed Administrative Unit	Total Area (Acres)	HCP Area Portion (Acres)	HCP Area Portion (Percent of WAU [%])	Status
Lester	32,803	5,145	15.7	Complete; approved by DNR
Upper Green	23,688	945	4.0	Draft complete; approval pending
Sunday	15,571	1,285	8.3	Draft complete; approval pending
Howard Hanson	46,501	4,915	10.6	Draft complete; approval pending
Smay	14,415	740	5.1	Draft complete; approval pending
North Fork Green	17,728	1,021	5.7	Pending
TOTAL	150,706	14,051	9.3	

Table 3-2. Water quality standards applicable to the Green River (WAC 173-201A-030).

Freshwater Class AA (extraordinary) Water Quality Standards	
Fecal coliform	Organism levels shall both not 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.
Dissolved oxygen	Shall exceed 9.5 mg/L. Total dissolved gas shall not exceed 110% of saturation at any point of sample collection.
Temperature	Shall not exceed 16.0 degrees Celsius (°C) due to human activities. When natural conditions exceed 16.0°C no temperature increases will be allowed that will raise receiving water temperatures by greater than 0.3°C.
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.
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.
Toxic substances	Shall be below those that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by Ecology (toxic substances include metals and ammonia nitrogen).
Freshwater Class A (excellent) Water Quality Standards	
Fecal coliform	Organism levels shall both not exceed a geometric mean value of 100 colonies/100 mL and not have more than 10% of all samples obtained for calculating the geometric mean value exceeding 200 colonies/100 mL.
Dissolved oxygen	Shall exceed 8.0 mg/L. Total dissolved gas shall not exceed 110% of saturation at any point of sample collection.
Temperature	Shall not exceed 18.0°C due to human activities. When natural conditions exceed 18.0°C no temperature increases will be allowed that will raise receiving water temperatures by greater than 0.3°C.
pH	Shall be within the range of 6.5 to 8.5 with a human-caused variation within a range of less than 0.5 units.
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.
Toxic substances	Shall be below those that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by Ecology (toxic substances include metals and ammonia nitrogen).

Source: Washington Department of Ecology (1997)

Table 3-2. Continued.

Freshwater Class B (good) Water Quality Standards	
Fecal coliform	Organism levels shall both not exceed a geometric mean value of 200 colonies/100 mL and not have more than 10% of all samples obtained for calculating the geometric mean value exceeding 400 colonies/100 mL.
Dissolved oxygen	Shall exceed 6.5 mg/L. Total dissolved gas shall not exceed 110% of saturation at any point of sample collection.
Temperature	Shall not exceed 21.0°C due to human activities. When natural conditions exceed 21.0°C no temperature increases will be allowed that will raise receiving water temperatures by greater than 0.3°C.
pH	Shall be within the range of 6.5 to 8.5 with a human-caused variation within a range of less than 0.5 units.
Turbidity	Shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20% increase in turbidity when the background turbidity is more than 50 NTU.
Toxic substances	Shall be below those that have the potential either singularly or cumulatively to adversely affect characteristic water uses, cause acute or chronic conditions to the most sensitive biota dependent upon those waters, or adversely affect public health, as determined by Ecology (toxic substances include metals and ammonia nitrogen).

Source: Washington Department of Ecology (1997)

Table 3-3. Forest age class distribution on Tacoma-owned lands within the upper Green River Watershed.

Forest Age (Years)	Conifer (Acres)	Hardwood (Acres)	Total (Acres)
1 to 5	341	0	341
6 to 15	1,212	0	1,212
16 to 25	709	150	859
26 to 35	929	351	1,280
36 to 45	228	559	787
46 to 55	255	526	781
56 to 65	341	611	952
66 to 95	4,298	697	4,995
96 to 145	302	13	315
146+	122	0	122
Total Forested Land	8,737	2,907	11,644
Non-forested Land	-	-	3,244
TOTAL	**-**	**-**	**14,888**

Source: Tacoma Water Geographic Information System

Table 3-4. Plant species with federal or state threatened or endangered status that occur in King County, Washington, and their likelihood of occurrence within the Action Area.

Common Name	Scientific Name	Federal Status[1]	State Status[1]	Occurrence Potential within the HCP Area	Habitat
~~Swamp~~ Marsh sandwort	*Arenaria paludicola*	LE	Possibly extinct	Not likely to occur	Wetlands along the Puget Sound and Pacific coast (Hitchcock and Cronquist 1964) and freshwater wetlands (Washington Natural Heritage Program 1981).
Golden Indian Paintbrush	*Castilleja levisecta*	LT	LE	Not likely to occur	Meadows and prairies at low elevations (10 to 300 feet) in the Puget Sound region (Abrams 1951; Washington Natural Heritage Program 1981; Washington Natural Heritage Program 1999). Will not tolerate a closed canopy, and typically found on glacial outwash.
White-top aster	*Aster curtus*	SC	S	Not likely to occur	Moist, gravelly, undisturbed natural prairie (100 to 550 feet above sea level) (Washington Natural Heritage Program 1981; Meinke 1982).
Stalked moonwort	*Botrychium pedunculosum*	SC	S	Moderate potential in Upper, Middle, or Lower Watersheds	Found in forested habitat, meadows, and roadside areas throughout its range from Southern British Columbia to Oregon (Lellinger 1985). Reported in a dry meadow site at 3,200 feet in King County (Rush, pers. comm., 8 June 1999).
Tall bugbane	*Cimicifuga elata*	SC	LT	High potential in Upper, Middle, or Lower Watersheds	Mixed, moist forest at low elevations (Potash 1991; Hitchcock and Cronquist 1964; Washington Natural Heritage Program 1981). Often associated with rocky cliffs and/or riparian areas (Dimlinger 1992).

Table 3-4. Continued.

Common Name	Scientific Name	Federal Status [1]	State Status [1]	Occurrence Potential within the HCP Area	Habitat
Water lobelia	*Lobelia dortmanna*	None	LT	Moderate potential in Upper, Middle, or Lower Watersheds	Shallow water at the edges of lakes and ponds (Hitchcock et al. 1959); usually in sandy soils (Gleason and Cronquist 1963).
Choris' bog-orchid	Platanthera chorisiana	None	LT	Moderate potential in Upper, Middle, or Lower Watersheds	Moist areas, especially edges of streams and bogs. Very wet meadows, rocky seeps, and lakeshores in the Mountain Hemlock Zone and Silver Fir Zone (Potash 1991).

[1] Washington Natural Heritage Program (1999)

LE listed endangered
LT listed threatened
S sensitive
SC species of concern

Table 3-5. Federal and state status of fish species present in the Green River Watershed.

Common Name	Scientific Name	Federal ESA Listing Status, Puget Sound	Date of Latest ESA Determination	Washington State Priority Species Status*
Chinook Salmon	*Oncorhynchus tshawytscha*	Threatened	March 1999	2,3
Coho Salmon	*Oncorhynchus kisutch*	Not Warranted	July 1995	2,3
Chum Salmon	*Oncorhynchus keta*	Not Warranted+	March 1998	2,3
Pink Salmon	*Oncorhynchus gorbuscha*	Not Warranted+	February 1996	2,3
Sockeye Salmon	*Oncorhynchus nerka*	Insufficient Information	December 1997	2,3
Steelhead Trout	*Oncorhynchus mykiss*	Not Warranted+	August 1996	3
Coastal Cutthroat Trout	*Oncorhynchus clarki clarki*	Not Warranted+	April 1999	3
Bull Trout	*Salvelinus confluentus*	Threatened	November 1999	2,3
Dolly Varden	*Salvelinus malma*	None	†	None
Pacific Lamprey	*Lampetra tridentatus*	Not Proposed	-	None
River Lamprey	*Lampetra ayresi*	Not Proposed	-	None

\+ Status reviews conclude a listing is Not Warranted at this time

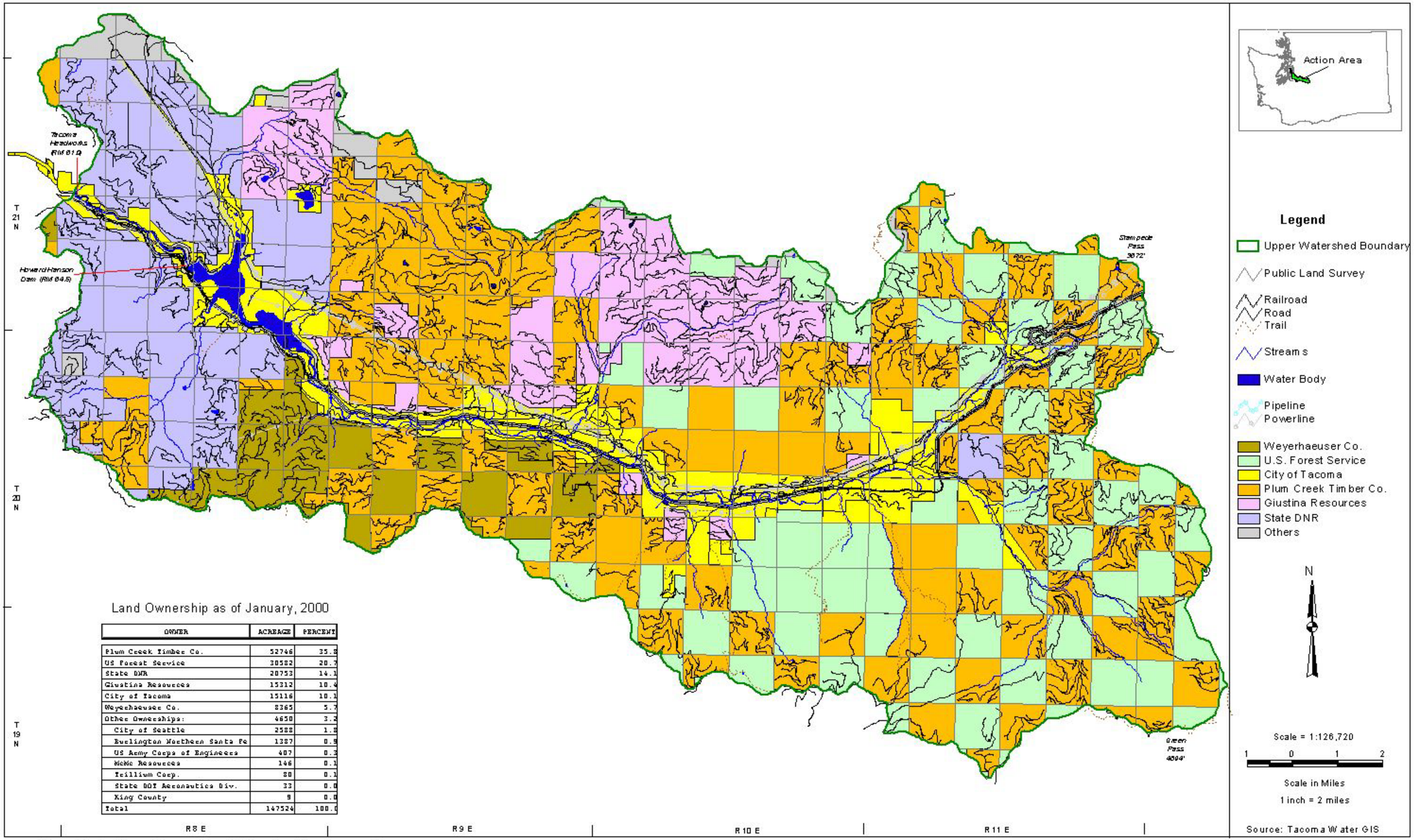
* State of Washington Species Criteria:
1 State Listed and Candidate Species
2 Vulnerable Aggregations (groups are susceptible to significant population declines)
3 Species of Recreational, Commercial, and/or Tribal Importance

† Dolly Varden are discussed in 64 Federal Register 58909

Table 3-6. Wildlife species to be covered under Tacoma Water's HCP.

Common Name	Scientific Name	Federal Status	State Status
Federally Listed Wildlife Species			
Gray wolf	*Canis lupus*	Endangered	Endangered
Bald eagle	*Haliaeetus leucocephalus*	Threatened	Threatened*
Marbled murrelet	*Brachryamphus marmoratus*	Threatened	Threatened
Northern spotted owl	*Strix occidentalis caurina*	Threatened	Endangered
Grizzly bear	*Ursus arctos*	Threatened	Endangered
Canada lynx	*Lynx canadensis*	~~Proposed~~ Threatened	Threatened
Federally Unlisted Wildlife Species			
Cascade torrent salamander	*Rhyacotriton cascadae*	Species of Concern	Candidate
Van Dyke's salamander	*Plethodon vandykei*	Species of Concern	Candidate
Larch Mountain salamander	*Plethodon larselli*	Species of Concern	Sensitive*
Peregrine falcon	*Falco peregrinus*	Species of Concern (Recently De-listed)	Endangered
Tailed frog	*Ascaphus truei*	Species of Concern	None*
Cascades frog	*Rana cascadae*	Species of Concern	None
Oregon spotted frog	*Rana pretiosa*	Candidate for Listing	Endangered
Northwestern pond turtle	*Clemmys marmorata*	Species of Concern	Endangered*
Common loon	*Gavia immer*	None	Candidate*
Vaux's swift	*Chaetura vauxi*	Species of Concern	Candidate
Pileated woodpecker	*Dryocopus pileatus*	None	Candidate*
Olive-sided flycatcher	*Contopus borealis*	Species of Concern	None
California wolverine	*Gulo gulo luteus*	Species of Concern	Candidate*
Pacific fisher	*Martes pennanti pacifica*	Species of Concern	Endangered
Northern goshawk	*Accipiter gentilis*	Species of Concern	Candidate

* Known to occur in or near the HCP Area (Washington Department of Fish and Wildlife 1999).



Land Ownership as of January, 2000

OWNER	ACREAGE	PERCENT
Plum Creek Timber Co.	52746	35.8
US Forest Service	30582	20.7
State DNR	20753	14.1
Giustina Resources	15312	10.4
City of Tacoma	15116	10.1
Weyerhaeuser Co.	8365	5.7
Other Ownerships:	4650	3.2
City of Seattle	2588	1.8
Burlington Northern Santa Fe	1387	0.9
US Army Corps of Engineers	407	0.3
McMc Resources	146	0.1
Trillium Corp.	80	0.1
State DOT Aeronautics Div.	33	0.0
King County	9	0.0
Total	147524	100.0

Figure 3 - 1. Upper Green River Watershed land ownership.

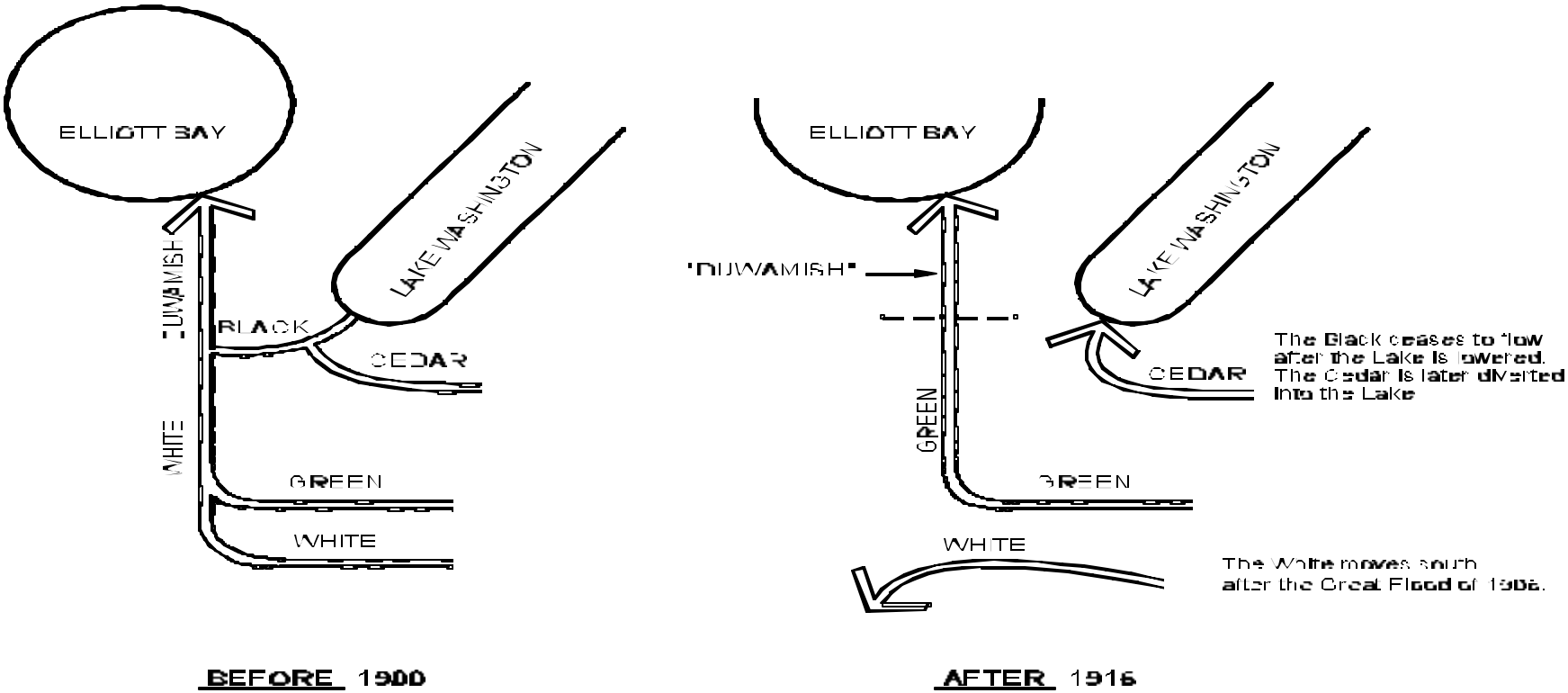


Figure 3-2. Configuration of the Duwamish basin prior to 1801 and after 1916 (after Dunne and Dietrich, 1978)

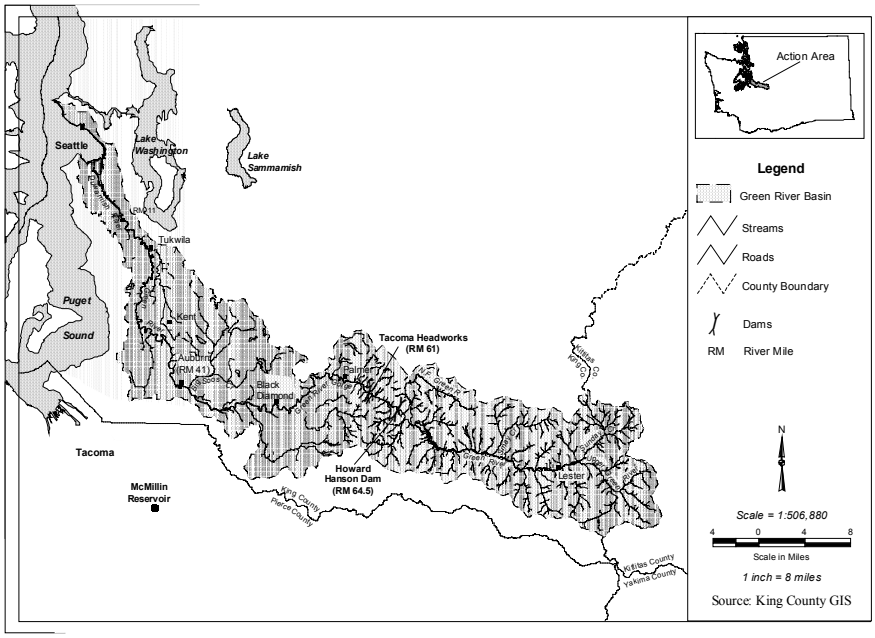


Figure 3-3. Major surface waters and drainage systems in the Action Area.

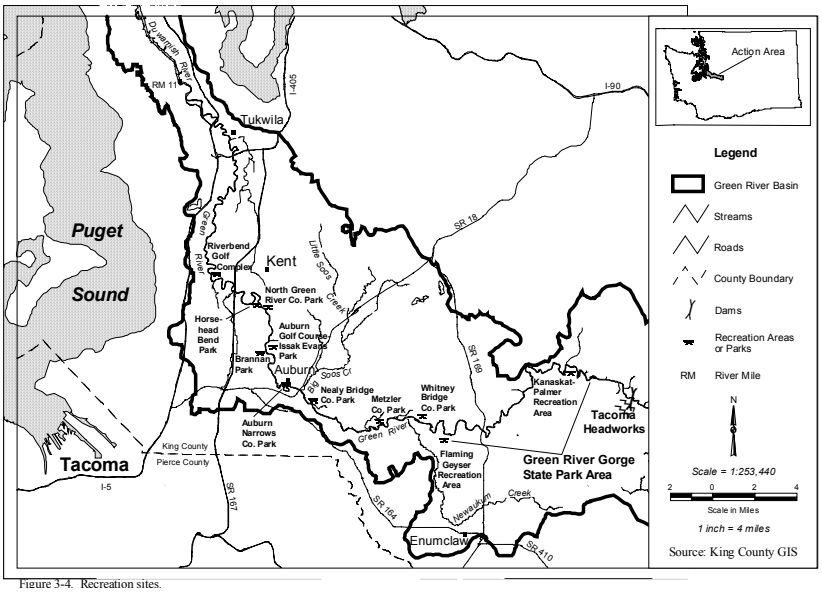


Figure 3-4. Recreation sites.

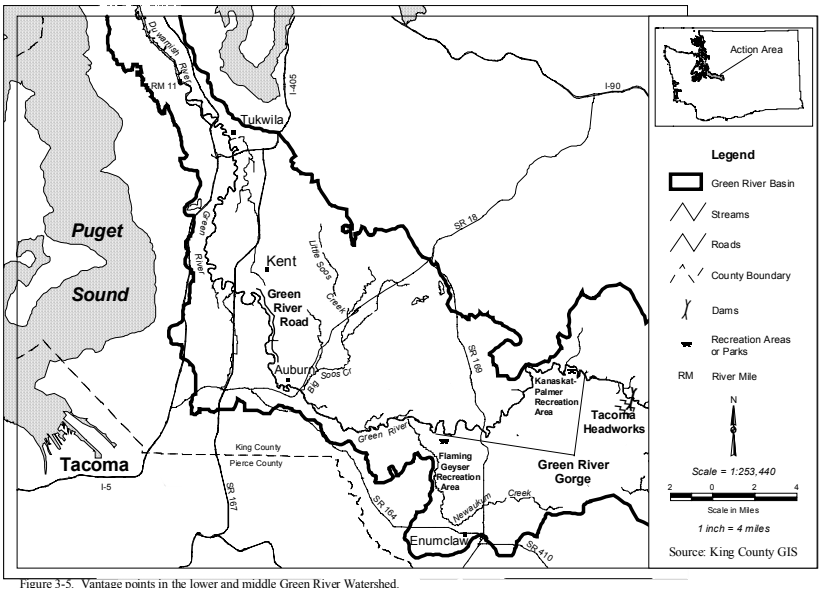


Figure 3-5. Vantage points in the lower and middle Green River Watershed.

4.0 Environmental Consequences

4.1 Introduction

The descriptions in this section contain comparative analyses of the consequences associated with each component of the affected environment discussed in Section 3.0. Consequently, subsections 4.2.1 and 4.3.1, Ownership and Land Use through 4.2.11 and 4.3.11, Cultural Resources of this section correspond directly to subsections 3.3, Ownership and Land Use through 3.13, Cultural Resources in Section 3.0. Included in each subsection is a comparison of the anticipated consequences associated with each of the action alternatives (Water Withdrawal Alternatives B and C, and Upland Management Alternatives B and C), to the baseline effects associated with the respective No Action Alternatives (Alternative A). For the purposes of this discussion, the terms "effects" and "impacts" will be considered synonymous with consequences, and consequences may be positive or negative.

The analyses in this section also include potential impacts that may result from specific activities covered under the ITP, which are in subsection 1.2.1, Purpose of the Proposed Action. The Services reviewed the potential for impacts to occur to each resource of the affected environment (Table 4-1); those resources that may receive either a positive or negative impact were further discussed within the text of this section.

The final subsection, Cumulative Effects Analysis (subsection 4.4), considers the incremental impact of each of the alternatives on the environment when added to past, present, and reasonably foreseeable actions regardless of what agency (federal or non-federal) or person undertakes such actions (40 CFR 1508.7).

A review of subsection 2.1, Introduction (to Alternatives) and subsections 2.2.2, Water Withdrawal Alternative A: No Action, through 2.4.3, Upper Watershed Alternative C: No Commercial Timber Harvest will be helpful in understanding how impacts are related to the details of each alternative.

Table 4-1. Covered activities anticipated to result in effects to the affected environment under an ITP for the Water Withdrawal and Upper Watershed Management Alternatives.

PLACEHOLDER

Tacoma Water is requesting incidental take coverage for two distinct sets of covered activities within the Green River Watershed: a) the withdrawal of water at the Tacoma Headworks facility (RM 61.0) and associated activities (Figure 2-1), and b) the management of City of Tacoma-owned lands in the upper watershed above the point of withdrawal. *These two, distinct activities are interrelated, but they are not interdependent; an ITP could be issued for one activity and not for the other. The water withdrawal facilities could be operated with or without incidental take coverage for the upper watershed, and management of Tacoma Water's upper watershed lands could continue regardless of the manner in which water is withdrawn.* For this reason, the analyses in this DEIS are done in two parts; one covering the alternatives for water withdrawal activities, and the other covering alternatives for land management activities in the upper watershed. The only potential avenue of interaction between the sets of alternatives is that anadromous fish access to the Upper Green River Watershed, which would be provided under either of the Water Withdrawal action alternatives (B and C), could increase the fisheries utilization of aquatic habitats being managed under the Upper Watershed alternatives. For this reason, the analyses of effects of the Upper Watershed alternatives include consideration of the impacts and/or benefits to salmon, steelhead, cutthroat trout, and bull trout.

It should also be noted that the USACE maintains responsibility for impacts associated with water storage under the Additional Water Storage Project. The Tacoma Water ITP would not include water storage as a Covered Activity. These impacts are addressed in Howard Hanson Additional Water Storage Project Draft Project Feasibility Study Report and Environmental Impact Statement (U.S. Army Corps of Engineers 1998). However, because Tacoma's activities (e.g., management and operational activities of the Upper Watershed, Second Supply Project, and Headworks Diversion) would occur simultaneously with the USACE's Additional Water Storage Project activities, some impact analyses demonstrate joint adverse or beneficial effects.

4.2 WATER WITHDRAWAL ALTERNATIVES

4.2.1 Ownership and Land Use

<u>All Alternatives</u>

The changes in stream flows under all water withdrawal alternatives would not affect riverine and riparian conditions to an extent that would affect property ownership or the use of adjacent lands pursuant to the

King County Comprehensive Plan or the plans of other local jurisdictions. Accordingly, no flow-related land use impacts are expected under any of the water withdrawal alternatives.

Construction of the downstream diversion and other facilities described under Water Withdrawal Alternative C would have temporary (i.e., construction-related) and long-term land use impacts. Although an exact location for this diversion has not been identified, it appears that a diversion near the Auburn Golf Course would likely be appropriate for engineering feasibility reasons. The City of Auburn Comprehensive Plan and zoning designation for the Auburn Golf Course is "Public and Quasi-Public Uses." Given the public works purpose of the diversion facilities envisioned under Water Withdrawal Alternative C, the downstream diversion facilities may be consistent with the "Public and Quasi-Public Uses" designation. However, a determination of land use consistency would be made by the City of Auburn prior to implementation of this alternative.

The diversion facilities under consideration would conflict with existing land uses in that relocation of portions of the golf course, and potentially other existing land uses, would likely be required. Surrounding land uses would potentially be affected by intake and treatment facilities, operations buildings, and roads (including temporary construction access roads and staging areas). In addition, the impoundment area created by the new diversion dam may also affect adjacent land uses.

The Auburn golf course area has a King County shoreline designation of Rural. Under the King County Shorelines Code all shoreline designations, including Rural, may allow the development of a new water diversion, subject to certain requirements (see subsection 3.3.1). Any alternative implementation would be subject to sensitive areas regulations and policies to ensure that no damage to sensitive areas, including critical habitat for protected species, occurs. The selected alternative will comply with all policies and regulations set forth in local comprehensive plans and other applicable planning documents.

King County's Environmentally Sensitive Areas regulations would prohibit development of a new water diversion facility wherever the project violates the regulation's goals and policies. An Exemption or Exception may be possible, but would depend upon the final location of the facility among other yet-to-be determined parameters.

Construction of the downstream diversion site remains speculative at this time. Specific areas to be affected by the proposed facilities have not been identified, and the extent of the impoundment area is not known. Although it is likely that land use impacts would occur, specific impacts are not known at this time because engineering specifications have not been developed.

4.2.2 Geology and Soils

4.2.2.1 Water Withdrawal Alternative A: No Action

Reductions in flow can alter the sediment transport regime of a river, reducing the transport capacity and thereby reducing the amount of bedload delivered to downstream reaches (Schumm 1977). Sediment transported by the river is responsible for maintaining floodplain soils, and periodic inundation of the floodplain by large floods gives those soils unique hydrologic and structural properties (Nunnally 1985). However, sediment transport and floodplain building or recharge generally occurs only during moderate to very large flow events, and has been substantially modified in the Green River by construction of Howard Hanson Dam. Tacoma's water withdrawal under Water Withdrawal Alternative A (113 cfs) would represent only a small fraction (less than 1%) of the largest flows currently possible in the Green River, and is frequently curtailed due to turbidity concerns during flood events large enough to transport substantial amounts of sediment. For these reasons, Tacoma's water withdrawal activities under Water Withdrawal Alternative A would not impact sediment transport and floodplain maintenance processes.

4.2.2.2 Water Withdrawal Alternative B: Proposed Action

Under Water Withdrawal Alternative B, the amount of water withdrawn by Tacoma Water would increase to up to 213 cfs. However, 213 cfs amounts to only a small fraction of the total volume of flow that occurs during flood events large enough to transport sediment, and, as under Water Withdrawal Alternative A, it is likely that Tacoma Water's diversion would be curtailed during such events due to turbidity concerns. For these reasons, Tacoma's water withdrawal activities under Water Withdrawal Alternative B would not impact sediment transport and floodplain maintenance processes.

One of the measures Tacoma Water would implement to benefit fish habitat in the Green River under Water Withdrawal Alternative B consists of the addition of up to 3,900 cubic yards of gravel to the mainstem Green River downstream of the Tacoma Headworks (HCP Chapter 5). The Habitat Conservation Measure is intended to restore an increment of the gravel that was previously transported into the middle Green River prior to construction of Howard Hanson Dam, and the amount to be input represents the estimated minimum average annual bedload contribution prior to construction of Howard Hanson Dam (U.S. Army Corps of Engineers 1998 - Appendix F).

Placement of gravel in the middle Green River would, under Water Withdrawal Alternative B, reduce the current rate of downcutting and downstream extension of bed armoring, which is currently estimated to be 700 to 900 linear feet per year in the mainstem channel (Perkins 1993). Since the volume to be input represents the most conservative estimate of pre-Howard Hanson Dam inputs, the addition of gravel is not expected to result in increases in the bed-surface elevation that would affect existing flood control structures downstream. The size of sediment input would range from coarse sand to large gravel, and the material would be trucked in from a nearby gravel pit. ~~Pit run gravel~~ Gravel input at RM 46.0 would be expected to become rounded and decrease in size by about 20 percent between RM 46.0 and RM 40.0 (Kuennen 1956). Transport and redistribution of the placed gravel would occur in the fall and winter during high flow events. A monitoring plan would be implemented under Water Withdrawal Alternative B to track the redistribution of added gravels, and annual placement could be reduced or halted if the USFWS, NMFS, and agencies responsible for flood control identified problematic aggradation.

Improvements at the Tacoma Headworks diversion and construction of a new 33.5-mile-long pipeline would disturb a limited amount of soil, temporarily increasing surface erosion and sediment inputs. Construction activities would be conducted according to all restrictions deemed necessary under the Section 404 permit and Hydraulic Project Approval obtained from the USACE and Ecology, respectively. Disturbed soils would be revegetated following construction; thus, impacts are not expected to persist for more than 1 year.

4.2.2.3 Water Withdrawal Alternative C: New Diversion

Construction of a new diversion dam and associated pipelines and infrastructure at RM 29.2 would disturb approximately 25 acres of soil for an estimated 2 to 3 years. Approximately 5 acres would be used for

temporary staging areas. Permanent facilities would occupy a total of about 20 acres following construction, resulting in a loss of otherwise productive soils. Surface erosion from the entire site would increase temporarily. Construction activities would be conducted according to all restrictions deemed necessary under the Section 404 permit and Hydraulic Project Approval obtained from the USACE and Ecology, respectively. Disturbed soils in the staging areas would be revegetated following construction. Construction of the fish ladder and holding facility at the existing Headworks Diversion would also temporarily increase surface erosion, but as with the new diversion sites, BMPs would be implemented to minimize sediment delivery to surface waters, and disturbed soils would be seeded and are expected to recover rapidly following construction.

Water impounded behind the new diversion dam would inundate approximately 1 mile of the mainstem Green River upstream of the structure. Existing riparian and wetland soils would be inundated. The increased water table would alter the structure and chemistry of soils along the margins of the new impoundment.

Sediment transport through the impounded reach would also be impacted. Deposition would increase within the impoundment. Because the bed material in the affected reach is dominated by fine material (sand and silt), it is unlikely that an armor layer would develop, but the bed may degrade downstream of the new diversion dam due to the lack of inputs from upstream reaches and increased transport capacity of water downstream of the diversion. These effects would be less if a rubber dam that could be collapsed during flood events were installed.

The impacts of water withdrawal under Alternative C would be identical as those described under Water Withdrawal Alternative A. The gravel nourishment conservation measure would also be implemented and would have the same effects as those described under Water Withdrawal Alternative B.

4.2.3 Air Quality

<u>All Water Withdrawal Alternatives</u>

The changes in stream flows under all water withdrawal alternatives would not affect riverine and riparian conditions to an extent that would change ambient PM_{10} conditions. Accordingly, no flow-related air quality impacts are expected under any of the water withdrawal alternatives.

Construction of the downstream diversion facilities described under Water Withdrawal Alternative C would have temporary (i.e., construction-related) and potentially long-term air quality impacts. Construction-related impacts would include dust generation caused by construction and use of temporary access roads, clearing, and site grading activities. In addition to dust generation and associated PM_{10} impacts, other criteria air pollutants (e.g., ozone precursors) may be generated during facilities construction from such sources as vehicle emissions and architectural coatings. Long-term air quality impacts would likely be minor and limited to on-site employee commute trips.

Site-specific construction and operation information has not been prepared for this alternative. However, it is likely that construction and operation of facilities under Water Withdrawal Alternative C would be in compliance with the SIP, which regulates particulate matter, visibility, and smoke management among other air quality pollutants.

4.2.4 Surface Water Quality and Quantity

Because of watershed protections necessary for a public water supply, waters impounded by Howard Hanson Dam contain lower concentrations of inorganics, metals, and fecal coliforms relative to waters in the lower and middle watershed. Thus, releases from Howard Hanson Dam are not a substantial source of these parameters in waters downstream. However, Tacoma Water operations may still affect the downstream concentrations of these constituents by controlling instream flows and dilution volumes in the lower and middle watershed.

4.2.4.1 Water Withdrawal Alternative A: No Action

Under Water Withdrawal Alternative A, water withdrawals would occur similar to current operations and would have the same influence on flows in the lower and middle Green River. Therefore, water quality in the lower and middle watershed is not expected to change relative to existing conditions. However, without options for increasing its water supply, Tacoma Water would not be able to provide assurances to the USACE that it could reduce water withdrawals during critical low flow periods if Tacoma Water's demand increases. If Tacoma Water does not reduce water withdrawals, as it has during the past 6 to 10 years

during these irregular, but critical periods, lower summer flows in the Green River would likely occur. Less flow would be available to dilute concentrations of mercury, oxygen-demanding substances, and fecal coliform bacteria in the lower watershed during critical low flow periods. Additionally, adult salmon would continue to be blocked from the upper watershed under Water Withdrawal Alternative A since the upstream passage facility at the Headworks Diversion would not be constructed.

4.2.4.2 Water Withdrawal Alternative B: Proposed Action

Under Water Withdrawal Alternative B, instream flows during ~~the summer~~ extreme summer droughts in the lower and middle watershed would be increased relative to existing conditions (i.e., Water Withdrawal Alternative A). Even under periods of high water demand, extreme low-flow conditions would be avoided by ~~minimum~~ flow agreements contained in the HCP. Greater flow could decrease water temperatures in the 3-mile reach below Howard Hanson Dam and would dilute concentrations of mercury, oxygen-demanding substances, and fecal coliforms in the lower and middle watershed. Mercury and fecal coliform levels could subsequently decrease during the summer; dissolved oxygen concentrations could increase.

In contrast, under Water Withdrawal Alternative B, flows during March and early April would decrease relative to Water Withdrawal Alternative A. Lower flows in early spring are due to Tacoma's exercise of the Second Diversion Water Right and the USACE's shifting water storage earlier in the spring as a result of the Additional Water Storage Project. Less flow would be available in the lower watershed to dilute levels of fecal coliforms during this period. Fecal coliform concentrations could increase in March and early April under Water Withdrawal Alternative B.

Under Water Withdrawal Alternative B, adult anadromous salmon would be provided access to the upper watershed. Once upstream fish passage facilities are completed, Tacoma Water would allow the agencies responsible for fisheries management to determine the number and species of fish to be transported into the upper watershed. Determining how many of which stocks and which species of fish should be considered for reintroduction to the upper watershed is a fish management decision that is beyond the responsibility of Tacoma Water. The Muckleshoot Indian Tribe and WDFW are co-managers of Green

River fish and wildlife resources and, together with the NMFS and USFWS, would evaluate fisheries aspects of re-introducing anadromous fish into the upper watershed.

Tacoma Water believes that reintroduction of anadromous fish to the upper watershed does not pose a risk to drinking water quality and public health at the proposed levels described in the Additional Water Storage Project Technical Appendices to the Draft EIS (USACE 1998 and HCP subsection 5.1.3, Tacoma Headworks Upstream Fish Passage Facility ~~Habitat Conservation Measures~~). This would include the introduction of up to 6,500 coho and 2,300 chinook adults. Due to the presence of the USACE's 235-foot high Howard Hanson Dam above Tacoma's Headworks, the Green River salmonid reintroduction plan provides for a trap-and-haul facility to move fish past both Tacoma's Headworks and Howard Hanson Dam. The reservoir behind Howard Hanson Dam and nearly 3 miles of river between Howard Hanson Dam and Tacoma's water intake would allow the natural uptake of nutrients from spawned salmon prior to withdrawal of water for municipal water supply purposes. The reservoir behind Howard Hanson Dam and the stream reach between Howard Hanson Dam and Tacoma's water intake would also minimize the occurrence of adult salmon immediately upstream of Tacoma's intake. Tacoma would monitor water quality at its Headworks as part of its surface water treatment program to verify the quality of the upper Green River as a source of safe drinking water.

The number of adults returning to the Upper Green River Watershed would be expected to increase over a period of years allowing adequate opportunity to assess water quality on an ongoing basis. If, to adequately protect drinking water quality, it becomes necessary to limit the biomass of adult fish transported into the upper watershed, Tacoma Water would coordinate with the NMFS, USFWS, and the fisheries managers before instituting measures to decrease fish passage. As part of this coordination effort, Tacoma Water would select one or more independent experts to evaluate available options. The independent expert would submit a report to the City of Tacoma, fisheries managers, and public health officials with recommendations as to the level of fish passage that can occur without posing a risk to drinking water quality and public health.

4.2.4.3 Water Withdrawal Alternative C: New Diversion

Under Water Withdrawal Alternative C, higher flows would occur through the middle watershed relative to Water Withdrawal Alternative A, and lower concentrations of inorganics, metals, and fecal coliforms

would be expected. Effects on water quality in the lower watershed would be similar to those analyzed under Water Withdrawal Alternative B. Compared to Water Withdrawal Alternative A, less flow would be available in the lower watershed, which may cause fecal coliform concentrations to increase during March and early April.

Under Water Withdrawal Alternative C, adult anadromous salmon would be provided access to the upper watershed. Monitoring of water withdrawn at the RM 61.5 Headworks Diversion would be similar to procedures planned under Water Withdrawal Alternative B. Adult anadromous fish already have access to 32 miles of river above the proposed site of the new Headworks. Water withdrawn at the new Headworks facility at RM 29.2 would require treatment, regardless of adult salmon passage since the water would not be withdrawn directly from a closed watershed.

4.2.5 Vegetation

4.2.5.1 Background

The water withdrawal alternatives would have a limited effect on vegetation as these alternatives focus primarily on the amount of water released below the Tacoma Headworks diversion. These flows are primarily contained within the stream channel and would not be substantial enough to alter the composition of streamside vegetation. The channel-forming flow events would continue to be controlled by the operation of Howard Hanson Dam, which restricts high flow events to a maximum of 12,000 cfs. The actions proposed under the water withdrawal alternatives that would affect vegetation are: 1) the loss of vegetation resulting from the construction of infrastructure necessary to support water withdrawal (treatment plant, pump station), and 2) fisheries and wildlife mitigation measures that would alter plant community structure and composition.

4.2.5.2 Water Withdrawal Alternative A: No Action

The water withdrawal operation proposed under Alternative A would have no effect on vegetation. Instream flows that are the same as current flows downstream of the Tacoma Headworks diversion would not cause a change in riparian plant communities as the operation of Howard Hanson Dam would remain the primary control of channel-forming events in the Green River channel in the middle and lower watersheds. No fish and wildlife mitigation measures would be implemented; therefore, no changes in plant communities would occur.

4.2.5.3 Water Withdrawal Alternative B: Proposed Action

Instream flows downstream of the Tacoma Headworks diversion that would result from water withdrawal operations proposed under Water Withdrawal Alternative B would not affect riparian vegetation in the middle and lower watershed Action Areas as these flows would be largely contained within the active, non-vegetated stream channel. Some proposed mitigation measures associated with the Second Supply Project and the Additional Water Storage Project that would be implemented by Tacoma Water would alter plant communities in limited areas as described below.

In the middle watershed, 1,000 linear feet of Signani Slough (RM 59.6) would be reconnected to the mainstem of the Green River (HCP subsection 5.2, Habitat Conservation Measure 2-07) allowing the vegetation along this reconnected channel to function as a riparian plant community. This plant community would create more potential habitat for sensitive plant species such as tall bugbane, Choris' bog orchid, and water lobelia, although it is impossible to predict if those species would inhabit the area in the future.

In the upper watershed several conservation measures would introduce emergent plants, shrubs, and trees into and adjacent to areas inundated by Howard Hanson Reservoir to attempt to establish more vegetated areas in the upper reservoir zone and to establish plant communities along the lower reaches of the tributaries discharging into the reservoir (HCP subsection 5.2, Habitat Conservation Measure 2-03). A headwater stream restoration proposal (HCP subsection 5.2, Habitat Conservation Measure 2-10) would also provide additional protection to riparian buffers and create an additional 4,000 linear feet of side channel habitat. In comparison to Water Withdrawal Alternative A, riparian plant communities, wetland habitat, and mature and old-growth forest plant communities would benefit from the actions implemented under Water Withdrawal Alternative B due to restoration or creation of conditions conducive to the development of these communities. These actions would not occur under Alternative A.

4.2.5.4 Water Withdrawal Alternative C: New Diversion

Under Water Withdrawal Alternative C, the construction of a new water diversion at approximately RM 29.2 on the Green River would require 20 acres near the Auburn Regional Golf Course to construct the necessary facilities and some additional impact (at least 5 acres) to accommodate construction staging

areas. Much of the impacted area would likely be golf course property resulting in substantial changes to the golf course landscape. As the majority of the impacts would likely be to golf course property that is currently landscaped or maintained as greens or fairways, impacts to native plant communities or sensitive native plant species would not likely occur. The riparian habitat in this area is comprised of grass and a few shrubs on the east side of the river (right bank as viewed downstream) and mature deciduous trees and shrubs on the west side (left bank as viewed downstream).

Riparian habitat extending 1 mile upstream of the new diversion would be inundated or influenced by the increased water surface elevation of the river resulting from the 12-foot-high diversion dam. The level of this impact would depend on the type of diversion dam constructed. If it were constructed as a fixed dam, impacts would include a floodplain area elevated to the equivalent of the new diversion dam increase, and would require the flood dikes to be raised to meet this flood elevation increase. Impacts would be considerably less if a rubber dam were installed that could be collapsed during flood events. Finally, although an exact location for the new diversion dam has not been determined, it is possible that vegetation associated with Isaac Evans and Brannan Parks would also be impacted by the increased water surface elevation.

The second pipe or increased pipe diameter necessary for this project would temporarily disturb vegetated areas in addition to those impacted for the Second Supply Project. However, the middle section of the Second Supply Pipeline would not need to be built, eliminating the temporary and permanent vegetation impacts associated with the mid section of the originally proposed pipeline. Therefore, the overall vegetation impacts resulting from pipeline construction from the new diversion to the Portland Avenue Reservoir should be less than construction of this section of the pipeline and the mid section of the pipeline proposed under the Second Supply Pipeline.

The increased flows in the middle and lower Green River between the Tacoma Headworks diversion and the new diversion at approximately RM 29.2 would not be expected to alter the riparian plant communities along this stretch of river. Similar benefits of the HCP measures discussed under Water Withdrawal Alternative B would also be realized under Water Withdrawal Alternative C as it is assumed these measures would be required to address potential resource impacts under Alternative C. Measures include

reconnection of Signani Slough to the mainstem Green River and the introduction of emergent plants in the Howard Hanson Reservoir inundation zone.

4.2.6 Fish and Aquatic Habitat

The following discussion analyzes potential impacts to the aquatic habitat and fish species for which Tacoma Water is requesting ITP coverage. Additional information can be found in the HCP in Chapters 4, Existing Condition of the Green River Basin and Chapter 7, Effects of Tacoma Water Withdrawal and Conservation Measures.

Background

Water withdrawals by Tacoma Water can have a number of adverse effects on fish populations in the lower and middle Green River. Reduced flows can hinder the upstream passage of adult anadromous fish (including salmon, steelhead, coastal cutthroat trout, and possibly bull trout/Dolly Varden), especially during low flow periods during the summer and fall. The upstream spawning migration of adult fish can be hindered by reduced depths in shallow riffles, which can delay or block passage. Upstream passage of salmon can also be delayed by poor water quality conditions, including warm water temperatures and low dissolved oxygen concentrations in the Duwamish and lower Green Rivers.

Water withdrawals by Tacoma Water reduce flows in the Green River below the Headworks diversion facility throughout the year. These flow reductions can lower the quantity and quality of spawning habitat available to adult anadromous and resident fish. Flow reductions impact habitat quantity by decreasing the wetted surface area of the mainstem river, as well as in the side channels present in the middle Green River. Habitat quality is degraded by decreased depths and velocities, which are often less suitable to spawning fish than those occurring prior to the water withdrawals. These flow reductions have their greatest potential impact during the summer and fall low flow period, when Tacoma's diversions remove the highest proportion of water in the river.

Flow reductions can degrade water quality by increasing the potential of water to warm during hot days, and by increasing the concentration of organic matter and pollutants in the water column. The increased concentration of organic matter, in combination with warmer water temperatures, can result in low dissolved oxygen concentrations in the Duwamish River during low flow periods. These water quality conditions subsequently lower the quality of habitat in the river for rearing salmonid fish. Flow reductions caused by water withdrawals can also potentially decrease the invertebrate food supply of fish, since low flows can decrease the diversity and production of macroinvertebrates.

The Tacoma Headworks diversion structure presents a barrier to the upstream migration of anadromous fish, which directly affects adult salmon returning to the river to spawn. Blocking the upstream migration of anadromous fish also indirectly affects a variety of fish and wildlife species due to the loss of marine-derived nutrients. Most adult anadromous fish die after spawning, and their carcasses play an important role in the nutrient cycle of Pacific Northwest watersheds.

4.2.6.1 Water Withdrawal Alternative A: No Action

Effects on Fish Habitat

Mainstem Green River

Under Water Withdrawal Alternative A, Tacoma Water would continue to withdraw up to 113 cfs from the Green River at its Headworks diversion. The actual volume of water that would be diverted from the river by Tacoma Water would be variable, depending on seasonal and climate-related patterns in municipal demand, but would not exceed 113 cfs. For the purpose of quantifying withdrawal impacts on fish, it is assumed Tacoma withdraws 113 cfs on a continuous basis. Tacoma's First Diversion Water Right claim allows it to unconditionally withdraw this amount of water from the river, and Tacoma Water has the ability to do so in the future. Tacoma Water may voluntarily reduce water withdrawals during drought periods to benefit instream resources including fish.

Outflows from Howard Hanson Dam would follow the USACE's present reservoir operational rule curves and guidelines (U.S. Army Corps of Engineers 1996). The USACE attempts to meet a minimum flow target of 110 cfs at Palmer (U.S. Army Corps of Engineers 1996). It does so by reserving 24,200

acre-feet of storage in Howard Hanson Reservoir for low-flow fish habitat augmentation. This volume is accumulated during the spring runoff period. Outflows from Howard Hanson Dam are gradually reduced following the spring peak runoff period until the summer low flow period to minimize impacts to spawning steelhead trout and their redds (U.S. Army Corps of Engineers 1998). During low flow periods in the summer and fall, the USACE attempts to release at least 223 cfs from Howard Hanson Dam; 113 cfs for withdrawal by Tacoma Water and 110 cfs to meet the minimum instream flow target at Palmer. The USACE may release less than 223 cfs during drought conditions, provided that reservoir inflows are less than this amount. The USACE may release more water than 223 cfs during the summer and fall if storage volumes and reservoir inflows exceed those necessary to meet the instream flow requirements through October (U.S. Army Corps of Engineers 1996).

The hydrograph for the lower and middle Green River under Water Withdrawal Alternative A would possess sizeable flow fluctuations from November though May under average year (Figure 4-1a), dry year (Figure 4-2a), and wet year conditions (Figure 4-3a). These fluctuations are the result of natural runoff patterns, since Howard Hanson Reservoir is maintained at minimum pool levels through March for flood control purposes (i.e., storage is maintained to a minimum and is used to control peak flow events).

No additional storage of municipal and industrial water would be provided in Howard Hanson Reservoir under Water Withdrawal Alternative A, since the Additional Water Supply Project would not occur. Flows in the lower and middle Green River under this alternative would be determined by outflows from Howard Hanson Dam, which are controlled by the USACE, minus the 113 cfs withdrawn at the Headworks diversion by Tacoma (Figures 4-1b, 4-2b, 4-3b).

Flows in the Green River at Auburn under Water Withdrawal Alternative A would vary between 500 and 4,000 cfs from November through May under average year conditions (Figure 4-1a), between 300 and 4,000 cfs under dry year conditions (Figure 4-2a) and between 700 and 12,000 cfs under wet year conditions (Figure 4-3a). Flows would remain relatively stable in the lower and middle Green River from July through October as a result of low-flow augmentation releases provided by the USACE from Howard Hanson Dam.

Figure 4-1a. Flows in the Green River, Washington at Auburn under Alternative A; average year conditions 1994).

PLACEHOLDER

Figure 4-2a. Flows in the Green River, Washington at Auburn under Alternative A; dry year conditions (1992).

PLACEHOLDER

Figure 4-3a. Flows in the Green River, Washington at Auburn under Alternative A; wet year conditions (1990).

PLACEHOLDER

Flows at Auburn would average about 220 cfs from July through October under average year (Figure 4-1a) and dry year (Figure 4-2a) conditions, with the lowest flow predicted to be about 180 cfs during both years. Flows at Auburn would average about 260 cfs under wet year conditions from July through October, with the lowest flow predicted to be about 230 cfs (Figure 4-3a).

THE FOLLOWING NEW TEXT REFLECTS PUBLIC COMMENTS ON THE DEIS

North Fork Green River

Under Water Withdrawal Alternative A, Tacoma would continue to withdraw water from the North Fork Wellfield during periods when turbidity in the surface water supply exceeds 5 NTUs. In general, pumping from the North Fork Wellfield would occur during the winter and spring when turbidity and runoff are highest. Based on an analysis of flow records in the 1960s, withdrawals from the North Fork Wellfield would average 85 days per year (Table 4a).

Table 4a. Summary of average daily flow in the North Fork Green River and expected well demand from the North Fork Wellfield by month.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Avg Daily Flow (cfs)[1]	147	124	92	117	121	73	26	12	24	38	96	169
Days of well use (avg)[2]	15.2	10	6.2	8.8	11	5.4	0	0	2.6	2.4	10.2	13
Days of well use (range)	4-25	0-28	0-18	0-23	0-20	0-20	0	0	0-13	0-4	7-13	7-19

[1] Mean average daily flow at USGS gauge 12105710 North Fork Green River near Lemolo, WA for the period July 1965-September 1982.

[2] Average number of days that well use would be required over a 5-year period in the 1960s, based on the number of days when turbidity exceeded 5 NTUs measured at the Headworks (Noble 1969).

Figure 4-1b. Flows in the Green River, Washington at Auburn under Alternative A; average year conditions 1994).

PLACEHOLDER

Figure 4-2b. Flows in the Green River, Washington at Auburn under Alternative A; dry year conditions (1992).

PLACEHOLDER

Figure 4-3b. Flows in the Green River, Washington at Auburn under Alternative A; wet year conditions (1990).

PLACEHOLDER

Under ongoing Section 7 consultations, it may be the responsibility of the USACE to provide upstream and downstream fish passage around Howard Hanson Dam; however, federal funding for such fish passage facilities is uncertain. Groundwater pumping from the North Fork Wellfield would not be expected to affect spawning or incubation of salmon or native char since upstream and downstream fish passage facilities would likely not be constructed. Without Tacoma Water's involvement in the Additional Water Storage Project, the opportunity for funding upstream and downstream fish passage at Howard Hanson Dam may be lost.

In the absence of a downstream fish passage facility at Howard Hanson Dam, it is uncertain whether the introduction of hatchery-origin, juvenile anadromous salmonids on an experimental basis would continue. If juvenile salmonids were planted in the upper watershed, pumping of the North Fork Wellfield would be expected to affect rearing conditions, depending on life history characteristics of the species. Groundwater pumping from the North Fork Wellfield is expected to have little effect on chinook rearing in the North Fork Green River since wellfield pumping primarily occurs during late fall and early spring high flow periods. Researchers from the USFWS observed an abundance of chinook rearing sites in the lower North Fork, but noted that chinook appeared to use the North Fork for short-term rearing and as a transportation corridor (Wunderlich and Toal 1992). Use of the North Fork Green River by juvenile chinook appeared to be completed by early July when flows naturally begin to decrease.

The observed movement of chinook fry out of the North Fork Green River channel by early July is consistent with an ocean-type early life history where chinook fry migrate to the estuary within 30 to 90 days of emergence (HCP Appendix A). Although USFWS researchers observed chinook fry moving out of the North Fork channel by early July, the proportion of chinook juveniles migrating as newly emerged fry, fingerlings, or yearlings may change if a naturally reproducing stock is reestablished in the upper watershed.

Pumping from the North Fork Wellfield during the summer and early fall, though rare, would be expected to have a negative effect on coho, steelhead, and yearling chinook salmon rearing habitat in the North Fork Green River. Pumping of the North Fork Wellfield during May and June would potentially reduce available steelhead spawning habitat and increase incubation mortality of steelhead eggs; however, little impact to steelhead spawning and incubation would be expected if pumping occurred during periods of high spring runoff.

END OF NEW TEXT

Spawning Habitat

Under Water Withdrawal Alternative A, Tacoma's water withdrawals would affect the availability of spawning habitat for anadromous and resident salmonids in both the mainstem river and side channel areas of the middle Green River. The side channels in this section of the river provide important habitat for salmon spawning, incubation, and juvenile rearing (Fuerstenberg et al. 1996; U.S. Army Corps of Engineers 1998). Reduced flows can also increase the susceptibility of salmon and steelhead redds to dewatering by exposing mainstem and side channel areas during the incubation period.

Redds constructed during periods of high flow are more susceptible to dewatering than redds constructed when Green River flows are low. Redds constructed during moderate and low-flow conditions have a higher chance of remaining wetted through the incubation period. However, spawning during periods of low flow may result in the concentration of redds near the center of the channel; these redds will remain wetted but are susceptible to destruction by channel bed movement during flood events.

The impacts of Tacoma's water withdrawals on spawning would be greatest for fall spawners, including chinook salmon, when the diversion of 113 cfs (Figure 4-2b) would reduce flows at Auburn to about 180 cfs under dry year conditions (Figure 4-2a). The impacts of Tacoma's withdrawals are reduced by low-flow augmentation releases from Howard Hanson Dam by the USACE (Figures 4-1b ,4-2b, 4-3b).

Groundwater and tributary inflows between Palmer and Auburn during low flow periods typically range from 70 to 120 cfs, resulting in annual low flows at Auburn between 180 and 230 cfs during the late summer and fall (Figures 4-1a, 4-2a, 4-3a). Tacoma's water withdrawals would reduce flows by 3 to 20 percent from the beginning of November through the end of June.

The availability of spawning habitat in the lower and middle Green River is presently limited by recruitment of gravels from upstream areas. The USACE's Howard Hanson Reservoir traps gravels originating from the Upper Green River Watershed, substantially reducing the supply of gravel to the lower watershed. Gravel accumulations in the lower and middle Green River have been declining since the construction of Howard Hanson Dam. Under Water Withdrawal Alternative A, the amount of gravel available for

spawning in the lower and middle Green River would continue to decline in the future. Tacoma's water withdrawals would have little effect on the recruitment of gravel to the lower and middle Green River.

Peak Flows

Under Water Withdrawal Alternative A, impacts of Tacoma's water withdrawals on peak flows in the lower and middle Green River would be minimal. Tacoma's 113 cfs diversion would reduce the magnitude of freshets (i.e., flows greater than 2,500 cfs) by only a few percent at most. The water withdrawals, which are relatively constant over time, would have minimal effect on the frequency and duration of freshets and peak flow events.

Summer Flows

Tacoma's water withdrawals under Water Withdrawal Alternative A would have substantial impacts on flows in the lower and middle Green River during summer and fall. The withdrawal of 113 cfs represents approximately one-half of the water in the river at Palmer (RM 60.3) (assuming a flow of 223 cfs from Howard Hanson Dam). Tacoma's impacts under this alternative would be greatly reduced by low-flow augmentation releases from Howard Hanson Dam. These releases would maintain flows of at least 110 cfs at Palmer, which is located a short distance downstream of Tacoma's Headworks diversion.

Side Channel and Tributary Habitat

Under Water Withdrawal Alternative A, Tacoma's water withdrawals would reduce the wetted area of side channels located in the middle Green River. The reductions in wetted side area would be greatest during summer and fall low flow periods, and would be least during the high flow period occurring from November through May (HCP subsection 7.1). Reduced flows resulting from these water withdrawals would impact fish by decreasing the quantity and quality of spawning, particularly for chum salmon, which have been observed by Muckleshoot Tribal biologists to spawn in side channels of the Green River in high numbers relative to main channel areas.

Flow reductions would also impact fish by subjecting redds located in the side channels to dewatering, as well as decreasing the amount of rearing available to juveniles in these areas. Side channels and other off-channel areas provide important overwintering habitat to juvenile salmonids, including coho salmon and steelhead trout (Grette and Salo 1986).

Large Woody Debris

The recruitment of LWD to the lower and middle Green River has declined from historic levels. Howard Hanson Dam has blocked recruitment of LWD from the upper watershed since its completion in 1962 (HCP subsection 4.5.3.3). The rate of LWD recruitment into the Howard Hanson Reservoir has been reduced by timber harvest operations, but the reservoir blocks the continued downstream movement of LWD. LWD provides important physical functions to many stream and rivers, including pool formation, retention of sediment, organic matter storage, and side channel development (Sedell and Swanson 1984; Beschta 1991) (subsection 3.8.2.2, Current Fish Habitat Conditions). Large woody debris benefits juvenile and adult salmonids by providing habitat cover, velocity refuges, and by retaining gravel-sized sediments suitable for spawning and invertebrate production (Sedell et al. 1982). The amount of LWD in the Green River has declined from historic levels due to reduced recruitment from the upper watershed, reduced lateral channel movement in the middle and lower river, and changes to riparian habitats due to land use developments in the middle and lower watershed (subsection 3.8.2.2, Current Fish Habitat Conditions). The decline in LWD would continue under Water Withdrawal Alternative A. However, Tacoma's water withdrawals under Water Withdrawal Alternative A would not directly affect the amount of LWD present in the Green River below Howard Hanson Dam.

Estuarine Habitat

Water quality limitations within the lower Green River include water temperature, dissolved oxygen, nutrient enrichment, and a variety of pollutants (HCP subsection 4.5.3.6). Dissolved oxygen problems are related to both elevated water temperatures and nutrients and are most severe in the lower Duwamish River within the tidal zone (up to RM 11.0). Such conditions can stress fish and render them more susceptible to the effects of other pollutants. However, the effects of Howard Hanson Dam and Tacoma's water withdrawals on water temperatures do not extend sufficiently far downstream to materially affect the lower Green River Watershed (HCP subsection 4.5.5.6).

Fish Passage Past Howard Hanson Dam and the Tacoma Headworks Diversion

Under Water Withdrawal Alternative A, the Headworks diversion structure would continue to prevent the upstream migration of fish above RM 61.0. Additionally, Howard Hanson Dam at RM 64.5 would remain a barrier to the upstream migration of anadromous species into the Upper Green River Watershed. Blockage of migration into the upper watershed prevents access to approximately 66 miles of potential salmon and steelhead habitat (HCP subsection 7.1.1.1).

Effects on Fish Species of Concern

Salmon

Under Water Withdrawal Alternative A, the Tacoma Headworks diversion structure would continue to prevent the upstream migration of adult salmon above RM 61.0. Additionally, Howard Hanson Dam at RM 64.5 has been a barrier to the upstream migration of chinook salmon into the Upper Green River Watershed since its construction in 1962.

Tacoma's water withdrawals have the potential to influence the upstream passage of chinook salmon more than other anadromous fish species present in the Green River. Adult chinook salmon are larger than most other salmonids and require greater water depths to move upstream over riffle areas. Chinook salmon also migrate upstream during the late summer and early fall, coincident with the lowest flow levels occurring in the Green River.

Based on data collected at riffle areas in the lower river during Ecology's instream flow study (Caldwell and Hirschey 1989), water depths in the lower river are sufficient for upstream passage of chinook when flows at the Auburn gauge exceed 200 cfs. Under Water Withdrawal Alternative A, flows would occasionally fall below this level during dry years resulting in delayed or blocked upstream passage of chinook salmon. Warm water temperatures and low dissolved oxygen concentrations could result in delayed upstream passage of chinook salmon in the lower Green River and Duwamish estuary, although these water quality conditions were not found to block migration (Fujioka 1970).

Flows occurring under Water Withdrawal Alternative A would not likely block the upstream migration of pink salmon and sockeye salmon, which can pass through shallower depths due to their smaller body size compared to chinook salmon (HCP subsection 7.6.1). Flows in the Green River are relatively high during the spawning period of chum and coho salmon. Consequently, the upstream passage of these species would not likely be blocked under Water Withdrawal Alternative A.

The survival of outmigrating juvenile salmon in the middle and lower Green River below the Tacoma Headworks is a function of flow, with survival assumed to increase as flows increase (Wetherall 1971). Based on the assumptions of Wetherall (1971), Tacoma's diversions under Water Withdrawal Alternative A are expected to result in decreased outmigrant survival values by reducing flows in the Green River below the Headworks diversion facility (HCP subsection 7.1.2). Fry outmigration survival values for the lower and middle Green River are an index of survival calculated as the sum of daily differences in estimated survival between each alternative and the No Action Alternative (i.e., Alternative A) (see HCP subsection 7.1.2 for details on methods used to calculate the relative index of survival).

Tacoma's water withdrawals under Water Withdrawal Alternative A would also affect the availability of salmon spawning habitat in both the mainstem river and side channel areas of the middle Green River. The side channels in this section of the river provide important habitat for salmon spawning, incubation, and juvenile rearing (Fuerstenberg et al. 1996; U.S. Army Corps of Engineers 1998).

The amount of mainstem habitat area in the lower and middle Green River was calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989) (HCP subsection 7.1.3). The amount of mainstem spawning habitat area for chinook salmon under Water Withdrawal Alternative A was 46.8 acres in the lower river and 80.5 acres in the middle river (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-2). The amount of mainstem spawning habitat area for coho salmon under Water Withdrawal Alternative A was 49.8 acres in the lower river and 68.1 acres in the middle river (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-9). Finally, the amount of mainstem spawning habitat area for coho salmon under Water Withdrawal Alternative A was 49.8 acres in the lower river and 68.1 acres in the middle river (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-16). Under Water Withdrawal Alternative A, the average side channel area in the middle Green River was 8.5 acres during the spawning period of chinook salmon (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-3); 12.2 acres during the spawning period of coho salmon (Table 4-3)

(Appendix B, Fisheries Data and Models, Table B-10); and 16 acres during the spawning period of chum salmon (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-17).

Reduced flows can also increase the susceptibility of salmon redds to dewatering by exposing mainstem and side channel areas during the incubation period. The potential impacts of Tacoma's withdrawals on salmon incubation were assessed by calculating spawnable widths and dewatered channel widths on a daily basis during the chinook spawning period (HCP subsection 7.1.3). The *spawnable width* for chinook salmon was calculated by: 1) determining the stage of the river for a given daily flow; 2) subtracting 1 foot from this stage for the minimum depth to spawn for chinook, chum, and coho salmon, and 0.5 foot for pink salmon; and 3) calculating the wetted width of the river channel for this lower stage value. The *dewatered width* was calculated by determining the spawnable width for a given day, and then subtracting the width occurring during the lowest two-day flow event in the 90 days (i.e., chinook salmon egg-to-fry emergence period) following that given day (HCP subsection 7.1.3).

Under Water Withdrawal Alternative A, average mainstem spawnable widths would be 134.5 feet for chinook salmon (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-4), 137.2 feet for coho salmon (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-11), and 140 feet for chum salmon (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18). Mainstem dewatered widths under this alternative would average 4.1 feet for chinook salmon (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-4), 5.4 feet for coho salmon (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-11), and 5.6 feet for chum salmon (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18).

The effect of Tacoma's water withdrawals on salmon incubation habitat in the side channels of the middle Green River were assessed using the side channel habitat area versus discharge curves developed by the USACE (1998). Effects of the water withdrawals on incubation habitat were quantified by comparing continuously wetted side channel habitat for the lowest two-day flow event during the incubation period of each species evaluated (HCP subsection 7.1.3). Under Water Withdrawal Alternative A, the continuously wetted side channel area averaged 6.3 acres during the chinook incubation period (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-5), 7.4 acres during the coho incubation period (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-12), and 7.4 acres during the chum incubation period (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18).

Table 4-2. Comparison of average mainstem and side channel habitat area values for chinook salmon spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

PLACEHOLDER

Table 4-3. Comparison of average mainstem and side channel habitat area values for coho salmon spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

PLACEHOLDER

Table 4-4. Comparison of average mainstem and side channel habitat area values for chum salmon spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

PLACEHOLDER

Under the Water Withdrawal Alternative A, Tacoma's withdrawals could affect salmon juvenile rearing habitat by reducing flows in the Green River below the Headworks diversion up to 113 cfs on a daily basis. The potential impacts of these withdrawals are lower for chinook, chum, and pink salmon fry, since these species have an ocean-type life history in the Green River (HCP subsection 7.1.4) and reside in fresh water for a few weeks to a few months following emergence. Coho salmon juveniles rear for at least 1 year in fresh water, and would be impacted by Tacoma's water withdrawals to a greater extent than the juveniles of the other salmon species (steelhead and cutthroat trout are addressed in the following subsection).

The effects of Tacoma's withdrawals were quantified using potential habitat area and flow functions developed by Ecology for juvenile chinook, coho, and chum salmon in the middle Green River (HCP subsection 7.1.4). Under Water Withdrawal Alternative A, the mainstem rearing area for chinook salmon averaged 28.2 acres in the lower river and 27.6 acres in the middle river (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-6). The average mainstem rearing area for coho salmon was 40.7 acres in the lower river and 33.1 acres in the middle river (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-13). Finally, the average mainstem rearing area for chum salmon was 28.2 acres in the lower river and 27.6 acres in the middle river (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-20). The side channel area available for rearing under Water Withdrawal Alternative A was 6.8 acres for chinook salmon (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-7), 11.9 acres for coho salmon (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-14), and 6.8 acres for chum salmon (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-21).

Steelhead and Cutthroat Trout

The migration of steelhead and cutthroat trout into the Upper Green River Watershed has been blocked by Tacoma's Headworks since 1911. The upstream migration of these species would continue to be blocked under Water Withdrawal Alternative A. Adult steelhead have been captured at a temporary trap-and-haul facility at the Tacoma Headworks and relocated above Howard Hanson Dam to the upper watershed since 1992. This limited trapping program may continue under Water Withdrawal Alternative A.

Under Water Withdrawal Alternative A, Tacoma's water withdrawals would impact the availability of steelhead and cutthroat trout spawning habitat in both the mainstem river and side channel areas of the middle Green River. The amount of mainstem spawning habitat area for steelhead trout under Water Withdrawal Alternative A was modeled to be 76.5 acres in the lower river and 103.9 acres in the middle river (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-23). Under Water Withdrawal Alternative A, the average side channel area in the middle Green River was modeled to be 8.5 acres during the spawning period of steelhead trout (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-24). The average side channel area available for cutthroat trout was assumed to be similar to that of steelhead under this alternative.

Reduced flows can also increase the susceptibility of steelhead and cutthroat redds to dewatering by exposing mainstem and side channel areas during the incubation period. Steelhead trout are particularly vulnerable to redd dewatering because they spawn in the spring, and incubation occurs when flows are declining from the spring high flow period. Cutthroat trout redds are assumed to be less susceptible to mainstem dewatering caused by Tacoma's water withdrawals because most cutthroat spawn in the tributaries to the Green River.

Under Water Withdrawal Alternative A, the average spawnable width of the mainstem Green River channel was modeled to be 144.4 feet for steelhead trout (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-25). Mainstem dewatered widths would average 1.8 feet for steelhead trout (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-25) under Water Withdrawal Alternative A.

Table 4-5. Comparison of average mainstem and side channel habitat area values for steelhead trout spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

PLACEHOLDER

Effects of the water withdrawals on incubation habitat for steelhead and coastal cutthroat were quantified by comparing continuously wetted side channel habitat for the lowest 2-day flow event during the incubation period for steelhead trout (HCP subsection 7.7.2). Under Water Withdrawal Alternative A, the continuously wetted side channel area averaged 4.2 acres during the steelhead and cutthroat trout incubation period (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-26).

The potential effects of Tacoma's withdrawals on steelhead and cutthroat trout rearing habitat in the mainstem of the Green River were quantified using potential habitat area and flow functions developed by Ecology for steelhead trout in the middle Green River (HCP subsection 7.7.4). The average mainstem rearing area for steelhead trout was 65.4 acres in the lower river and 67.8 acres in the middle river (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-27). The average side channel area available for rearing under Water Withdrawal Alternative A was 6.8 acres for steelhead trout (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-28). The rearing habitat values in the mainstem and side channels for coastal cutthroat trout were assumed to be the same as that for steelhead trout since these species have similar juvenile life histories and habitat requirements.

Bull Trout/Dolly Varden

The upstream migration of adult bull trout/Dolly Varden would potentially be hindered by Tacoma's water withdrawals under Water Withdrawal Alternative A. Water depths in the lower river may not be sufficient for upstream passage of large anadromous individuals when flows at the Auburn gauge are less than 200 cfs, which could occur during the late summer migration and fall under this alternative. Migration of bull trout/Dolly Varden would not likely be impeded by flows from November through June. The upstream migration of bull trout/Dolly Varden would continue to be blocked by Tacoma's Headworks diversion and Howard Hanson Dam under Water Withdrawal Alternative A.

Bull trout/Dolly Varden juveniles generally remain in their natal streams and rivers up to 3 years before migrating to large rivers (fluvial forms), lakes (adfluvial forms), or the ocean (anadromous forms). The outmigration timing of bull trout/Dolly Varden juveniles is not well known, although anadromous forms probably outmigrate to the ocean in the spring (Wydoski and Whitney 1979). If bull trout/Dolly Varden

are reproducing in the Green River, Tacoma's water withdrawals could potentially impact outmigrating juvenile bull trout/Dolly Varden in ways similar to those of steelhead juveniles, which also outmigrate in the spring after 2 to 3 years of freshwater residency.

Bull trout/Dolly Varden have a spawning periodicity similar to chinook salmon (i.e., fall spawners). Tacoma's water withdrawals under Water Withdrawal Alternative A were assumed to impact bull trout/Dolly Varden spawning in ways similar to fall chinook salmon spawning in the mainstem sections of the river. However, it is unlikely that juvenile bull trout/Dolly Varden will utilize the lower and middle Green River during the summer, since temperatures in most sections of the river may be too warm during this season to support juvenile bull trout/Dolly Varden. Adult bull trout/Dolly Varden may opportunistically move into the lower Green River during the winter and spring when water temperatures are cold and flows relatively high. Tacoma's water withdrawals under Water Withdrawal Alternative A are not expected to impact adult bull trout/Dolly Varden under these higher flow conditions.

4.2.6.2 Water Withdrawal Alternative B: Proposed Action

<u>Effects on Fish Habitat</u>

<u>Mainstem Green River</u>

Tacoma's water withdrawals from the Green River under Water Withdrawal Alternative B would be up to 213 cfs throughout the year, which includes the First and Second Diversion Water Rights. Under Water Withdrawal Alternative B, flows in the Green River would also be affected by changes in the USACE's operation of Howard Hanson Dam under the Additional Water Storage Project. The effects of Tacoma's water withdrawals and the USACE's operations would reduce flows in the Green River at Auburn by up to 400 cfs compared to those occurring under Water Withdrawal Alternative A during the months of March through mid-April under average year (Figure 4-4a), dry year (Figure 4-5a), and wet year conditions (Figure 4-6a). The combined effects of Tacoma's withdrawals and the USACE's operation of Howard Hanson Dam would increase flows in the Green River by up to 400 cfs (Figures 4-4b, 4-5b, 4-6b) for sustained periods from mid-April through mid-June under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A.

Figure 4-4a. Flows in Green River, Washington at Auburn under Alternative B; average year conditions (1994).

PLACEHOLDER

Figure 4-5a. Flows in Green River, Washington at Auburn under Alternative B; dry year conditions (1992).

PLACEHOLDER

Figure 4-6a. Flows in Green River, Washington at Auburn under Alternative B; wet year conditions (1990).

PLACEHOLDER

Figure 4-4b. Green River flow changes under Water Withdrawal Alternative B at the USGS gauge at Auburn; average year conditions (1994).

PLACEHOLDER

Figure 4-5b. Green River flow changes under Water Withdrawal Alternative B at the USGS gauge at Auburn; dry year conditions (1992).

PLACEHOLDER

Figure 4-6b. Green River flow changes under Water Withdrawal Alternative B at the USGS gauge at Auburn; wet year conditions (1990).

PLACEHOLDER

Under Water Withdrawal Alternative B, Tacoma Water would contribute funds for a number of habitat rehabilitation projects in the upper watershed to be carried out by the USACE as the mitigation and restoration component associated with original construction of Howard Hanson Dam and Phase 1 of the Additional Water Storage Project. Although the mitigation and restoration actions are associated with water storage in the Howard Hanson Reservoir by the USACE (a federal action), Tacoma Water, as local sponsor of the Additional Water Storage Project, would fund the construction, monitoring, and maintenance costs over the 50-year Project period.

The pool raise associated with the Additional Water Storage Project would replace free-flowing streams with a slack-water reservoir pool. The physical loss of stream habitat resulting from the Additional Water Storage Project pool raise would be mitigated for by a series of habitat improvements implemented within the inundation zone, reservoir perimeter, and mainstem channel and tributaries. Habitat improvements would include the placement of LWD in 11.5 miles of mainstem channel and 2.4 miles of tributary habitat in and upstream of the inundation zone. Approximately 1.1 acres of off-channel habitat (beaded ponds, side channels, and dendrites) would be created, and boulders and LWD would be used to stabilize the banks and to maintain the existing channel configuration in the new seasonally inundated reaches. Additional LWD placement and off-channel habitat excavation would occur as partial restoration for the original construction of Howard Hanson Dam, but the extent of this activity has yet to be determined by the USACE.

Monitoring, maintenance, and surveying would occur under Water Withdrawal Alternative B to identify the distribution of fish within the Action Area and to generally monitor implementation of the HCP measures (HCP Chapter 6.0, Monitoring and Research Program). Potential impacts could occur to fish or habitat as a result of surveying efforts, but the net effect to species would be positive. If surveying would include species collection and handling, Tacoma Water would obtain a Scientific Collectors Permit from the WDFW, which prohibits adverse impacts to populations or habitats (the federal ITP would also cover surveying collection and handling as a Covered Activity in the IA).

THE FOLLOWING NEW TEXT REFLECTS PUBLIC COMMENTS ON THE DEIS

North Fork Green River

Under Water Withdrawal Alternative B, upstream and downstream fish passage facilities would be constructed at Howard Hanson Dam and Tacoma's Headworks, providing the opportunity to restore naturally reproducing populations of anadromous fish to the upper watershed. These populations would be exposed to the effects of Tacoma Water's use of the North Fork Wellfield during periods of turbid surface water supplies. The greatest potential risk of Tacoma Water's use of the North Fork Wellfield on instream resources would occur during the late summer and early fall depending on operating procedures. If pumping from the wellfield was to occur without a storm-related rise in streamflow, adult and juvenile salmonids holding in the lower North Fork Green River channel in the fall could be exposed to channel dewatering. Groundwater outflow below the wellfield maintains cool water temperatures and provides potentially important adult holding and rearing habitat for salmonids. If pumping from the North Fork Wellfield during the late summer interrupted the outflow of groundwater and reduced flow into the channel, fish holding in the lower North Fork could be trapped in isolated pools or be forced to move downstream to the reservoir.

Under Water Withdrawal Alternative B, use of the North Fork Wellfield may occur more often than under Water Withdrawal Alternative A. Under Water Withdrawal Alternative B, there may be increased incidences of mainstem Green River turbidity exceeding 5 NTUs associated with storage of water behind Howard Hanson Dam beginning earlier in the spring compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative B, pumping from the North Fork Wellfield would be restricted to periods when the turbidity of Green River surface water supplies approached 5 NTUs, unless emergency conditions required use of the North Fork aquifer in lieu of surface water. During the period 1 July through 31 October, should turbidity of the mainstem Green River approach 5 NTUs, Tacoma would begin pumping from the North Fork Wellfield at a rate that maintains a maximum pumping-related stage drop of no greater than 1 inch per hour in the lower North Fork channel at an area of potential salmonid holding refugia to be determined in coordination with the NMFS and USFWS. Restricting withdrawals from the North Fork Wellfield to periods when the turbidity of the mainstem Green River approaches 5 NTUs would reduce the risk of impact to instream resources in the lower North Fork to those periods when water withdrawals

were needed to avoid violation of Primary Drinking Water Standards. Restricting the pumping of water from the North Fork Wellfield to a rate that maintains a pumping-related stage reduction of no greater than 1 inch per hour in the lower North Fork Green River channel during the period 1 July through 31 October would help ensure that fish holding in the lower North Fork channel would have the opportunity to move downstream to the reservoir and potentially avoid becoming stranded by pumping-related reductions in stage.

END OF NEW TEXT

Spawning Habitat

Flows in the Green River would be higher during the early fall spawning period of chinook salmon, and bull trout/Dolly Varden under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. During the late fall and early winter spawning period of coho and chum salmon flows would be up to 100 cfs lower under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A due to Tacoma's exercise of their Second Diversion Water Right.

Flows would be reduced by up to 400 cfs under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A during the early steelhead trout spawning period (March through April), and would increase by up to 400 cfs during the later part of the steelhead spawning period (May). The change in springtime flow levels is due to changes in storage and release procedures by the USACE at Howard Hanson Dam in response to the Additional Water Storage Project, and to changes in Tacoma's water withdrawals. The flows provided under Water Withdrawal Alternative B are intended to minimize the dewatering of steelhead redds by preventing fish from spawning high along the channel margins early during their spawning period, and by maintaining higher flows during the following incubation period (HCP subsection 7.7.3).

Under Water Withdrawal Alternative B, gravel would be introduced into one or more reaches of the Green River below Tacoma's Headworks to augment the supply of gravels in the middle Green River. This would reduce the continuing decline of gravel available to spawning anadromous and resident fish, which would occur under Water Withdrawal Alternative A.

Summer Flows

The severity and duration of extreme low flows during the summer would be reduced under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. Although Tacoma's water withdrawals would increase up to a total of 213 cfs under Water Withdrawal Alternative B, the Proposed Action Alternative includes ~~higher minimum flow requirements as~~ a guaranteed minimum flow level provided by the MIT/TPU Agreement that is not provided ~~than~~ under Water Withdrawal Alternative A. Under Water Withdrawal Alternative B, flows in the Green River at Auburn during the late summer ~~and fall~~ would be between 30 and 90 cfs higher under average year conditions (Figure 4-4a), between 20 and 40 cfs higher under dry year conditions (Figure 4-5a), and between 40 and 120 cfs higher under wet year conditions (Figure 4-6a).

Peak Flows

Under Water Withdrawal Alternative B, two short-term (36-hour) flow releases of up to 2,500 cfs (i.e., freshets) could occur at the discretion of fish management entities during April and May. These freshets are intended to improve the survival of outmigrating salmon fry. Otherwise, Water Withdrawal Alternative B would not have any substantial effects on the frequency and magnitude of peak flow events compared to those that would occur under Water Withdrawal Alternative A.

Side Channel and Tributary Habitat

Under Water Withdrawal Alternative B, a large side channel (Signani Slough at RM 59.6), which was separated from the Green River by the realignment of Burlington Northern Railroad tracks, would be reconnected to the main river channel to provide up to 3.4 acres of side-channel habitat (HCP subsection 5.2, Habitat Conservation Measure 2-07). This side channel area, which would provide valuable off-channel rearing and spawning habitat to salmon and steelhead, would remain separated from the mainstem river under Water Withdrawal Alternative A. Additional off-channel habitat (at least 1.1 acres) would be created in the Upper Green River Watershed as part of the mitigation for the Additional Water Supply Project under Water Withdrawal Alternative B. This additional habitat would not be made available under Water Withdrawal Alternative A.

Large Woody Debris/Riparian Vegetation

Under Water Withdrawal Alternative B, woody debris, including rootwads, would be placed in the free-flowing reaches of the upper mainstem Green River, upper watershed tributaries, and in the Tacoma Headworks diversion inundation pool. Woody debris (including both small and large woody debris) would also be collected in the Howard Hanson Reservoir, transported downstream around Howard Hanson Dam, and placed in the mainstem channel below the Headworks. In comparison, transport of woody debris in the lower and middle Green River would continue to be precluded by Howard Hanson Dam under Water Withdrawal Alternative A.

Estuarine Habitat

As compared to Water Withdrawal Alternative A, increased flows during the summer and fall under Water Withdrawal Alternative B may result in slight improvements to water quality conditions by increased flushing of pollutants during extreme low-flow conditions.

Passage Past Howard Hanson Dam and the Tacoma Headworks Dam

Under Water Withdrawal Alternative B, a permanent trap-and-haul facility would be constructed and used to capture upmigrating adult anadromous salmonids, including salmon, steelhead, cutthroat trout, and bull trout/Dolly Varden (if present), at Tacoma's Headworks diversion structure. These fish would be relocated into the Upper Green River Watershed to spawn. This measure would provide anadromous fish access to up to 66 miles of potential salmon and steelhead habitat in the upper watershed. This upstream passage approach was selected in lieu of laddering Tacoma's diversion dam due to the upstream proximity of Howard Hanson Dam and the difficulty of laddering that 235-foot-high structure.

In comparison, blockage of anadromous fish passage into the upper watershed by Tacoma Water's diversion dam and Howard Hanson Dam would continue under Water Withdrawal Alternative A. A temporary adult fish trap at the base of the Tacoma Headworks diversion has been used to capture adult steelhead since 1992. Some of the captured adult steelhead have been transported above Howard Hanson Dam and released to spawn naturally in the upper watershed under Water Withdrawal Alternative B. This

temporary trap would be replaced by a permanent trap facility, which could provide upstream passage to a variety of adult anadromous fish species.

Under Water Withdrawal Alternative B, a downstream passage facility would be partially funded by Tacoma (U.S. Army Corps of Engineers 1998) to provide for downstream passage of juvenile salmonids and steelhead kelts (spawned steelhead adults that survive to potentially spawn again) through Howard Hanson Dam. In addition, a downstream fish bypass facility would be installed at Tacoma's Headworks to increase the survival of outmigrating juvenile salmonids. The Tacoma Headworks downstream fish bypass facility would include a 220-foot by 24-foot conventional screen designed to meet state and federal fish protection design criteria.

In comparison, no downstream fish passage facilities would be constructed and operated at Howard Hanson Dam and the Tacoma Headworks diversion under Water Withdrawal Alternative A. If chinook salmon, coho salmon, and steelhead trout juveniles would continue to be planted in the Upper Green River Watershed in the future, their downstream passage survival rates through the Howard Hanson Project (U.S. Army Corps of Engineers 1998, Appendix F1) would continue to be low under Water Withdrawal Alternative A.

Downstream survival rates of juveniles through Howard Hanson Dam are expected to substantially increase under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. Downstream survival rates of juveniles for combined reservoir and dam passage are estimated to be 60 percent for chinook salmon, 89 percent for coho salmon, and 87 percent for steelhead trout under Water Withdrawal Alternative B. In contrast, combined downstream survival rates for juvenile fish through the reservoir and dam were estimated to be 8 percent for chinook salmon, 20 percent for coho salmon, and 9 percent for steelhead trout under Water Withdrawal Alternative A (U.S. Army Corps of Engineers 1998, Appendix F1, Section 8E).

Effects on Fish Species of Concern

Salmon

Changes in flow under Water Withdrawal Alternative B would have little effect on calculations of the survival index of outmigrating chinook salmon fry in the lower river and would slightly improve in the middle river when compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative B, the outmigrant survival index of chinook fry in the lower river would increase by 0.01 percent, and by 0.06 percent in the middle river (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-1). The survival index of outmigrating coho salmon would improve by 0.94 percent in the lower river and by 2.22 percent in the middle river under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-8). The survival index of outmigrating chum salmon would decrease by 2.65 percent in the lower river and 3.71 percent in the middle river under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-15). Calculating the survival index of outmigrating juveniles is based on changes in daily flows under each alternative and does not incorporate side channel or LWD rehabilitation.

Under Water Withdrawal Alternative B, mainstem spawning habitat area for chinook salmon would average 41.8 acres (6.1% increase from Water Withdrawal Alternative A) in the lower river, and 69.3 acres (8.5% increase from Water Withdrawal Alternative A) in the middle river (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-2). Another 24 miles of mainstem and major tributary spawning habitat would be made available to chinook salmon in the upper watershed by the trap-and-haul program under Water Withdrawal Alternative B (U. S. Army Corps of Engineers 1998). None of this habitat would be accessible under Water Withdrawal Alternative A.

Mainstem spawning habitat area for coho salmon under Water Withdrawal Alternative B would average 76.2 acres in the lower river (0.4% decrease from Water Withdrawal Alternative A), and 104.4 acres in the middle river (0.5% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-9). As much as 49 additional miles of spawning habitat would be accessible to coho salmon in the upper watershed under Water Withdrawal Alternative B, as opposed to none under Water Withdrawal Alternative A.

Mainstem spawning habitat area for chum salmon under Water Withdrawal Alternative B would average 41.8 acres in the lower river (6.1% increase from Water Withdrawal Alternative A), and 69.3 acres in the middle river (8.5% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-16).

Under Water Withdrawal Alternative B, the average area of side channels in the lower and middle Green River would be 8.4 acres during the chinook spawning period (1.2% decrease from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-3), 11.8 acres during the coho spawning period (3.3% decrease from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-10), and 15.3 acres during the chum spawning period (4.4 % decrease from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-17).

Under Water Withdrawal Alternative B, the spawnable width of the mainstem river in the lower and middle Green River would average 134.5 feet for chinook salmon (no change from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-4), 137 feet for coho salmon (0.1% decrease from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-11), and 139.5 feet for chum salmon (0.4% decrease from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18). The dewatered spawnable width of the river would average 4.1 feet for chinook salmon (no change from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-4), 5.6 feet for coho salmon (3.7% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-11), and 5.8 feet for chum salmon (3.6% increase from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18). The small changes in these values from Water Withdrawal Alternative A (113 cfs) to B (213 cfs) suggest that impacts to salmon spawning caused by Tacoma Water's increased diversions under the Proposed Action Alternative would be minimal.

Under Water Withdrawal Alternative B, the continuously wetted area of side channels in the lower and middle Green River would average 6.3 acres during the incubation period of chinook salmon (no change from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-5), and 7.1 acres during the incubation period of coho and chum salmon (4.1% decrease from Water

Withdrawal Alternative A) (Tables 4-3 and 4-4) (Appendix B, Fisheries Data and Models, Tables B-12 and B-19). Again, the reductions in side channel area during the incubation period of these species suggest that potential dewatering impacts to salmon redds resulting from Tacoma's increased diversion under Water Withdrawal Alternative B would also be minimal.

Mainstem rearing habitat would improve for all salmon species under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative B, mainstem rearing habitat area for chinook salmon would average 30.9 acres in the lower river (9.6% increase from Water Withdrawal Alternative A), and 29.5 acres in the middle river (6.9% increase from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-6). Mainstem rearing habitat area for coho salmon would average 42.6 acres in the lower river (4.7% increase from Water Withdrawal Alternative A), and 34.4 acres in the middle river (3.9% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-13). Finally, mainstem rearing habitat area for chum salmon would average 30.9 acres in the lower river (9.6% increase from Water Withdrawal Alternative A), and 29.5 acres in the middle river (6.9% increase from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-20).

Under Water Withdrawal Alternative B, there would be slight increases in the amount of mainstem summer rearing habitat for all salmonid species in the lower and middle Green River compared to Water Withdrawal Alternative A. Predicted increases in mainstem juvenile rearing habitat reflect results of Ecology's instream flow model (Caldwell and Hirshey 1989). Ecology used the Instream Flow Incremental Methodology (IFIM) to model flow and habitat functions and, while this analysis represents state-of-the-art instream flow assessments, there are uncertainties associated with modeling juvenile salmonid rearing habitat. Actual benefits of predicted increases in juvenile salmonid rearing habitat might be less than expected.

The rearing habitat for salmon in the side channels of the middle river would slightly decrease under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. Wetted side channel area during the chinook salmon rearing period would average 6.4 acres under Water Withdrawal Alternative B (5.9% decrease from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models,

Table B-7). Under Water Withdrawal Alternative B, the wetted area of side channels would average 11.5 acres during the coho salmon rearing period (3.4% decrease from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-14), and 6.4 acres during the rearing period of chum salmon (5.9% decrease from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-21). The slight decrease in the availability of salmonid rearing habitat in Green River side channels reflects changes in flow between the two Water Withdrawal Alternatives. The side channel analysis does not incorporate benefits to side channel habitat provided by stream rehabilitation projects associated with the Additional Water Storage Project.

Steelhead and Cutthroat Trout

The survival of outmigrating steelhead and cutthroat trout would improve by 0.94 percent in the lower river and by 1.31 percent in the middle river under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-22).

Mainstem spawning habitat area for steelhead trout and cutthroat trout under Water Withdrawal Alternative B would average 76.2 acres in the lower river (0.4% decrease from Water Withdrawal Alternative A), and 104.4 acres in the middle river (0.5% increase from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-23). The 66 miles of mainstem and tributary spawning habitat currently available to steelhead and cutthroat trout in the upper Green River would remain accessible, and would possibly experience greater utilization due to the trap and haul operation under Water Withdrawal Alternative B.

Under Water Withdrawal Alternative B, the average area of side channels in the lower and middle Green River would be 13 acres during the steelhead and cutthroat trout spawning period (5.1% decrease from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-24). The small changes in these values under Water Withdrawal Alternative B suggest that impacts to steelhead and cutthroat trout spawning caused by Tacoma's increased diversions (from 113 cfs to 213 cfs) under the Proposed Action Alternative would be slight.

Under Water Withdrawal Alternative B, the spawnable width of the mainstem river in the lower and middle Green River would average 144.4 feet for steelhead and cutthroat trout (no change from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-25). The dewatered spawnable width of the river would average 1.9 feet for these two species (5.6% increase from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-25). The continuously wetted area of side channels under Water Withdrawal Alternative B would average 4.5 acres during the incubation period of steelhead and cutthroat trout (7.1% increase from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-26). The small dewatered width value, combined with improved incubation conditions in the side channels, suggest that the Proposed Action Alternative would provide an overall benefit to steelhead and cutthroat trout incubation in the lower and middle Green River compared to that occurring under Water Withdrawal Alternative A.

Mainstem rearing habitat would improve for steelhead and cutthroat trout under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative B, mainstem rearing habitat area for steelhead trout would average 67.8 acres in the lower river (3.7% increase from Water Withdrawal Alternative A), and 71.5 acres in the middle river (5.5% increase from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-27). The rearing habitat for steelhead and cutthroat in the side channels of the middle river would slightly decrease under Water Withdrawal Alternative B compared to Water Withdrawal Alternative A. Wetted side channel area during the rearing period of these species would average 11.5 acres under Water Withdrawal Alternative B (3.4% decrease from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-28).

Bull Trout/Dolly Varden

As stated in subsection 3.8.1.2, Proposed and Candidate Species for Federal Listing, water temperatures may be too warm and habitat conditions too degraded to support juvenile bull trout/Dolly Varden in the lower and middle Green River. If bull trout/Dolly Varden are present, Tacoma's water withdrawals under Water Withdrawal Alternative B, like Water Withdrawal Alternative A, are expected to have minimal impact on juvenile and adult bull trout/Dolly Varden in the lower and middle sections of the Green River (assumed similar or less than effects on coho salmon).

4.2.6.3 Water Withdrawal Alternative C: New Diversion

Effects on Fish Habitat

Mainstem Green River

Under Water Withdrawal Alternative C, a new diversion would be constructed at approximately RM 29.2 for water withdrawals by Tacoma Water (although an exact location has not been identified). The new diversion dam would be approximately 12 feet high, and inundate a 1-mile section of the lower Green River upstream of the dam. Tacoma's water withdrawals under Alternative C would be the same as those under Water Withdrawal Alternative B, except for the new location of the diversion(i.e., RM 29.2 instead of RM 61.5). The new diversion would consequently modify the flow regime in a 32.3-mile section of the lower and middle Green River.

One of the primary environmental benefits of Water Withdrawal Alternative C would be the ability to allow water destined for municipal and industrial use to remain in the Green River channel until it reaches the new diversion at RM 29.2. Tacoma supplies water to a few communities that are located immediately downstream of the existing RM 61.0 Tacoma Headworks, and their water demand would most likely be met by continued use of the existing Headworks Diversion. Supplying these communities would require a withdrawal of approximately 15 cfs at the RM 61.0 Headworks Diversion, allowing a maximum of approximately 198 cfs to remain in the river channel until RM 29.2. The modeling analyses of the instream effects of Water Withdrawal Alternative C assumed that all of the water would be withdrawn at the RM 29.2 Headworks Diversion. If Water Withdrawal Alternative C were selected as the preferred alternative, instream benefits would be slightly less than calculated; however, for planning purposes this assumption represents a best-case scenario for instream benefits.

As with Water Withdrawal Alternative B, Tacoma Water would reduce flows in the lower Green River below the new diversion dam by up to 213 cfs (i.e., First Diversion Water Right claim and Second Diversion Water Right), which would occur throughout the year, except when the minimum flow requirements provided under the MIT/TPU Agreement could not be met at Auburn and Palmer control points. Instream flow requirements during the summer under the MIT/TPU Agreement are measured at

the USGS gauge at Auburn at RM 32.0. The new Headworks is at approximately RM 29.2, well below the Auburn gauge. For planning purposes, the measurement point of the MIT/TPU Agreement was assumed to be relocated to a new gauging site to be located below the RM 29.2 Headworks. When flows in the river drop below the minimum instream flow requirements, the Second Diversion Water Right diversions are reduced to comply with the flow requirement until the second supply diversion is shut down completely. At this point, Tacoma's diversions would be 113 cfs for the First Diversion Water Right claim, and would continue except under drought conditions when the diversion is reduced by Tacoma Water as provided under the MIT/TPU Agreement (Table 2-9) (subsection 2.2.4.1, Water Supply Features and Operations Under Water Withdrawal Alternative C).

Under Water Withdrawal Alternative C, flows in the Green River at Auburn upstream of RM 29.2 would increase by 113 cfs from early November through mid-February compared to Water Withdrawal Alternative A. Instead of withdrawing water at the RM 61.0 Headworks, Tacoma would allow the water to remain in the middle Green River channel until it reached a new Headworks diversion facility at RM 29.2. Between mid-February and the end of February, flows in the river upstream of RM 29.2 under Water Withdrawal Alternative C would be equivalent to those under Water Withdrawal Alternative A for average, dry, and wet year conditions. From early March through mid-April, flows at Auburn upstream of RM 29.2 under Water Withdrawal Alternative C would be reduced from approximately 100 to 300 cfs (Figures 4-7a, 4-8a, 4-9a) from those occurring under Water Withdrawal Alternative A due to the storage of this water in Howard Hanson Reservoir, as provided under the Additional Water Supply Project (U.S. Army Corps of Engineers 1998). This storage would be released from Howard Hanson Dam, conveyed downstream through the natural river channel, and withdrawn at RM 29.2 by Tacoma for municipal and industrial use during the summer.

Figure 4-7a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative C; average year conditions (1994)**.**

PLACEHOLDER

Figure 4-8a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative B; dry year conditions (1992).

PLACEHOLDER

Figure 4-9a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative C; wet year conditions (1990).

PLACEHOLDER

From mid-April through mid-June, flows in the Green River at Auburn above RM 29.2 would increase between approximately 100 and 550 cfs under Water Withdrawal Alternative C when compared to Water Withdrawal Alternative A (Figures 4-7b, 4-8b, 4-9b). Flows at Auburn above RM 29.2 under Water Withdrawal Alternative C would remain unchanged from those under Water Withdrawal Alternative A from mid-to late June (Figures 4-7 through 4-9). Under Water Withdrawal Alternative C, flows in the Green River above RM 29.2 would increase between approximately 200 and 300 cfs from early July through late October under average year (Figure 4-7b) and wet year (Figure 4-9b) conditions. Flows under Water Withdrawal Alternative C above RM 29.2 would increase between approximately 110 and 230 cfs under dry year conditions (Figure 4-8b) compared to those occurring under Water Withdrawal Alternative A from early July through late October.

Under Water Withdrawal Alternative C, flows at Auburn below RM 29.2 would remain the same as those under Water Withdrawal Alternative B (subsection 4.2.6.2, Water Withdrawal Alternative B: Proposed HCP) (Figures 4-4a, 4-5a, 4-6a). Consequently, changes in flow in the lower Green River downstream of RM 29.2 from those occurring under Water Withdrawal Alternative A would be the same as those changes resulting from Water Withdrawal Alternative B.

As with Water Withdrawal Alternative B, upstream and downstream fish passage would be provided under Water Withdrawal Alternative C, allowing for the reestablishment of anadromous salmonids, and potentially bull trout, in the upper watershed.

Figure 4-7b. Green River flow changes under Water Withdrawal Alternative C at the USGS gauge at Auburn; average year conditions (1994)

PLACEHOLDER

Figure 4-8b. Green River flow changes under Water Withdrawal Alternative C at the USGS gauge at Auburn; dry year conditions (1992)

PLACEHOLDER

Figure 4-9b. Green River flow changes under Water Withdrawal Alternative C at the USGS gauge at Auburn; wet year conditions (1990)

PLACEHOLDER

THE FOLLOWING NEW TEXT REFLECTS PUBLIC COMMENTS ON THE DEIS

North Fork Green River

Under Water Withdrawal Alternative C, upstream and downstream fish passage facilities would be constructed at Howard Hanson Dam and Tacoma's Headworks, providing the opportunity to restore naturally reproducing populations of anadromous fish to the upper watershed. These populations would be exposed to the effects of Tacoma Water's use of the North Fork Wellfield during periods of turbid surface water supplies. Under Water Withdrawal Alternative C, use of the North Fork Wellfield would occur as often as under Water Withdrawal Alternative A, but the quantity of water to be withdrawn from the North Fork Wellfield would be reduced relative to Alternative A.

Surface water withdrawn from the mainstem Green River at RM 29.2 would be filtered to meet water quality standards, and would not need to meet quality standards of less than 5 NTUs. Water supplied to customers upstream of McMillin Reservoir and withdrawn at Tacoma's Headworks at RM 61.5 would still depend on water supplies of less than 5 NTUs, and would depend on the North Fork Wellfield as a water source during periods of surface water turbidity. About 15 cfs of water would be required to satisfy water supply customers upstream of McMillin Reservoir; this would represent between 7 and 13 percent of the total volume available under the First Diversion Water Right claim and Second Diversion Water Rights. Since maximum withdrawals from the North Fork Wellfield would be reduced to about 15 cfs, the physical impact of water withdrawals on potential salmonid habitat in the North Fork channel would be reduced compared to Water Withdrawal Alternative A.

END OF NEW TEXT

Spawning Habitat

Under Water Withdrawal Alternative C, flows in the middle Green River above RM 29.2 would be substantially higher (increase between 200 to 300 cfs for average and wet years) during the fall spawning period of chinook salmon, pink salmon, and bull trout/Dolly Varden compared to conditions under Water Withdrawal Alternative A (Figures 4-7b, 4-8b, 4-9b). Flows in the middle Green River during the fall

spawning period of these species would range between 380 and 440 cfs under Water Withdrawal Alternative C. Flows in the middle Green River above RM 29.2 would be between approximately 100 and 200 cfs higher under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A during the late fall and early winter spawning period of coho and chum salmon.

Flows would be reduced by up to 300 cfs under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A during the early steelhead trout spawning period (March through April), and would increase by up to 500 cfs during the later part of the steelhead spawning period (May) (Figures 4-7b, 4-8b, 4-9b). The changes in flow under Water Withdrawal Alternative C during this period would result from the storage and release by the USACE of water under the Additional Water Supply Project, which would be operated the same as under Water Withdrawal Alternative B. Flows in the lower Green River below RM 29.2 would remain unchanged from those occurring under Water Withdrawal Alternative B. Thus, the effects of Water Withdrawal Alternative C on steelhead spawning habitat would be the same as those described for Water Withdrawal Alternative B (subsection 4.2.6.2, Water Withdrawal Alternative B: Proposed HCP).

Like Water Withdrawal Alternative B, gravel would be introduced into the Green River to augment the supply of gravels in the middle Green River under Water Withdrawal Alternative C. This would increase the amount of gravel available to spawning anadromous and resident fish. In comparison, the amount of gravel present in the middle Green River would continue to decline under Water Withdrawal Alternative A.

Summer Flows

Under Water Withdrawal Alternative C, flows during the summer in the middle Green River above RM 29.2 would substantially increase over those occurring under Water Withdrawal Alternative A. The increases in flow would be greatest in the lower and middle Green River above RM 29.2. Flows in the middle Green River above RM 29.2 would increase by approximately 200 and 300 cfs from early July through late October under average and wet year conditions (Figure 4-7b and 4-8b), and by approximately 110 and 230 cfs under dry year conditions (Figure 4-9b). Flows in the lower Green River downstream of RM 29.2 would be the same as those under Water Withdrawal Alternative B during the summer (i.e.,

flows would increase by 30 and 90 cfs under average year conditions (Figure 4-4b), between 20 and 40 cfs higher under dry year conditions (Figure 4-5b), and between 40 and 120 cfs higher under wet year (Figure 4-6b)conditions from those occurring under Alternative A).

The increases in summer flows in the lower and middle Green River above RM 29.2 under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A would be attributed to the use of the mainstem river channel to convey water released from storage in Howard Hanson Dam for withdrawal at Tacoma's new diversion site, and by higher minimum flow requirements provided by the MIT/TPU Agreement (Table 2-9). Compared to Alternative A, flows in the lower Green River below RM 29.2 under Alternative C would increase because of the higher minimum flow requirements.

Peak Flows

As under Water Withdrawal Alternative B, two short-term (36-hour) flow releases of up to 2,500 cfs could occur at the discretion of fish management entities during April and May under Water Withdrawal Alternative C (Figures 4-7b, 4-8b, 4-9b). These freshets are intended to improve the survival of outmigrating salmon fry. Otherwise, Water Withdrawal Alternative C would not have any major effects on the frequency and magnitude of peak flow events compared to those occurring under Water Withdrawal Alternative A.

Side Channel and Tributary Habitat

Under Water Withdrawal Alternative C, like Water Withdrawal Alternative B, a large side channel (Signani Slough at RM 59.6) would be reconnected to the main river channel to provide up to 3.4 acres of side-channel habitat (HCP subsection 5.2, Habitat Conservation Measure 2-07). This side channel area, which would provide valuable off-channel rearing and spawning habitat to salmon and steelhead, would remain separated from the mainstem river under Water Withdrawal Alternative A. A minimum of 1.1 acres of additional off-channel habitat would also be created in the upper Green River under Water Withdrawal Alternative C, but not under Water Withdrawal Alternative A.

Large Woody Debris/Riparian Vegetation

As under Water Withdrawal Alternative B, woody debris, including rootwads, would be placed in the free-flowing reaches of the upper mainstem Green River, upper watershed tributaries, and the Tacoma Headworks inundation pool under Water Withdrawal Alternative C. Woody debris (including both small and large woody debris) would also be collected in the Howard Hanson Reservoir, transported downstream around Howard Hanson Dam, and placed in the mainstem channel below the Tacoma Headworks.

Estuarine Habitat

Under Water Withdrawal Alternative C, the effects of flows on water quality conditions and estuarine habitat in the Duwamish River and lower Green River below RM 29.2 would be the same as those occurring under Water Withdrawal Alternative B (subsection 4.2.6.2, Water Withdrawal Alternative B: Proposed HCP). Flows in the Duwamish and lower Green Rivers below the new diversion dam would be the same as those occurring under Water Withdrawal Alternative B.

Passage Past New Diversion Dam, Tacoma Headworks Diversion, and Howard Hanson Dam

Under Water Withdrawal Alternative C, like Water Withdrawal Alternative B, a permanent trap-and-haul facility would be constructed and used to capture upmigrating adult anadromous salmonids at Tacoma's Headworks diversion structure. These fish would be relocated into the Upper Green River Watershed to spawn. This measure would provide anadromous fish access to up to 66 miles of potential salmon and steelhead habitat in the upper watershed. An upstream fish passage facility would also be constructed at the new diversion to allow anadromous fish to pass into the middle Green River, and ultimately to the trap-and-haul facility at Tacoma's Headworks.

Under Water Withdrawal Alternative C, a downstream passage facility would be partially funded by Tacoma Water (U.S. Army Corps of Engineers 1998) to provide for downstream passage of juvenile salmonids and steelhead kelts (spawned steelhead adults that survive to potentially spawn again) through

Howard Hanson Dam. In addition, a downstream fish bypass facility would be installed at the new diversion dam to protect outmigrating salmonids.

<u>Effects on Fish Species of Concern</u>

Salmon

The survival of outmigrating chinook salmon fry would not change in the lower river below RM 29.2 and would moderately improve above RM 29.2 under Water Withdrawal Alternative C when compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative C, the index of outmigrant survival of chinook fry in the lower river would increase by 0.01 percent, and by 4.50 percent in the middle river (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-1) due to increased flows and the assumption that increased flows increase outmigrant survival.

Improvement in coho salmon outmigrant survival would be similar to that of chinook salmon under Water Withdrawal Alternative C when compared to Water Withdrawal Alternative A. The survival index of outmigrating coho salmon would improve by 0.94 percent in the lower river, and by 6.62 percent in the middle river under Water Withdrawal Alternative C (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-8). However, the survival index of outmigrating chum salmon would decrease by 2.65 percent in the lower river, but would increase by only 0.12 percent in the middle river under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-15).

Under Water Withdrawal Alternative C, spawning habitat area in the mainstem river for chinook salmon would average 52.2 acres in the lower river (11.5% increase from Water Withdrawal Alternative A) and 104.7 acres in the middle river (30.1% increase from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-2). The potential spawning habitat area for spawning coho and chum salmon in the middle Green River would decrease in area because the higher flows resulting under Water Withdrawal Alternative C would produce velocities that are higher than optimal for this species (based upon Ecology's IFIM model, Caldwell and Hirshey 1989). An estimated 24 miles of

mainstem and major tributary spawning habitat in the upper watershed would be made accessible to chinook salmon under Water Withdrawal Alternative C, while none of this habitat would be accessible under Water Withdrawal Alternative A.

Mainstem spawning habitat area for coho salmon under Water Withdrawal Alternative C would average 52.2 acres in the lower river (5.7% increase from Water Withdrawal Alternative A) and 64.9 acres in the middle river (4.7% decrease from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-9). As much as 49 additional miles of mainstem and tributary spawning habitat in the upper watershed would become accessible to coho salmon under Water Withdrawal Alternative C. None of this would be accessible under Water Withdrawal Alternative A.

Mainstem spawning habitat area for chum salmon under Water Withdrawal Alternative C would average 41.8 acres in the lower river (6.1% increase from Water Withdrawal Alternative A), and 59.0 acres in the middle river (7.7% decrease from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-16).

The area of side channel habitat in the lower and middle Green River available for spawning would slightly to moderately increase under Water Withdrawal Alternative C compared to that provided under Water Withdrawal Alternative A, depending upon the salmon species. Under Water Withdrawal Alternative C, the average area of side channels would be 10.3 acres during the chinook spawning period (21.2% increase from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-3), 13.6 acres during the coho spawning period (11.5% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-10), and 16.8 acres during the chum spawning period (5% increase from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-17).

The spawnable width of the mainstem channel (i.e., water depth greater than 1.0 feet) in the lower and middle Green River would increase slightly under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative C, the spawnable width of the mainstem river would average 136.1 feet for chinook salmon (1.2% change from Water Withdrawal Alternative A)

(Table 4-2) (Appendix B, Fisheries Data and Models, Table B-4), 138.4 feet for coho salmon (0.9% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-11), and 140.7 feet for chum salmon (0.5% increase from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18). Changes in dewatered spawnable width would be slight or would not change under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A, depending upon the species. The dewatered spawnable width of the river under Water Withdrawal Alternative C would average 3.9 feet for chinook salmon (4.9 percent decrease from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-4), 5.4 feet for coho salmon (no change from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-11), and 5.6 feet for chum salmon (no change from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-18).

The area of side channel habitat available for incubation in the lower and middle Green River would increase moderately for all salmon species under Water Withdrawal Alternative C when compared to Water Withdrawal Alternative A, a result of increased baseflows in the middle Green River that would occur during incubation of these species under Water Withdrawal Alternative C. The continuously wetted area of side channels under Water Withdrawal Alternative C would average 7.6 acres during the incubation period of chinook salmon (20.6% increase from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-5), and 8.4 acres during the incubation period of coho and chum salmon (13.5 increase from Water Withdrawal Alternative A) (Tables 4-3 and 4-4) (Appendix B, Fisheries Data and Models, Tables B-12 and B-19).

Mainstem rearing habitat for juvenile salmon in the lower Green River below RM 29.2 would not change under Water Withdrawal Alternative C when compared to Water Withdrawal Alternative A. However, rearing habitat in the middle Green River would decrease because the higher flows occurring under Water Withdrawal Alternative C. Baseflows during the summer would range between 440 and 540 throughout most of the summer under average year conditions (Figure 4-7). This range of flows exceeds those determined to be optimal for rearing salmon according to Ecology's Instream Flow Incremental Methodology (IFIM) study in the Green River (Caldwell and Hirschey 1989).

Under Water Withdrawal Alternative C, mainstem rearing habitat area for chinook salmon would average 30.9 acres in the lower river (9.6% increase from Water Withdrawal Alternative A), and 27.2 acres in the middle river (1.4% decrease from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-6). Mainstem rearing habitat area for coho salmon under Water Withdrawal Alternative C would average 42.6 acres in the lower river (4.7% increase from Water Withdrawal Alternative A), and 30.6 acres in the middle river (7.6% decrease from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-13). Finally, mainstem rearing habitat area for chum salmon would average 30.9 acres in the lower river (9.6% increase from Water Withdrawal Alternative A), and 27.2 acres in the middle river (1.4% decrease from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-20).

The rearing habitat for salmon in the side channels of the middle river would moderately increase under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A. Wetted side channel area during the chinook salmon rearing period would average 7.8 acres under Water Withdrawal Alternative C (14.7% increase from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-7). Under Water Withdrawal Alternative C, the wetted area of side channels would average 13 acres during the coho salmon rearing period (9.2% increase from Water Withdrawal Alternative A) (Table 4-3) (Appendix B, Fisheries Data and Models, Table B-14), and 7.8 acres during the rearing period of chum salmon (14.7% increase from Water Withdrawal Alternative A) (Table 4-4) (Appendix B, Fisheries Data and Models, Table B-21).

Steelhead and Cutthroat Trout

The calculated survival index of outmigrating steelhead and cutthroat trout would slightly improve by 0.94 percent in the lower river, and moderately improve by 5.71 percent in the middle river under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-22).

Mainstem spawning habitat area for steelhead trout and cutthroat trout under Water Withdrawal Alternative C would average 76.2 acres in the lower river (0.4% decrease from Water Withdrawal Alternative A), and

100.2 acres in the middle river (3.6% decrease from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-23). The decrease in potential spawning area under Water Withdrawal Alternative C results from higher flows that would occur during the peak spawning month of May, compared to those that would occur under Water Withdrawal Alternative A. These higher flows produce velocities which exceed the optimal for steelhead spawning, according to Ecology's IFIM model of the middle Green River (Caldwell and Hirschey 1989). The 66 miles of mainstem and tributary spawning habitat currently available to steelhead and cutthroat trout in the upper Green River would remain accessible, and would possibly experience greater utilization than under Water Withdrawal Alternative A because of the trap-and-haul program that would be developed under Water Withdrawal Alternative C.

The higher flows that would occur under Water Withdrawal Alternative C would result in a slight increase in the amount of spawning habitat available to steelhead and cutthroat trout in the side channels of the middle Green River compared to that occurring under Water Withdrawal Alternative A. Under Water Withdrawal Alternative C, the average area of side channels would be 14.1 acres during the steelhead and cutthroat trout spawning period (2.9% increase from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-24).

Water Withdrawal Alternative C would slightly decrease the vulnerability of steelhead and cutthroat trout redds to dewatering in the lower and middle Green River mainstem compared to Water Withdrawal Alternative A. Under Water Withdrawal Alternative C, the spawnable width of the mainstem river would average 145.1 feet for steelhead and cutthroat trout (0.5% change from Water Withdrawal Alternative A) (Table 4-2) (Appendix B, Fisheries Data and Models, Table B-25). The dewatered spawnable width of the river would average 1.4 feet for these two species (22.2% decrease from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-25). The change in dewatered spawnable width is small considering that the dewatered width would decrease by 0.4 feet on average from Water Withdrawal Alternative A to Water Withdrawal Alternative C.

The amount of continuously wetted side channel area available in the lower and middle Green River during the incubation period of steelhead and cutthroat trout between RM 61.0 and RM 29.2 would increase substantially under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A.

Continuously wetted side channel area under Water Withdrawal Alternative C would average 6.6 acres during the incubation period of these spring spawning species (57.1% increase from Water Withdrawal Alternative A) (Table 4-2)(Appendix B, Fisheries Data and Models, Table B-26).

Under Water Withdrawal Alternative C, mainstem rearing habitat in the lower and middle Green River would not change for steelhead and cutthroat trout under Water Withdrawal Alternative C in the lower Green River below RM 29.2, but would decline slightly in the middle Green River compared to Water Withdrawal Alternative A. The decline in juvenile rearing habitat in the middle Green River would result from flows that are higher than optimal for rearing fish during the summer and fall, according to the results of Ecology's IFIM model for this section of the river (Caldwell and Hirschey 1989).

Under Water Withdrawal Alternative C, mainstem rearing habitat area for steelhead trout would average 67.8 acres in the lower river (3.7% increase from Water Withdrawal Alternative A), and 67.3 acres in the middle river (0.7% decrease from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-27). The rearing habitat for steelhead and cutthroat in the side channels of the middle river would increase under Water Withdrawal Alternative C compared to Water Withdrawal Alternative A. Wetted side channel area during the rearing period of these species would average 13 acres under Water Withdrawal Alternative C (9.2% increase from Water Withdrawal Alternative A) (Table 4-5) (Appendix B, Fisheries Data and Models, Table B-28).

Bull Trout/Dolly Varden

Water temperatures may be too warm, and habitat conditions too degraded, to support juvenile bull trout/Dolly Varden in the lower and middle Green River. If bull trout/Dolly Varden are present, Tacoma's water withdrawals under Water Withdrawal Alternative C, like Water Withdrawal Alternative A, are expected to have minimal impact on juvenile and adult bull trout/Dolly Varden. In the lower and middle sections of the Green River the effects of Water Withdrawal Alternative C on juvenile bull trout/Dolly Varden are expected to be similar or less than the effects on juvenile coho salmon (Table 4-3). If bull trout/Dolly Varden are present, providing access to up to 106 miles of habitat in the upper watershed will benefit both juvenile and adult bull trout/Dolly Varden by providing increased spawning and rearing opportunities.

4.2.7 Wildlife

The following analysis addresses the effects of water withdrawal alternatives on wildlife in the lower and middle Green River Watersheds, as well as effects on aquatic and riparian wildlife in the upper watershed. Upland species in the upper watershed are excluded from this discussion because all effects of water withdrawal on wildlife would take place at or downstream of the Tacoma Headworks (at RM 61.0) and would not involve species or habitats restricted to the upper watershed. A number of aquatic and riparian mitigation measures would occur in the upper watershed under some of the water withdrawal alternatives, which may impact aquatic and riparian wildlife in the upper watershed.

Of the 21 species that would be covered by the HCP, eight are upland species restricted to the upper watershed and would be unaffected by the water withdrawal alternatives (i.e., peregrine falcon, marbled murrelet, northern spotted owl, grizzly bear, gray wolf, Canada lynx, California wolverine, and Pacific fisher). The remaining 13 species include: a) two aquatic species that could occur in the middle or lower reaches of the Green River (Oregon spotted frog and Northwestern pond turtle), b) six upland species that could be affected by the construction of facilities adjacent to the river (bald eagle, Larch Mountain salamander, northern goshawk, olive-sided flycatcher, Vaux's swift, and pileated woodpecker), and c) five aquatic species of the upper watershed (tailed frog, Cascades frog, Cascade torrent salamander, Van Dyke's salamander, and common loon). All 13 will be discussed in this section.

4.2.7.1 Water Withdrawal Alternative A: No Action

<u>Effects on Wildlife Habitats</u>

Continued withdrawal of the first diversion water right from the existing Tacoma Headworks and operation of the North Fork Wellfield would result in no change from the current condition of wildlife habitats in the Action Area. No major clearing or construction activities would occur in the Action Area that would alter wildlife habitats, and there would be no substantial changes in river flows or water storage that would inundate or drain riparian or wetland habitats. Other land use activities (e.g., forestry, agriculture, and residential development) would continue in the uplands adjacent to the lower and middle reaches of the

Green River, but the operation of the water withdrawal project under Alternative A would not influence these activities in any way that would alter the effect they have on wildlife or wildlife habitat.

Effects on Wildlife Populations

The existing operation of the Green River Project, which would continue under Water Withdrawal Alternative A without mitigation measures proposed in Tacoma's HCP, would have a negligible effect on the populations of wildlife in the area. Human presence at the Tacoma Headworks and along access roads could cause minor disturbance to wildlife, but such disturbance would be undetectable against the background of agricultural, residential, commercial, and industrial activity in the surrounding area. Animals that breed and or feed in the vicinity have long since habituated to the presence of humans, or have been displaced to more remote areas. Continued displacement as a result of water withdrawal activity is extremely unlikely.

Effects on Wildlife Species of Special Interest

Federally Listed Species

Bald Eagle *(Haliaeetus leucocephalus)*

Bald eagles would continue to nest and forage along the middle and lower reaches of the Green River under Water Withdrawal Alternative A, and they would be unaffected by the continued presence of the Green River Project. Water withdrawal during the summer months (the time of year when the effects of withdrawal are most noticeable on the river) would not exceed the historic withdrawal regime under which existing bald eagle nests and foraging areas were established. Foraging habitat would, therefore, not be negatively impacted. On the contrary, measures to avoid the take of listed fish species in the Green River could lead to increased numbers of adult salmon in the river, thereby increasing the availability of prey for the bald eagle. Human disturbance associated with the project would also be negligible, because all existing nests and foraging areas are located away from Green River Project facilities. Existing bald eagle nests would likely persist unless displaced by the activities of other parties on lands adjacent to the Action Area.

Federally Unlisted Species

Cascade Torrent Salamander *(Rhyacotriton cascadae)*
Water Withdrawal Alternative A would have no effect on this species. The Cascade torrent salamander is only likely to occur in small, cold headwater streams of the upper watershed, outside the geographic area that would be influenced by this alternative.

Van Dyke's Salamander (*Plethodon vandykei)*
This species, like the Cascade torrent salamander, occurs only in cold headwater streams in the upper watershed. Water Withdrawal Alternative A would have no effect on this species because the effects of withdrawal would be confined to the middle and lower reaches of the Green River.

Larch Mountain Salamander (*Plethodon larselli*)
Continued operation of the Green River Project under Water Withdrawal Alternative A would have no effect on the habitat or individuals of this species. This species is found in talus slopes and rocky soils, often those found in association with dense forest cover. If it occurs in the lower or middle reaches of the Action Area, it is on the rock slopes of the Green River Gorge well above the active river channel. It would be unaffected by continued withdrawal of water upstream of the Gorge.

Tailed Frog *(Ascaphus truei)*
This species is known to occur in the Upper Green River Watershed, and could occur in the middle watershed as well. It would not be affected by Water Withdrawal Alternative A, however, because it is restricted to cold, headwater streams beyond the area influenced by flows in the mainstem Green River.

Cascades Frog *(Rana cascadae)*
The Cascades frog is found in lakes, ponds, wetlands, and bogs above 2,000 feet in elevation in the Cascade Mountains. It does not occur in the lower and middle reaches of the Green River, primarily because these areas are at elevations well below 2,000 feet. Consequently, this species would not be affected by activities conducted under Water Withdrawal Alternative A.

Oregon Spotted Frog *(Rana pretiosa)*

The Oregon spotted frog would not be affected by Water Withdrawal Alternative A. While this species was once common in western Washington, wetland destruction and the introduction of the bull frog (a predator of the spotted frog) are generally considered to be the principal causes of its decline. The species likely does not occur in the Action Area. If present, however, it would be found in small numbers in calm side channels and isolated pools along the middle reach of the Green River. Continued withdrawal of water from the river would increase the likelihood that these areas stay calm and isolated, and thereby suitable for spotted frogs.

Northwestern Pond Turtle *(Clemmys marmorata)*

The Northwestern pond turtle, like the spotted frog, is extremely rare in the Action Area, and it would not be affected by Water Withdrawal Alternative A. The species prefers calm waters (primarily lakes and ponds) and could occur in small numbers in side channels and isolated pools along the middle reach of the Green River. Continued withdrawal of water from the river would serve to maintain these channels in conditions favorable to pond turtles.

Common Loon *(Gavia immer)*

The only known occurrence of common loons in the Action Area is a nesting pair on Howard Hanson Reservoir. Water Withdrawal Alternative A would have no effect on the management of the reservoir, and would therefore have no effect on loons.

Northern Goshawk *(Accipiter gentilis)*

The northern goshawk is a species found in remote forested areas that is susceptible to nest destruction and habitat fragmentation during logging and land clearing. Water Withdrawal Alternative A would have no effect on the northern goshawk, because it would not involve logging, land clearing, or increased levels of human activity in areas of potential goshawk use. Northern goshawks could inhabit forested areas along the Green River Gorge, but the water supply project would have no effect on this portion of the watershed other than continued modification of flows in the river. The northern goshawk is strictly an upland species, and would be unaffected by changes in river flow.

Vaux's Swift *(Chaetura vauxi)*

The Vaux's swift occurs in low numbers throughout western Washington, where it is highly dependent on the presence of large, hollow, live or dead trees ("chimney snags"). It is known to use house chimneys for nesting and roosting in the Portland, Oregon, metropolitan area, suggesting that human presence does not affect the species, but the loss of natural chimney snags does (Griffee 1961). Water Withdrawal Alternative A would result in no logging or land clearing that would require the removal of large trees or snags, and would, therefore, have no impact on the Vaux's swift. This species could be present in the middle Green River Watershed, but water withdrawal, and its effects on river flows in this reach, would not affect Vaux's swifts.

Pileated Woodpecker *(Dryocopus pileatus)*

This species is relatively common in western Washington, but its dependence on large tracts of mature forest and large dead trees (snags) makes it vulnerable to land development and commercial forestry. It is somewhat elusive, but its frequent presence in forests of rural and suburban residential areas suggests that suitable habitat, not human presence, is the limiting factor on its distribution (Smith et al. 1997). Water Withdrawal Alternative A would have no effect on the pileated woodpecker because no logging or land clearing would occur that could impact pileated woodpecker habitat. The species is likely present in the lower and middle Green River Watersheds, but continued modification of flows in the river through these reaches would have no effect on this strictly upland species.

Olive-sided Flycatcher *(Contopus borealis)*

Water Withdrawal Alternative A would have no effect on the olive-sided flycatcher. This is a small songbird associated with habitat along the edges of mature forest. It is believed the species nests within dense forest cover, and hunts for insects in adjacent open areas. It is negatively impacted by activities that reduce this forest edge, either by eliminating mature forest or by managing broad areas of the landscape in continuous forest with no openings. Continued operation of the Green River Project under Water Withdrawal Alternative A would result in no modification of upland habitats, and would, therefore, have no effect on the olive-sided flycatcher.

4.2.7.2 Water Withdrawal Alternative B: Proposed Action

Effects on Wildlife Habitats

Implementation of the Proposed Action under Water Withdrawal Alternative B would have minor effects on wildlife habitats. The first is associated with the withdrawal of the Second Diversion Water Right. The withdrawal of additional water under the Second Supply Water Right could affect habitat conditions for aquatic and streamside amphibians in general in the lower and middle Green River Watersheds, but these effects would be minimized or mitigated altogether by instream flow requirements in the HCP. Measures to manage flows for fish in the lower and middle reaches of the Green River (Habitat Conservation Measures 1-01, 1-02 and 2-02; subsection 2.2.3.2, Fish and Wildlife Mitigation Measures under Alternative B) would benefit amphibians by guaranteeing adequate flows during summer months when warm weather and low precipitation could otherwise make streamside riparian habitats unsuitable. Guaranteed flows would reduce water temperatures, increase or maintain dissolved oxygen, and dilute pollutants in the river compared to current conditions.

The second effect of Water Withdrawal Alternative B on wildlife habitats would occur through the removal or modification of habitat during the construction of new project facilities. Enlargement of the intake and construction of a fish trap at the Tacoma Headworks diversion would occur mostly in areas already disturbed by previous project development, with little new loss of wildlife habitat. Raising of the Headworks and enlargement of the inundation pool, however, would flood approximately 7 acres of riparian habitat and reduce water velocity for an additional 1,800 feet upstream from the Headworks (the current pool extends 770 feet above the Headworks). The area that would be inundated averages 85 feet wide on each side of the river. This reach is relatively steep and is dominated by upland forest habitat. While it probably provides limited habitat for riparian species associated with streamside pools and wetlands, such as amphibians and reptiles, it is likely used for cover by a number of birds and mammals that forage in the river. If similar forest cover were allowed to remain or develop at the edge of the enlarged inundation pool under Water Withdrawal Alternative B, the riparian function served by the existing river bank would simply be transferred to the new river bank, for no net loss of riparian habitat.

Habitat conditions for calm water species would be improved by the reduction in water velocity within the inundation pool, although this would not be a substantial change. The placement of boulders and tree root wads in the new inundation pool as habitat for fish (HCP subsection 5.1, Habitat Conservation Measure 1-05) could also improve habitat for amphibians and reptiles, and provide foraging substrate for predatory birds and mammals such as the dipper (*Cinclus mexicanus*) and river otter (*Lutra canadensis*).

The third effect of Water Withdrawal Alternative B on wildlife habitat would occur as a result of the fish habitat mitigation measures proposed for the middle and upper Green River Watersheds. The measure to re-connect a 3.4-acre wetland (Signani Slough at RM 59.6) to the mainstem of the Green River (HCP subsection 5.1, Habitat Conservation Measure 2-07) would alter the water regime in this wetland and make the wetland accessible to salmon and other fish. Amphibians and reptiles that favor calm pools and isolated wetlands could experience decreases in habitat and increases in egg predation by salmon. Conversely, wildlife species that prey upon young salmon could find increased habitat in the slough. Amphibians, reptiles, and ground-dwelling small mammals could be impacted directly during the process of connecting the slough to the Green River, and aquatic species could experience short-term increases in sediment during the same period. These impacts would be minimized by timing restrictions and erosion-control measures developed during the acquisition of necessary permits. Overall, positive and negative effects of Habitat Conservation Measure 2-07 on wildlife would be small because of the small size of the slough (3.4 acres).

Similar measures to improve fish habitat elsewhere in the Green River Watershed could have greater effects on wildlife habitat, however, because of the larger number of acres potentially involved. Habitat Conservation Measures 2-03 and 2-10 (HCP subsection 5.1) would involve the placement of boulders and LWD, the excavation of side channels, the removal of blockages to fish passage, and the re-vegetation of seasonally flooded areas throughout the watershed to improve fish habitat conditions. These measures would benefit aquatic and riparian wildlife by improving habitat conditions and by increasing the numbers of fish eggs, fry, and adults that are potential prey of wildlife. Site disturbance and increased sedimentation would occur during the performance of these mitigation measures, but both types of impacts would be minimized by timing restrictions and erosion control measures developed in conjunction with necessary state and federal permits, such as Section 404 permits under the federal Clean Water Act and Hydraulic Project Approvals from the state of Washington.

Habitat Conservation Measure 2-04 (HCP subsection 5.1) would require Tacoma Water to leave 229 acres of existing hardwood, mixed, and conifer forest adjacent to Howard Hanson Reservoir when the USACE raises the reservoir under the Additional Water Storage Project (U.S. Army Corps of Engineers 1998). Trees in this area would be killed by inundation, and would provide a source of snags (and eventually floating logs) for wildlife.

Effects on Wildlife Populations

Wildlife populations in and near Tacoma Water's Action Area would benefit from a net increase in habitat and an increase in prey (i.e., fish) under Water Withdrawal Alternative B. Alternately, some wildlife species, particularly amphibians, would be negatively affected by the presence of greater numbers of predatory fish (i.e., adult salmon). Measures to open side channel habitat in the middle Green River Watershed (HCP subsection 5.1, Habitat Conservation Measure 2-07), to facilitate anadromy in the Upper Green River Watershed (HCP subsection, 5.1, Habitat Conservation Measures 1-03, 1-04, 2-01, and 2-05), and to improve fish habitat conditions throughout the watershed (HCP subsection 5.1, Habitat Conservation Measures 1-05, 2-03, 2-08, 2-09, and 2-10) would have mixed effects on wildlife by increasing the numbers of both predators and prey. Overall, the effects of these measures on native wildlife would be positive, as they would represent at least partial re-creation of pre-development conditions in this managed watershed. No wildlife species would be negatively affected to the extent that its population in the Green River Watershed would be substantially reduced or threatened with local extirpation. Human activity in the Action Area would not change from current levels under Water Withdrawal Alternative B, so there would be no disturbance-related impacts to local wildlife communities.

Effects on Wildlife Species of Special Interest

Federally Listed Species

Bald Eagle *(Haliaeetus leucocephalus)*

Bald eagles would continue to nest and forage in the lower, middle and upper Green River Watersheds under Water Withdrawal Alternative B, and they could benefit from fisheries enhancement measures

proposed in Tacoma Water's HCP. Water withdrawals under the Second Supply Water Right would have no negative impact on bald eagles, but the guarantee of late summer flows (Habitat Conservation Measures 1-01 and 1-02) and overall improvements in habitat conditions for salmon throughout the watershed could increase the food supply for both nesting and wintering bald eagles. No nesting or wintering habitat would be lost as a result of clearing at the Tacoma Headworks diversion or expansion of the inundation pool, and human disturbance associated with the project would not change from current conditions. Use of the upper watershed could increase if the year-round fish population in Howard Hanson Reservoir increases. Bald eagles would experience better habitat conditions under Water Withdrawal Alternative B than under Water Withdrawal Alternative A.

Federally Unlisted Species

Cascade Torrent Salamander *(Rhyacotriton cascadae)*

Changes in mainstem Green River flows under Water Withdrawal Alternative B would have no effect on this species because the Cascade torrent salamander is limited to cold headwater streams of the upper watershed. Fish habitat enhancement measures, particularly those involving instream habitat improvements and riparian protection (Habitat Conservation Measures 1-05, 2-03, and 2-10) could improve habitat conditions for this species if the improvements occur in the headwater streams it inhabits.

The increased presence of adult fish in headwater streams, as a result of blockage removal under Habitat Conservation Measure 2-03, could increase predation on salamander eggs and make these stream segments unsuitable for the species. The loss of these habitats would have a minor impact on the Cascade torrent salamander, however, because several miles of non-fish-inhabited streams would remain available to the species throughout the upper watershed.

The status of the Cascade torrent salamander in the Green River Watershed would not change as a result of Water Withdrawal Alternative B. Overall, the effects of Water Withdrawal Alternative B on the Cascade torrent salamander would be comparable to those under Water Withdrawal Alternative A.

Van Dyke's Salamander *(Plethodon vandykei)*

This species, like the Cascade torrent salamander, occurs only in cold headwater streams in the upper

watershed. Changes in mainstem Green River flows under Water Withdrawal Alternative B would have no effect on this species. Fish habitat enhancement measures, particularly those involving instream habitat improvements and riparian protection (Habitat Conservation Measures 1-05, 2-03, and 2-10) could also improve habitat conditions for this species if the activities occur in the headwater streams it inhabits. Conversely, the increased presence of adult fish in headwater streams could increase predation on salamander eggs and make these stream segments unsuitable for the species. The loss of these habitats would have a minor impact on the Van Dyke's salamander, however, because several miles of non-fish-inhabited streams would remain available to the species throughout the upper watershed.

The status of the Van Dyke's salamander in the Green River Watershed would not change as a result of Water Withdrawal Alternative B. The overall effects of Water Withdrawal Alternative B on the Van Dyke's salamander would be comparable to those under Water Withdrawal Alternative A.

Larch Mountain Salamander *(Plethodon larselli)*

Operation of the Green River Project and implementation of fish habitat mitigation measures under Water Withdrawal Alternative B would have no effect on the habitat or individuals of this species. This is a species found in talus slopes and rocky soils, often those found in association with dense forest cover. If it occurs in the Action Area, it is on rock slopes well above the channel of the Green River or its tributaries. It would be unaffected by continued withdrawal of water, or by habitat improvement within the river or tributary streams. This is comparable to potential effects under Water Withdrawal Alternative A.

Tailed Frog *(Ascaphus truei)*

This species is known to occur in the Upper Green River Watershed, and could occur in the middle watershed as well. Like the Cascade torrent and Van Dyke's salamanders, it occurs only in cold headwater streams. Changes in mainstem Green River flows under Water Withdrawal Alternative B would have no effect on this species. Fish habitat enhancement measures, particularly those involving instream habitat improvements and riparian protection (Habitat Conservation Measures 1-05, 2-03 and 2-10) could also improve habitat conditions for this species if the improvements occur in the headwater streams it inhabits. Conversely, the increased presence of adult fish in headwater streams could increase predation on tailed frog eggs and make these stream segments unsuitable for the species. The loss of these habitats would have a minor impact on the tailed frog, however, because several miles of non-fish-inhabited streams

would remain available to the species throughout the upper watershed.

The status of the tailed frog in the Green River Watershed would not change as a result of Water Withdrawal Alternative B. The potential effects of this alternative would be similar to those under Water Withdrawal Alternative A.

Cascades Frog *(Rana cascadae)*

The Cascades frog would not be affected by Water Withdrawal Alternative B. This frog is found in lakes, ponds, wetlands, and bogs above 2,000 feet in elevation in the Cascade Mountains, well above the areas that would be influenced by water withdrawal and fish mitigation activities under this alternative. This is similar to the lack of potential effects under Water Withdrawal Alternative A.

Oregon Spotted Frog *(Rana pretiosa*)

The Oregon spotted frog could be impacted by Water Withdrawal Alternative B, although the impact would be minor. Wetland destruction and predation are considered the primary causes for the decline of this species in western Washington. While this species likely does not occur in the Action Area, the modification of wetland habitat to benefit fish could decrease the potential for this species to occupy the Action Area in the future. Specifically, the 3.4-acre wetland at Signani Slough would be modified under Habitat Conservation Measure 2-07, and made accessible to adult salmon. This could result in deteriorated habitat conditions and increased predation that would make spotted frog use of this area in the future less likely. Increased late summer flows in the mainstem of the Green River under Habitat Conservation Measures 1-01 and 1-02 could also alter conditions in side channel wetlands along the middle reach of the Green River, but the effect of these changes on potential spotted frog habitat cannot be predicted.

Overall, the effects of Water Withdrawal Alternative B on the Oregon spotted frog would be minor because of the unlikely presence of the species in the Action Area. Negative impacts under this alternative would be slightly greater than those that would occur under Water Withdrawal Alternative A because of the potential for adverse modification of habitat under the Proposed Action.

Northwestern Pond Turtle *(Clemmys marmorata)*

The Northwestern pond turtle, like the spotted frog, is extremely rare in the Action Area. It could benefit under Water Withdrawal Alternative B, however, if measures to guarantee late summer flows (Habitat Conservation Measures 1-01 and 1-02) and the measure to increase LWD (Habitat Conservation Measure 2-08) in the middle and lower reaches of the Green River also increase the amount of basking and foraging habitat for the species. No negative impacts on pond turtles would occur under Water Withdrawal Alternative B. Overall, this alternative would benefit the Northwestern pond turtle more than Water Withdrawal Alternative A, although the difference would be minor due to the limited distribution of the species in the area.

Common Loon *(Gavia immer)*

The only known occurrence of common loons in the Action Area is a nesting pair on Howard Hanson Reservoir. These loons would benefit under Water Withdrawal Alternative B because of Habitat Conservation Measure 2-04, which would increase the amount of floating wood (i.e., potential nesting substrate), and Habitat Conservation Measures 1-03, 1-04, 2-01, 2-03, 2-05, and 2-10, which would increase the abundance of young fish (i.e., prey) in the reservoir. This alternative would result in no change in water-level fluctuations in Howard Hanson Reservoir, and would have no negative effects on common loons. Overall, Water Withdrawal Alternative B would provide better habitat conditions for common loons than Water Withdrawal Alternative A.

Northern Goshawk *(Accipiter gentilis)*

Water Withdrawal Alternative B would have no effect on the northern goshawk. This is a species found in remote forested areas that is susceptible to nest destruction and habitat fragmentation during logging and land clearing. Water withdrawal and fisheries enhancement activities under Water Withdrawal Alternative B would have no effect on this upland species, and no goshawk habitat would be modified or destroyed during minor land clearing activities at the Tacoma Headworks diversion. The potential effects of Water Withdrawal Alternative B on northern goshawks would be comparable to those under Water Withdrawal Alternative A.

Vaux's Swift *(Chaetura vauxi)*

It is highly unlikely that Water Withdrawal Alternative B would have any effect on the Vaux's swift. This

species is highly dependent on the presence of large, hollow, live trees or snags. Water Withdrawal Alternative B would result in no logging or land clearing that would require the removal of large trees or snags, and fisheries enhancement measures would not likely result in the creation of new hollow snags. Additionally, the trees to be left around Howard Hanson Reservoir under Habitat Conservation Measure 2-04 would not likely develop into suitable hollow snags before they rot and fall into the water. The potential effects of Water Withdrawal Alternative B on Vaux's swifts would be comparable to those under Water Withdrawal Alternative A.

Pileated Woodpecker *(Dryocopus pileatus)*

Under Water Withdrawal Alternative B, the pileated woodpecker would experience very minor negative impacts from the clearing of forest habitat to enlarge the Tacoma Headworks inundation area, and short- to mid-term positive impacts from the retention of 229 acres of trees during the raising of Howard Hanson Reservoir. While the 7 acres of forest habitat to be cleared for the expansion of the Headworks inundation pool is of marginal value to pileated woodpeckers, it likely receives at least occasional foraging use by the species. Loss of this 7 acres would reduce the available habitat for the species in the watershed by an insubstantial amount. Conversely, the existing forest along Howard Hanson Reservoir is known to be used by pileated woodpeckers, and the retention of 229 acres within the raised pool area would provide foraging habitat when the existing trees die and begin to rot. This habitat would remain available until the trees eventually fall into the reservoir (probably several decades). Modification of flows in the Green River would have no effect on this strictly upland species. Habitat conditions for pileated woodpeckers in the Action Area would not be substantially different under Water Withdrawal Alternatives A or B.

Olive-sided Flycatcher *(Contopus borealis)*

Water Withdrawal Alternative B would have little or no effect on the olive-sided flycatcher. This is a small songbird associated with habitat along the edges of mature forest. The retention of 229 acres of trees within the raised pool area of Howard Hanson Reservoir could temporarily increase the availability of hunting perches for flycatchers nesting in the adjacent upland forests, but the overall effect of this would be negligible. Modifications to flows on the mainstem Green River, and minor clearing for the Tacoma Headworks inundation pool would have no effect on this species. Habitat conditions for olive-sided flycatchers in the Action Area would be no different under Water Withdrawal Alternatives A or B.

4.2.7.3 Water Withdrawal Alternative C: New Diversion

Effects on Wildlife Habitats

Water Withdrawal Alternative C would affect wildlife habitat in the Action Area in three general ways, all of which are similar to the effects described for Water Withdrawal Alternative B. First, flows in the lower and middle reaches of the Green River would be altered, specifically to increase flows during the dry summer months. Second, the construction of new project facilities would require the clearing of existing wildlife habitat, mostly agricultural pasture and golf course areas at the site of the proposed new dam. Third, fish habitat enhancement measures would alter habitat for various species of wildlife, with positive and negative implications.

The movement of Tacoma Water's primary withdrawal downstream to approximately RM 29.2, combined with HCP measures to guarantee flows for fish in the lower and middle reaches of the Green River (similar to Habitat Conservation Measures 1-01, 1-02, and 2-02), would result in substantially more water in the middle reach of the Green River than the current condition or under the Proposed Action. This would have greatest effect in the late summer, when flows are normally at the lowest for the year. Increased flows would benefit streamside amphibians in the lower and middle reaches by increasing the total wetted area of the streambed, reducing river water temperature, increasing or maintaining dissolved oxygen, and diluting pollutants in the river compared to current conditions. Increased flows could have a negative impact on amphibians and reptiles, however, if they substantially increase water velocities in calm side channels, or increase access by predatory fish to areas used for amphibian reproduction.

The second effect of Water Withdrawal Alternative C on wildlife habitats would occur through the removal or modification of habitat during the construction of new project facilities. Enlargement of the intake and construction of a fish trap at the existing Tacoma Headworks would occur mostly in areas already disturbed by previous project development, with little new loss of wildlife habitat. The existing Headworks diversion would not be raised (as it would under Water Withdrawal Alternative B), so there would be no impacts to riparian wildlife habitats upstream of the existing Headworks. A new dam would be constructed at approximately RM 29.2, however, requiring the permanent removal of roughly 20 acres of riparian pasture

and golf course (for intake area, treatment plant, associated buildings, parking areas and roads) and the temporary disturbance of another 5 acres for construction staging. The new dam also would create a pool, inundating additional riparian pasture and reducing water velocity for about 1 mile upstream. The habitats lost to project construction would not be particularly rare or important habitats, as most have already been substantially modified from their natural condition by development and/or agricultural use. The riparian habitats created along the shoreline of the new inundation area probably would be superior to those along the shoreline of the existing Green River channel, because the new shoreline would be shallower and more gradual, and water velocities would be lower. Use of these areas by amphibians, reptiles, birds, and small mammals would likely increase, particularly by those species less sensitive to the presence of humans.

The third effect of Water Withdrawal Alternative C on wildlife habitat would occur as a result of the fish habitat mitigation measures proposed for the middle and upper Green River Watersheds, and would be identical to the effects described for Water Withdrawal Alternative B. The measure to re-connect a 3.4-acre wetland (Signani Slough at RM 59.6) to the mainstem of the Green River (HCP subsection 5.1, Habitat Conservation Measure 2-07) would alter the water regime in this wetland and make the wetland accessible to salmon and other fish. Amphibians and reptiles that favor calm pools and isolated wetlands could experience decreases in habitat and increases in egg predation by salmon. Conversely, wildlife species that prey upon young salmon could find increased habitat in the slough. Overall, positive and negative effects of a measure similar to Habitat Conservation Measure 2-07 (HCP subsection 5.1) on wildlife would be small because of the small size of the slough (3.4 acres).

Similar measures to improve fish habitat elsewhere in the Green River Watershed could have greater effects on wildlife habitat, however, because of the larger number of acres potentially involved. Measures similar to Habitat Conservation Measures 2-03 and 2-10 would involve the placement of boulders and LWD, the excavation of side channels, the removal of blockages to fish passage, and the re-vegetation of seasonally flooded areas throughout the watershed to improve fish habitat conditions. These measures would benefit aquatic and riparian wildlife by improving habitat conditions and by increasing the numbers of fish eggs, fry, and adults that are potential prey of wildlife. A measure similar to Habitat Conservation Measure 2-04 would require Tacoma Water to leave 229 acres of existing hardwood, mixed, and conifer forest adjacent

to Howard Hanson Reservoir when the USACE raises the reservoir under the Additional Water Storage Project (U.S. Army Corps of Engineers 1998). Trees in this area would be killed by the inundation, and would provide a source of snags (and eventually floating logs) for wildlife.

Effects on Wildlife Populations

Wildlife populations in and near the Action Area would benefit from a net increase in habitat and an increase in prey (i.e., fish) under Water Withdrawal Alternative C. Alternately, some wildlife species, particularly amphibians, would be negatively affected by the presence of greater numbers of predatory fish (i.e., adult salmon). Measures to open side channel habitat in the middle Green River Watershed (similar to Habitat Conservation Measure 2-07), to facilitate anadromy in the Upper Green River Watershed (similar to Habitat Conservation Measures 1-03, 1-04, 2-01, and 2-05), and to improve fish habitat conditions throughout the watershed (similar to Habitat Conservation Measures 2-03, 2-08, 2-09, and 2-10) would have mixed effects on wildlife by increasing the numbers of both predators and prey. Overall, the effects of these measures on native wildlife would be positive, as they would represent at least partial re-creation of pre-development conditions in this managed watershed. No wildlife species would be negatively affected to the extent that its population in the Green River Watershed would be substantially reduced or threatened with local extirpation.

Human activity in the Action Area would increase in the vicinity of the new diversion dam, but probably decrease a minor amount at the existing Tacoma Headworks diversion. These changes would not be enough to alter overall wildlife use of the Action Area.

Effects on Wildlife Species of Special Interest

Federally Listed Species

Bald Eagle *(Haliaeetus leucocephalus)*

Bald eagles would continue to nest and forage in the lower, middle, and upper Green River Watersheds under Water Withdrawal Alternative C, and they could benefit from increased flows and fisheries

enhancement measures similar to those proposed in Tacoma Water's HCP. Improvements at the Tacoma Headworks diversion, construction of the new dam, and inundation of a portion of the Green River would all occur outside known bald eagle nest areas, and would not impact any known high-use foraging areas along the river. Inundation of approximately 1 mile of the river could create better winter foraging for bald eagles by decreasing stream velocity and allowing fish carcasses to become stranded, but this would be a minor positive effect. Increased spring and summer flows in the lower and middle reaches of the river, and overall improvements in habitat conditions for salmon throughout the watershed, could increase the food supply for both nesting and wintering bald eagles. Human disturbance associated with the project would increase at the site of the new dam, but the increase would be minor relative to the current high level of human activity in the area. Use of the upper watershed by bald eagles could increase if the year-round fish population in Howard Hanson Reservoir increases. Bald eagles would experience better habitat conditions under Water Withdrawal Alternative C than under Water Withdrawal Alternative A.

Federally Unlisted Species

Cascade Torrent Salamander *(Rhyacotriton cascadae)*

Changes in mainstem Green River flows under Water Withdrawal Alternative C would have no effect on this species because it is limited to cold headwater streams of the upper watershed. Fish habitat enhancement measures, particularly those involving instream habitat improvements and riparian protection (similar to Habitat Conservation Measures 2-03 and 2-10) could improve habitat conditions for this species if the improvements occur in the headwater streams it inhabits. The increased presence of adult fish in headwater streams, as a result of blockage removal under a measure similar to Habitat Conservation Measure 2-03, could increase predation on salamander eggs and make these stream segments unsuitable for the species. The loss of these habitats would have a minor impact on the Cascade torrent salamander, however, because several miles of non-fish-inhabited streams would remain available to the species throughout the upper watershed.

The status of the Cascade torrent salamander in the Green River Watershed would not change as a result of Water Withdrawal Alternative C. Overall, the effects of Water Withdrawal Alternative C on the Cascade torrent salamander would be comparable to those under Water Withdrawal Alternative A.

Van Dyke's Salamander (*Plethodon vandykei)*
This species, like the Cascade torrent salamander, occurs only in cold headwater streams in the upper watershed. Changes in mainstem Green River flows under Water Withdrawal Alternative C would have no effect on this species. Fish habitat enhancement measures, particularly those involving instream habitat improvements and riparian protection (similar to Habitat Conservation Measures 2-03 and 2-10) could also improve habitat conditions for this species if the activities occur in the headwater streams it inhabits. Conversely, the increased presence of adult fish in headwater streams could increase predation on salamander eggs and make these stream segments unsuitable for the species. The loss of these habitats would have a minor impact on the Van Dyke's salamander, however, because several miles of non-fish-inhabited streams would remain available to the species throughout the upper watershed.

The status of the Van Dyke's salamander in the Green River Watershed would not change as a result of Water Withdrawal Alternative C. The overall effects of Water Withdrawal Alternative C on the Van Dyke's salamander would be comparable to those of Water Withdrawal Alternative A.

Larch Mountain Salamander (*Plethodon larselli*)
Operation of the Green River Project and implementation of fish habitat mitigation measures under Water Withdrawal Alternative C would have no effect on the habitat or individuals of this species. This is a species found in talus slopes and rocky soils, often those found in association with dense forest cover. If it occurs in the Action Area, it is on rock slopes well above the channel of the Green River or its tributaries. It would be unaffected by continued withdrawal of water, by construction of new facilities at approximately RM 29.2, or by habitat improvement within the river or tributary streams. This is comparable to the potential effects of Water Withdrawal Alternative A on Larch Mountain salamanders.

Tailed Frog *(Ascaphus truei)*
This species is known to occur in the Upper Green River Watershed, and could occur in the middle watershed as well. Like the Cascade torrent and Van Dyke's salamanders, it occurs only in cold headwater streams. Changes in mainstem Green River flows under Water Withdrawal Alternative C would have no effect on this species. Construction of new project facilities would not occur in or near the habitat of this species. Fish habitat enhancement measures, particularly those involving instream habitat improvements and riparian protection (similar to Habitat Conservation Measures 2-03 and 2-10) could

improve habitat conditions for this species if the improvements occur in the headwater streams it inhabits. Conversely, the increased presence of adult fish in headwater streams could increase predation on tailed frog eggs and make these stream segments unsuitable for the species. The loss of these habitats would have a minor impact on the tailed frog, however, because several miles of non-fish-inhabited streams would remain available to the species throughout the upper watershed.

The status of the tailed frog in the Green River Watershed would not change as a result of Water Withdrawal Alternative C. The potential effects of this alternative on tailed frogs would be similar to those under Water Withdrawal Alternative A.

Cascades Frog *(Rana cascadae)*

The Cascades frog would not be affected by Water Withdrawal Alternative C. This frog is found in lakes, ponds, wetlands, and bogs above 2,000 feet in elevation in the Cascade Mountains, well above the areas that would be influenced by water withdrawal, construction, and fish mitigation activities under this alternative. This is similar to the lack of potential effects under Water Withdrawal Alternative A.

Oregon Spotted Frog *(Rana pretiosa)*

The Oregon spotted frog could be affected by Water Withdrawal Alternative C, although the effect would be minor. While this species likely does not occur in the Action Area, the construction of new project facilities at RM 29.2, the modification of wetland habitat to benefit fish, and substantial increases in flows along the middle reach of the Green River could alter the potential for this species to occupy the Action Area in the future. The new dam and associated structures would permanently impact 20 acres of streamside habitat, and temporarily impact another 5 acres. Spotted frogs are not likely to inhabit these areas now or in the future, so impacts would be negligible. Inundation of the Green River for about 1 mile upstream of the new dam could potentially improve habitat for the spotted frog if non-woody wetlands develop along the stream bank.

The 3.4-acre wetland at Signani Slough would likely be modified under a measure similar to Habitat Conservation Measure 2-07 (HCP subsection 5.1), and made accessible to adult salmon. This could result in deteriorated habitat conditions and increased predation that would make spotted frog use of this area in the future less likely. Increased late summer flows in the mainstem of the Green River as a result of the

new diversion (at approximately RM 29.2) and instream flow guarantees (similar to Habitat Conservation Measures 1-01 and 1-02) could also alter conditions in side channel wetlands along the middle reach of the Green River. The effect of these changes on potential spotted frog habitat cannot be predicted. Overall, the effects of Water Withdrawal Alternative C on the Oregon spotted frog would be minor because of the unlikely presence of the species in the Action Area. Negative impacts under this alternative would be slightly greater than those that would occur under Water Withdrawal Alternative A because of the potential for adverse modification of habitat under the Proposed Action measures for fish.

Northwestern Pond Turtle *(Clemmys marmorata)*

The Northwestern pond turtle, like the spotted frog, is extremely rare in the Action Area. The pond turtle could benefit under Water Withdrawal Alternative C, however, if basking and foraging habitat are increased by increased flows and increased LWD in the lower and middle reaches of the Green River, and by the creation of an approximate 1-mile inundation pool behind the new dam. No negative impacts on pond turtles would occur under Water Withdrawal Alternative C. Overall, this alternative would benefit the Northwestern pond turtle more than Water Withdrawal Alternative A, although the difference would be minor due to the limited distribution of the species in the area.

Common Loon *(Gavia immer)*

The only known occurrence of common loons in the Action Area is a nesting pair on Howard Hanson Reservoir. These loons would benefit under Water Withdrawal Alternative C because of measures similar to Habitat Conservation Measure 2-04, which would increase the amount of floating wood (i.e., potential nesting substrate), and Habitat Conservation Measures 1-03, 1-04, 2-01, 2-03, 2-05, and 2-10, which would increase the abundance of young fish (i.e., prey) in the reservoir. This alternative would result in no change in water-level fluctuations in Howard Hanson Reservoir, and would have no negative effects on common loons. Overall, Water Withdrawal Alternative C would provide better habitat conditions for common loons than Water Withdrawal Alternative A.

Northern Goshawk *(Accipiter gentilis)*

Water Withdrawal Alternative C would have no effect on the northern goshawk. This is a species found in remote forested areas that is susceptible to nest destruction and habitat fragmentation during logging and land clearing. Water withdrawal and fisheries enhancement activities would have no effect on this upland

species, and no goshawk habitat would be modified or destroyed during land clearing activities at the existing Tacoma Headworks diversion or the new dam site. The potential effects of Water Withdrawal Alternative C on the northern goshawk would be comparable to those under Water Withdrawal Alternative A.

Vaux's Swift *(Chaetura vauxi)*

It is highly unlikely that Water Withdrawal Alternative C would have any effect on the Vaux's swift. This species is highly dependent on the presence of large, hollow, live trees or snags. Water Withdrawal Alternative C would result in no logging or land clearing that would require the removal of large trees or snags, and fisheries enhancement measures would not likely result in the creation of new hollow snags. Additionally, the trees to be left around Howard Hanson Reservoir under a measure similar to Habitat Conservation Measure 2-04 would probably not develop into suitable hollow snags before they rot and fall into the water. The potential effects of Water Withdrawal Alternative C on Vaux's swifts would be comparable to those under Water Withdrawal Alternative A.

Pileated Woodpecker *(Dryocopus pileatus)*

Under Water Withdrawal Alternative C, the pileated woodpecker would experience no negative impacts and short- to mid-term positive impacts from the retention of 229 acres of trees during the raising of Howard Hanson Reservoir. No pileated woodpecker habitat would be altered or disturbed during construction activities at the existing Tacoma Headworks or the new dam site. The pileated woodpecker does find habitat along existing Howard Hanson Reservoir, however, and the retention of 229 acres within the raised pool area would provide foraging habitat when the existing trees die and begin to rot. This habitat would remain available until the trees eventually fall into the reservoir (probably several decades). Modification of flows in the Green River would have no effect on this strictly upland species. Habitat conditions for pileated woodpeckers in the Action Area would not be substantially different under Water Withdrawal Alternatives A or C.

Olive-sided Flycatcher *(Contopus borealis)*

Water Withdrawal Alternative C would have little or no effect on the olive-sided flycatcher. This is a small songbird associated with habitat along the edges of mature forest. The retention of 229 acres of trees within the raised pool area of Howard Hanson Reservoir could temporarily increase the availability of hunting

perches for flycatchers nesting in the adjacent upland forests, but the overall effect of this would be negligible. Modifications to flows on the mainstem Green River, construction of fish facilities at the existing Tacoma Headworks, and clearing for the new dam would have no effect on this species. Habitat conditions for olive-sided flycatchers in the Action Area would be no different under Water Withdrawal Alternatives A or C.

4.2.8 Recreation

This section considers the potential effects of the proposed action and alternatives on water-dependent recreation activities in the lower and middle Green River. As described in subsection 3.10, Recreation, water-dependent recreation activities in the lower and middle Green River Watershed include rafting, kayaking, canoeing, swimming, and fishing.

Whitewater rafting and kayaking, which are highly dependent on flow levels, are quantitatively evaluated in this section. As described in Chapter 7 of the HCP, hydrologic modeling was conducted for the water withdrawal alternatives; this modeling provided information on expected flows in the Green River under each alternative scenario (Figures 4-1 through 4-9). This modeled flow information was compared to preferred rafting and kayaking flow conditions (as described in subsection 3.10, Recreation) to determine how the alternatives may affect the availability of preferred recreation flows.

4.2.8.1 Water Withdrawal Alternative A: No Action

As described in subsection 3.10, Recreation, the preferred flow range for whitewater rafting in the Green River Gorge is 1,300 to 4,000 cfs, and the preferred flow range for kayaking is 1,000 to 3,000 cfs. Modeled flows under Water Withdrawal Alternative A were compared to these preferred flow ranges to determine the percentage of days in which average monthly flows would meet the preferred rafting and kayaking conditions (Table 4-6.). Because rafting in the Green River Gorge appears more related to flows rather than to air temperature or other factors, these data are presented for all months of the year.

Table 4-6. Percentage of days under the No Action Alternative with average flows within the preferred range for rafting and kayaking (Water Withdrawal Alternative A).

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Under Water Withdrawal Alternative A, the greatest percentage of days with preferred flows for rafting and kayaking would occur during late fall, winter, and early spring (Table 4-6). Modeled flows reflect hydrologic conditions under Water Withdrawal Alternative A, and would be similar to current flow conditions, especially during summer months[1].

Other water-use recreational activities such as floating and canoeing are not as dependent on high flow conditions as whitewater rafting and kayaking. As described above, Green River flows under Water Withdrawal Alternative A would be similar to existing conditions, especially during summer months. Therefore, other water-use recreation activities would be expected to continue in the same manner as current activities.

As described in subsection 4.2.6, Fish and Aquatic Habitat, the populations of sportfishes (e.g., steelhead) are likely to be supported in a similar manner as current conditions.

Because the expected flows under Water Withdrawal Alternative A would continue to support water-based recreation, it is also expected that land-based recreation activities (e.g., use of park facilities for picnicking or camping) would continue to be supported in the same manner as current conditions.

4.2.8.2 Water Withdrawal Alternative B: Proposed Action

As with Water Withdrawal Alternative A, flows under Water Withdrawal Alternative B were compared to the preferred flow range for rafting and kayaking (Table 4-7). The extent of potential impacts to rafting and kayaking opportunities were analyzed by comparing modeled flows under Water Withdrawal Alternative B to modeled flows under Water Withdrawal Alternative A (Table 4-7).

Under Water Withdrawal Alternative B, the general pattern of the rafting/kayaking season would remain the same as under Water Withdrawal Alternative A. Summer would continue to be the off-season with very limited opportunities for rafting in the Green River Gorge. Throughout most

[1] Under Water Withdrawal Alternative A modeling, it was assumed that Tacoma Water would divert its First Diversion Water Right claim of 113 cfs year-round. Currently, Tacoma Water only diverts its full amount during summer months.

Table 4-7. Percentage of days under the Proposed Action Alternative with average flows within the preferred range for rafting and kayaking (Water Withdrawal Alternative B).

PLACEHOLDER.

of the year, there would be a slight decrease in the percentage of days with preferable rafting/kayaking flows under Water Withdrawal Alternative B as compared to Water Withdrawal Alternative A. Finally, there would be a substantial decrease in the percentage of days with preferable rafting/kayaking flows during an average March, but a substantial increase during an average May. This is a result of the USACE management of Howard Hanson Dam releases to minimize redd dewatering and shifting storage earlier in the spring for later release per the Additional Water Storage Project.

Canoeing and inner-tubing would not be adversely affected under Water Withdrawal Alternative B. Flows downstream of the Green River Gorge would decrease slightly during the late fall, winter and early spring and increase slightly during summer months under Water Withdrawal Alternative B relative to Water Withdrawal Alternative A. However, the magnitude of these flow changes would not likely negatively impact non-whitewater river uses.

As described in subsection 4.2.6, Fish and Aquatic Habitat, the populations of sportfishes may experience some improvements to various habitat categories relative to Water Withdrawal Alternative A. Other habitat factors, however, may decrease. Overall, Water Withdrawal Alternative B is expected to have a slight beneficial effect on sportfish populations and would, therefore, be beneficial to recreation as well.

Because the expected flows under Water Withdrawal Alternative B would not adversely affect water-based recreation, it is also expected that land-based recreation activities (e.g., use of park facilities for picnicking or camping) would not be affected relative to Water Withdrawal Alternative A.

4.2.8.3 Water Withdrawal Alternative C: New Diversion

Under Water Withdrawal Alternative C, Tacoma Water's primary diversion activities would occur at approximately RM 29.2 north of the City of Auburn. The primary purpose of this alternative would be to increase flows downstream of the Tacoma Headworks. The effects of this alternative on rafting and kayaking opportunities in the Green River Gorge are presented in Table 4-8.

Table 4-8. Percentage of days under the New Diversion Alternative with average flows within the preferred range for rafting and kayaking (Water Withdrawal Alternative C).

PLACEHOLDER.

In general, Water Withdrawal Alternative C would improve conditions for rafting and kayaking in the Green River Gorge as compared to Water Withdrawal Alternative A by providing a slight increase in the percentage of days in which Green River flows fall within the preferred flow range. As described above under Alternative B, the effects of changing Howard Hanson Dam operations for redd protection and water storage are more pronounced in March and May, as illustrated by the more substantial decrease in the percentage of rafting and kayaking days in March, and the more substantial increase in May.

Other water-use recreational activities may be affected by the Water Withdrawal Alternative C. Flows from the Tacoma Headworks downstream to RM 29.2 would increase in most months of the year under Water Withdrawal Alternative C as compared to Water Withdrawal Alternative A. However, the magnitude of these flow changes would not likely negatively impact non-whitewater river uses.

However, the downstream diversion facility, particularly the associated diversion dam, would interfere with canoeing, floating, swimming, and other water-use recreation activities occurring between the Cities of Auburn and Kent. Passage around the diversion dam would likely be restricted, and the flow characteristics of the impoundment area (i.e., extending about 1 mile above the dam) would be altered. It is possible that mitigation for these impacts could be incorporated into the design of the facilities; however, specifications for this alternative have not been developed.

As described in subsection 4.2.6, Fish and Aquatic Habitat, the populations of sportfishes may experience some improvements to various habitat categories relative to Water Withdrawal Alternative A. Overall, Water Withdrawal Alternative C is expected to have a slight beneficial effect on sportfish populations and would, therefore, be beneficial to recreation as well.

Because the expected flows under Water Withdrawal Alternative C would not adversely affect water-based recreation, it is also expected that land-based recreation activities upstream of RM 29.2 would not be affected relative to Water Withdrawal Alternative A. However, the diversion facilities would interfere with land-based recreation, as conflicts with the Auburn Golf Course and Isaac Evans Park may occur that require realignment of portions of the course and relocation of park facilities. As described above, specifications for this alternative have not been developed; therefore, the specific extent of land-based recreation impacts cannot be fully evaluated.

4.2.9 Visual Resources

Changes in visual resources may occur as a result of Tacoma Water's diversion activities associated with the water withdrawal alternatives. The key visual resource analyzed in this section is the scenic quality of the river corridor downstream of the Tacoma Headworks. For this analysis, "scenic quality" is measured in terms of impacts to riparian vegetation.

4.2.9.1 Water Withdrawal Alternative A: No Action

Under Water Withdrawal Alternative A, Green River flows would be maintained in a similar manner as existing conditions. As described in subsection 4.2.5.2, Vegetation, riparian habitats downstream of the Tacoma Headworks would continue to be maintained by the flows expected under Water Withdrawal Alternative A.

4.2.9.2 Water Withdrawal Alternative B: Proposed Action

Green River flows under Water Withdrawal Alternative B are expected to be similar to or slightly less than flows under Water Withdrawal Alternative A. However, as described in subsection 4.2.5.3, Vegetation, riparian habitats downstream of the Tacoma Headworks would not be adversely affected by the change in flows expected under Water Withdrawal Alternative B. Accordingly, no flow-related visual resource impacts would likely occur. In addition, the scenic quality of the Green River would likely experience localized benefits as a result of implementing the riparian habitat restoration measures of the HCP.

4.2.9.3 Water Withdrawal Alternative C: New Diversion

Green River flows under Water Withdrawal Alternative C are expected to be similar to or slightly higher than flows under Water Withdrawal Alternative A. However, as described in subsection 4.2.5.4, Vegetation, riparian habitats downstream of the Tacoma Headworks would not be affected by the changes in flows expected under Water Withdrawal Alternative C. Accordingly, no visual resource impacts (adverse or beneficial) associated with flows would likely occur.

A visual resource impact may occur under Water Withdrawal Alternative C due to the downstream diversion facilities. Although an exact location for the diversion dam has not been determined, it is possible that the downstream diversion could be located on the site of the Auburn Golf Course and, therefore, may also be visible from Isaac Evans Park and Brannan Park. The structures associated with the downstream diversion may conflict with the Green River, which possesses a moderate visual amenity value in this area. Depending on the design of downstream diversion facilities, the extent of this visual impact could range from moderate to severe. An additional visual impact would occur from the reservoir created behind the new diversion for approximately 1 mile upstream of RM 29.2. This reservoir would substantially alter the visual quality of this reach of the Green River. Specific visual resource impacts would require further evaluation if detailed engineering specifications were developed.

4.2.10 Social and Economic Conditions

4.2.10.1 Water Withdrawal Alternative A: No Action

As described in subsection 1.6.5, Growth Management Act, Tacoma's service of water from the Green River system is in response to the growth-related service requirements identified by the Growth Management Act. In the state of Washington, therefore, the distribution of water does not induce growth, but rather responds to the growth needs previously identified through a statewide process and specifically allocated by units of government planning under the Growth Management Act.

If Tacoma Water did not implement the elements of the proposed HCP, the potential for a water supply shortage would occur during drought periods. Furthermore, it is possible that some requirements would be placed on Tacoma's existing water supply operations by the Services as a result of the listing of Puget Sound chinook salmon and the potential bull trout/Dolly Varden listing. Such requirements could result in the lack of available water supply regionally to accommodate growth and economic development. There are a sufficient number of water utilities that are acting in reliance on the availability of Tacoma's Second Supply Project, such that a failure of the project to proceed, including the HCP, would leave these utilities without an available source of water supply. It is doubtful these utilities could redirect their source development programs to avoid substantial social and economic impacts. This would be particularly true for the Cities of Federal Way, Covington, and Kent. Each of these cities has indicated that its current water

supply would run out near year 2000. The development of a new source of supply could take in excess of 15 years.

Under a status quo, No Action, scenario, the Services may require some level of mitigation for ongoing damages resulting from Tacoma Water's operation of its diversion on the Green River. It is difficult to assess the impacts of such required mitigation at this time, but the impact on Tacoma's ratepayers would be approximately a 4 percent increase for each $1 million of annual mitigation required (based on current annual budget).

4.2.10.2 Water Withdrawal Alternative B: Proposed Action

Tacoma's proposed HCP would have a number of economic and social impacts associated with it. The assured availability of adequate water supply to meet projected needs in the area served by Tacoma Water and its project partners is probably the most substantial positive impact associated with the project. Construction of the Second Supply Project would provide water to support forecasted population and economic growth in the Tacoma service area, Pierce County, and areas served by the co-participants with Tacoma in the Second Supply Project. However, the cost of water from this project would be substantially higher than water available from any current water supplies in the region. The cost per million gallons per day of available supply would be in the range of $5 million. This high cost of public water supply is likely to adversely affect the feasibility of some development, both residential and commercial/industrial.

The history and reputation of the Pacific Northwest is one of readily available water resources. The costs and programs envisioned by Tacoma's HCP seems certain to raise the cost of water supply to a level where it is no longer attractive for the development of water intensive industry. The higher cost of water and the emphasis on habitat protection associated with the proposed HCP may also achieve a conservation benefit by influencing individuals to reduce their consumption of water either through cost consciousness or environmental commitments.

4.2.10.3 Water Withdrawal Alternative C: New Diversion

The primary socioeconomic impact associated with Water Withdrawal Alternative C would be the increased cost of water supply. Other related impacts could include loss of all or a portion of the recreational opportunities represented by the Auburn Golf Course, a portion of which may need to be purchased to allow for the development of this alternative. In addition, the small diversion pool necessary to allow operation of the diversion could result in flooding of one or more current property owners in the vicinity. A further socioeconomic impact associated with this alternative would be the development of an industrial facility, the water treatment plant, in proximity to the Green River in an area that is currently in residential and recreational land uses. Steps could be taken architecturally to minimize this impact but it could not be altogether avoided.

Compared to Water Withdrawal Alternative A, the most substantial socioeconomic impact would be the increased price of water supply from Tacoma's Second Supply Project as a result of the development of a diversion in the vicinity of RM 29.2. Increased costs associated with this alternative include the following:

1. Additional costs of water treatment, which is necessary due to the location of this diversion downstream of both population centers and agricultural activities. A new water treatment plant would cost approximately $125 million.

2. In addition to the costs of water treatment plant construction, annual operating costs for such a facility have been estimated at $5 million.

3. Due to the location of this facility at a lower elevation, relative to utility operating pressures, water service by gravity would not be possible. This would require the development of a new pumping station at a cost of approximately $14 million.

4. As a result of diversion at this low elevation, pumping costs on an ongoing basis would be substantially higher as compared to Water Withdrawal Alternative A. Diversion of this size would require a pump station of approximately 22,000 horsepower, which would cost

roughly $4 million in power costs annually to pump diverted water to system operating pressures based on a power cost of .04 cents per kilowatt hour and a uniform power use rate (the assumption of uniform power use rate is likely underestimating the power costs due to the normal peak use required for water utilities). Additional costs could be incurred to guarantee standby power.

5. Construction of the diversion facility would cost approximately $5 million (this cost does not include pumping, filtering, or other associated costs).

6. New and upgraded pipelines would cost approximately $46 million. A portion of the proposed second supply pipeline (from the existing Tacoma Headworks diversion to the vicinity of the new diversion) would not be necessary under this alternative. In its place, a duplicate or enlarged pipeline would be necessary from the new diversion to Tacoma to carry water that is now withdrawn at the existing diversion. In addition, another smaller pipeline would also be necessary from the new diversion to the Tacoma/Seattle intertie location. Eliminating a portion of the second supply pipeline would result in savings of approximately $44 million, but the replacement pipelines would cost an estimated $90 million for a net cost increase of $46 million.

7. The size of the pumping station and its attendant horsepower requirement would require an electrical substation to support the facility. The cost of such a facility has not been estimated.

8. Additional costs would be incurred to handle waste from the treatment facility. The approach to addressing waste handling is undefined at this time and could not be further refined without the development of a pilot treatment study at the Auburn location.

9. Approximately 20 acres of riverfront property would need to be acquired for staging areas during construction and for permanent facilities. The range of estimated values for 20 acres of property along the Green River in the Auburn area is $4,540,000 to $5,400,000.

4.2.11 Cultural Resources

Upon review of the cultural resources documentation provided in subsection 3.13, Cultural Resources, it is unlikely that activities under any of the water withdrawal alternatives would adversely impact cultural resources below Howard Hanson Dam. Temporary ground disturbance activities would occur under Water Withdrawal Alternative C, which would have an unquantified potential to impact unknown cultural sites. However, there is also a potential that cultural resources would not likely be impacted because the approximate 25 acres needed for staging and permanent facilities would likely be located on the site of the Auburn Regional Golf Course (although the exact location of this alternative has not been developed). This location has experienced prior disturbance and has been converted to a recreation use. Regardless, river-related construction activities under Water Withdrawal Alternatives A, B, and C would require a thorough, site-specific cultural review to obtain state and USACE permits.

4.3 UPPER WATERSHED ALTERNATIVES

Tacoma Water is requesting incidental take coverage for two distinct sets of covered activities within the Green River Watershed: a) the withdrawal of water at the Tacoma Headworks facility (RM 61.0) and associated activities (Figure 2-1), and b) the management of City of Tacoma-owned lands in the upper watershed above the point of withdrawal. *These two, distinct activities are interrelated, but they are not interdependent; an ITP could be issued for one activity and not for the other. The water withdrawal facilities could be operated with or without incidental take coverage for the upper watershed, and management of Tacoma Water's upper watershed lands could continue regardless of the manner in which water is withdrawn.* For this reason, the analyses in this DEIS are done in two parts; one covering the alternatives for water withdrawal activities, and the other covering alternatives for land management activities in the upper watershed.

4.3.1 Ownership and Land Use

There is little difference among the upper watershed alternatives in terms of land use and shoreline impacts; therefore, potential ownership and land use impacts have been presented as one analysis, below.

All Upper Watershed Alternatives

The proposed activities under each upper watershed alternative would not change Tacoma Water's land use goals of managing its lands in the Upper Green River Watershed for the protection of water quality and for commercial timber harvesting, except under Alternative C where no harvest would occur. In addition, Tacoma Water is not seeking to change King County's land use designation of Forestry on its timberlands in the upper watershed and no ownership changes would occur under any alternative.

Because land use would essentially remain the same, no land use impacts would occur under Alternatives A or B. Moreover, timber harvest activities under Upper Watershed Alternative B would provide enhanced compatibility with adjacent land uses as compared to Upper Watershed Alternative A because several adjacent ownerships are managed under federally approved HCPs (i.e., Plum Creek Timber Company and DNR timberlands) or pursuant to the Northwest Forest Plan (i.e., Mt. Baker-Snoqualmie National Forest). Consequently, habitat protection measures in Tacoma's HCP would be compatible with protection measures in these adjacent landowner HCPs, which would provide additional habitat improvements within the vicinity of the Action Area for species such as the spotted owl. Upper Watershed Alternative C would differ from Upper Watershed Alternative A since no commercial timber harvest activities would occur. However, ceasing to commercially manage its timberlands would not result in a land use impact because Tacoma Water would not convert the timberlands to another land use (e.g., developed for residential or commercial use). Tacoma Water would continue to manage its lands in the upper watershed to protect water quality under Upper Watershed Alternative C.

The King County shoreline designation for the Green River upstream of Howard Hanson Dam is Conservancy. The Conservancy designation would likely allow the forest management activities described under Upper Watershed Alternative A. Proposed forest management activities under Upper Watershed Alternative B, including additional timber harvesting, would also likely be allowed under the Conservancy designation, subject to certain requirements (subsection 3.3.2.). Final requirements under this designation would be determined based on details within Tacoma Water's Forest Management Plan.

4.3.2 Geology and Soils

4.3.2.1 Upper Watershed Alternative A: No Action

Forest management activities have the potential to influence erosional processes and soil productivity, generating both site-specific and cumulative effects. Activities such as timber harvest and road building increase the potential for landslides by changing the path taken by surface and subsurface flows, and by altering root strength, hillslope gradients, or the distribution of materials on steep slopes (Swanston and Swanson 1976).

Surface erosion is most likely to occur when soils on steep slopes are exposed to precipitation or overland flow. Delivery of sediment from soils exposed by harvest activities depends on soil texture, slope steepness, and proximity to a stream channel (Washington Forest Practices Board 1997). Road building exposes soils, compacts the road surface, and may intercept sub-surface flow and transform it into surface runoff that is routed to streams or hillslopes via ditches (Megahan 1972). Ditches that are connected to the channel network deliver sediment generated from road surfaces directly to streams (Weaver and Hagans 1994).

The primary factors influencing soil productivity include organic matter content, soil structure, and nutrient availability (Oregon State University Extension Service 1977). Harvest and site preparation activities such as burning or piling may disturb or destroy the duff layer (Reid 1993). Sensitive soils may be compacted under the weight of ground-based harvest equipment (Johnson and Beschta 1980).

Under Upper Watershed Alternative A, Tacoma Water would continue to manage forestlands in the Upper Green River Watershed according to its Forest Land Management Plan, agreements with the Muckleshoot Indian Tribe, and Forest Practices Rules where those rules exceed protection provided by the Forest Land Management Plan (Ryan 1996) or MIT/TPU Agreement. Tacoma Water's primary concern in the Upper Green River Watershed is to protect water quality in streams that represent the source of water supplied to municipal and industrial users. Tacoma's existing Forest Land Management Plan (Ryan 1996) and the MIT/TPU Agreement generally equal or exceed current Forest Practices Rules because no-harvest riparian zones are up to 150 feet wider than those recommended by the state, and include the entire length of both perennial and seasonal Type 4 and 5 streams and all fish-bearing waters. Riparian and wetland buffer

widths that would be applied under Upper Watershed Alternative A are summarized in Tables 2-13a and 2-13b.

Under Upper Watershed Alternative A, harvest activities could take place within 50 to 200 feet of fish-bearing channels that are not designated Shorelines of the State and that are located in the Commercial and Conservation Zones, or in areas where the width of the Natural Zone adjacent to fish-bearing streams is less than 200 feet. Surface erosion of exposed soils within 200 feet of a stream can deliver sediment via overland flow during large storms, particularly on steep slopes (Washington Forest Practices Board 1997). Increased delivery of fine sediment can result in longer or more frequent elevations of turbidity, and may detrimentally affect salmonids by filling interstitial spaces in the substrate and reducing intragravel dissolved oxygen concentrations (MacDonald et al. 1991).

Bank protection would be maintained by leaving a no-harvest buffer ranging from 25 to 50 feet wide along all streams, including seasonal Type 5 channels. Retention of riparian vegetation within one-half site-potential tree height of an active stream channel is necessary to maintain streambank stability. Assuming site potential tree heights range from approximately 90 to 200 feet (U.S. Fish and Wildlife Service et al. 1999), no-harvest riparian buffers under Upper Watershed Alternative A would provide adequate bank protection on Type 1 and 2 streams, but may provide less than complete bank protection on Type 3, 4, and 5 streams (Tables 2-13a and 2-13b). Retaining vegetation to maintain bank stability will reduce erosion of banks and inputs of fine sediment. However, incomplete protection of banks on smaller tributaries may result in erosion and sediment delivery rates that exceed those of unmanaged systems.

Road-related surface erosion and mass wasting would be addressed through the Watershed Analysis process under Upper Watershed Alternative A. Tacoma Water has participated in Watershed Analysis conducted on five of the six WAUs within the Upper Green River Watershed that have been completed or are currently in progress. Draft or final Watershed Analysis prescriptions currently guide activities governing road surface erosion and mass wasting on 88 percent of the Action Area (13,030 of 14,852 acres) (Table 3-1). Additionally, prescriptions that provide greater resource protection would be implemented over comparable Forest Land Management Plan (Ryan 1996) measures.

Watershed Analysis prescriptions developed to date require landowners to avoid unstable landforms if possible; to construct roads according to strict standards that require end-hauling and full-bench construction; and to specify allowable fill depth, type of stream crossing structure (i.e., bridge or ford), and the location and frequency of drainage sites (Plum Creek Timber Company 1996a). Site-specific assessment and design by a slope stability specialist and road engineer may also be required. In addition, existing roads in high hazard areas must be reviewed by a slope stability specialist, and a Road Restoration Plan and Road Sediment Reduction Plan that includes provisions for road maintenance or upgrading sufficient to keep road sediment inputs to less than 50 percent of the estimated background sediment production must be submitted to the DNR (Plum Creek Timber Company 1996a). Tacoma Water is currently collaborating with other landowners in the Upper Green River Watershed to complete the required road inspections and Road Sediment Reduction Plan, which would continue to occur under Upper Watershed Alternative A. Such a systematic, watershed-wide approach is the most effective means of reducing road sediment inputs (Weaver and Hagans 1994).

Tacoma Water is also committed to minimizing traffic on roads controlled by the City of Tacoma that are not required to remain open to provide public access to USFS-managed lands. One of the most important determinants of the amount of sediment produced on roads is the traffic rate (Washington Forest Practices Board 1997). Tacoma Water would close City-controlled roads to public traffic, and restrict heavy truck traffic during wet periods. This would substantially reduce the rate of sediment production from road surfaces under Upper Watershed Alternative A.

4.3.2.2 Upper Watershed Alternative B: Proposed Action

Under Upper Watershed Alternative B, sediment delivered by surface erosion is expected to be less than under Upper Watershed Alternative A. No-harvest riparian zones would be 150 to 200 feet wide on all fish-bearing streams, and Type 3 streams would have an additional 50-foot partial harvest buffer (Tables 2-13a and 2-13b). No-harvest buffers on Type 4 streams would be 50 to 100 feet wide, and an additional 25-foot partial harvest buffer would be added to the existing 25-foot no-harvest buffer on Type 5 streams. Since no harvest activities would be conducted under Upper Watershed Alternative B within 150 to 200 feet of fish-bearing streams, and protection of non-fish-bearing streams would increase, the likelihood of surface erosion delivering sediment to streams via overland flow would be reduced as compared to Upper

Watershed Alternative A. No-harvest buffers would exceed those required to maintain bank stability on all fish-bearing streams, and equal the minimum width necessary to maintain stability on portions of non-fish-bearing Type 4 streams under Upper Watershed Alternative B. Over time, reducing surface erosion will return sediment delivery rates to levels that better approximate natural geomorphic process, and should result in improved water quality and aquatic habitat as compared to Upper Watershed Alternative A.

Citifor, Inc. and Plum Creek Timber Company have reserved the option to harvest timber on approximately 1,346 acres of lands recently acquired by Tacoma~~-owned lands~~ Water in the Upper Green River Watershed, including 314 acres within Tacoma Water's designated buffer widths. The 314 acres of buffer represent approximately 15 percent of the total acres of buffer on Tacoma-owned land in the upper watershed (of the 314 acres, Plum Creek's ~~option is for~~ portion is 292 acres, and Citifor's ~~option is for~~ portion is 22 acres). The 314 acres of buffer would be managed according to standards described in the Plum Creek Timber Company HCP (Plum Creek Timber Company 1996b) or, in the case of lands reserved to Citifor, Inc., Forest Practices Rules (which include Watershed Analysis prescriptions where available). Timber rights to the lands reserved to Citifor, Inc. ~~revert back~~ automatically transfer to Tacoma Water in December ~~1999~~ 2000, and those reserved to Plum Creek Timber Company ~~revert back~~ transfer to Tacoma Water in December 2007, at which time those lands would be managed using buffer widths committed to in Tacoma's proposed HCP. Since the buffers specified in the Plum Creek Timber Company HCP and in existing Forest Practices Rules allow partial harvest activities within 200 feet of stream channels, the possibility that soils exposed during harvest activities in these areas could contribute sediment to stream channels via overland flow is somewhat greater than it would be following reversion of the timber rights back to Tacoma Water. The rate and effect of sediment delivery from these lands would remain equivalent to those described for Upper Watershed Alternative A until 2007, delaying realization of benefits under Upper Watershed Alternative B.

Under Upper Watershed Alternative B, Tacoma Water would continue to manage unstable lands as prescribed by Watershed Analysis prescriptions described in subsection 4.3.2.1, Upper Watershed Alternative A, No Action Alternative, thus no difference in sediment delivery by management-related landslides is expected by implementation of the HCP (Table 3-1). Tacoma Water would also make a commitment to complete slope stability and road surface erosion assessments

comparable to those conducted for Watershed Analysis if draft Watershed Analysis assessment reports and prescriptions are not completed for the remaining WAUs in a timely manner. This commitment guarantees that all of Tacoma Water's ownership in the Upper Green River Watershed would receive protection comparable to that recommended by Watershed Analyses under Upper Watershed Alternatives A and B. Lastly, Tacoma Water would continue to implement all public-use and wet-weather road restrictions currently in effect in the Upper Watershed. The increased level of protection provided under these Alternatives is expected to reduce the rate of mass wasting as compared to historic conditions, and, over time, will allow the sediment transport regime and aquatic habitats to return to a condition that more closely resembles unmanaged systems.

4.3.2.3 Upper Watershed Alternative C: No Commercial Timber Harvest

Under Upper Watershed Alternative C, Tacoma Water would discontinue all commercial timber harvest activities in the Upper Green River Watershed. In the absence of timber harvest, none of Tacoma Water's management activities would have the potential to cause surface erosion or to exacerbate slope stability problems from non-roaded areas; thus, sediment delivery would be reduced as compared to Upper Watershed Alternative A.

Under Upper Watershed Alternative C, the 314 acres of riparian buffer currently reserved to Citifor, Inc. and Plum Creek Timber Company would be harvested in compliance with either Plum Creek Timber Company's HCP (timber reserved to Plum Creek Timber Company) or Forest Practices Rules (timber reserved to Citifor, Inc.). After the timber rights to those lands revert back to Tacoma Water, no further harvest would occur for the duration of the ITP. Impacts associated with harvest activities on these reserved lands are comparable to those described under Upper Watershed Alternative B.

Tacoma Water would continue to participate in Watershed Analyses to ensure that water quality concerns were adequately addressed by the prescription team under Upper Watershed Alternative C (Table 3-1). Tacoma Water would also continue to participate in road maintenance planning as required under Watershed Analysis prescriptions, with the goal of reducing road-related sediment delivery to less than 50 percent of background, as described under Upper Watershed Alternative A. Existing road agreements would also be continued under Upper Watershed Alternative C that allow adjacent landowners access across Tacoma-owned lands, but as under Alternative B, public access would be restricted where possible,

and Tacoma Water would close roads to heavy truck traffic during wet periods when there would be a high risk of water quality impacts. It is also anticipated that under Upper Watershed Alternative C, more roads would be eligible for abandonment if Tacoma Water discontinues timber harvest than under Upper Watershed Alternative A; therefore, the road density would be expected to be lower than under Alternative A. However, road abandonment sometimes results in short-term increases in sediment inputs, and these short-term increases would be expected to exceed those associated with road abandonment under Alternative A.

4.3.3 Air Quality

The three potential sources of particulate air pollution associated with forest management activities are slash burning, wildfire, and road use.

All Upper Watershed Alternatives

Tacoma Water uses slash burning as part of its site preparation activities, usually by concentrating slash in piles and burning the piles (slash concentration burning) rather than by broadcast burning. As a result of state restrictions on burning pursuant to the Smoke Management Plan (Washington Department of Natural Resources 1995), most of Tacoma Water's slash concentration burning occurs during cooler, rainy conditions. This practice would continue in the same manner under Upper Watershed Alternatives A and B. Because PM_{10} (see Glossary) emissions are currently in compliance with the 31 December 2000 goals of the Smoke Management Plan, no impact to smoke-related PM_{10} levels would occur under either these alternatives. A beneficial effect on smoke-related PM_{10} levels would occur under Upper Watershed Alternative C because timber harvest activities, including the need for slash concentration burning, would be curtailed.

Wildfire is a stochastic event; it occurs irregularly and cannot be predicted. The risk of wildfire is generally low on Tacoma Water's forestlands due to their location in the valley bottom (Ryan, pers. comm., 29 June 1999), and is minimized to the extent possible by following the logging-related hazard reduction measures of the state Fire Protection Code (WAC 332-24). Management of Tacoma Water's forestlands to minimize the threat of wildfire would occur in a similar manner under all alternatives and, therefore, potential air quality impacts associated with wildfire would be minimized under all upper watershed alternatives.

Air quality impacts associated with road use is primarily related to the entrainment of dust into the air by vehicles traveling over unpaved roads[2]. In general, entrainment of dust is expected to be reduced under Upper Watershed Alternative B as compared to Alternative A due to improved road maintenance practices, and under Upper Watershed Alternative C due to reduced construction, maintenance, and use of roads for timber management purposes.

4.3.4 Surface Water Quality and Quantity

4.3.4.1 Upper Watershed Alternative A: No Action

Surface water quality protections provided under Upper Watershed Alternative A would be consistent with those provided under Tacoma Water's existing Forest Land Management Plan (Ryan 1996). The plan includes the designation of riparian buffers and road construction and maintenance protections (Tables 2-13a and 2-13b). Most of these measures exceed current Forest Practices Rules. These protections are intended to preserve wetland function, reduce fine sediment inputs to surface waters, and reduce water temperature increases attributable to decreased shading. In areas that have received Watershed Analysis prescriptions, additional protections would also be implemented.

Forest practices have the greatest potential to impact surface water quality by altering nutrient (nitrogen and phosphorus) concentrations, turbidity, temperature, and intragravel dissolved oxygen (Naiman et al. 1992). Under Upper Watershed Alternative A, timber management activities, including timber harvest, road maintenance, and road construction, could affect both water quantity and quality in the Action Area. Impacts associated with forest activities managed under the Forest Land Management Plan (Ryan 1996) are detailed below.

<u>Timber Harvest</u>

Timber harvest can affect the input of thermal energy, fine sediment, dissolved solids, fine particulate and dissolved organic matter, and nutrients to surface waters (Beschta et al. 1987; Swanson et al. 1982, 1987). Thermal energy inputs increase because of reduced shade and reduced buffering of microclimatic variations

[2] Much of this dust is not PM_{10} and is, therefore, not considered under Washington's SIP.

(Beschta et al. 1987; Brosofske et al. 1997), both of which may occur with reduced forest cover. Fine sediment inputs may increase because of soil disturbance associated with timber harvest and road construction and use (Everest et al. 1987; Swanson et al. 1987).

Dissolved solid, fine particulate and dissolved organic matter, and nutrient inputs may also increase because of increased microbiotic activity that reduces slash, downed wood, and soil organic matter on the site. This microbiotic activity frees nutrients and minerals for leaching and subsequent transport into ground and surface waters (Fredriksen et al. 1975; Gregory et al. 1987). Oxygen demand caused by inputs of fine particulate and dissolved organic matter may reduce dissolved oxygen concentrations in surface waters. Consequently, intragravel dissolved oxygen concentrations in redds may fall low enough to stress developing salmonid eggs and recently hatched fry (Hicks et al. 1991; Naiman et al. 1992). Broadcast burning and burning of landings or other slash concentrations accelerate the decomposition process by rapidly oxidizing organic material and freeing nutrients and minerals for leaching and transport (Feller and Kimmins 1984; Grier 1975; Knight 1966). Timber harvest may also trigger mass wasting, which may deliver fine sediment and dissolved solids to surface waters (Swanson et al. 1987). Finally, timber harvest reduces the ability of a forest stand to retain precipitation. This may cause abnormal increases in runoff, total annual streamflow, and seasonal variation in streamflow (Harr 1983; Harr et al. 1979; Hicks et al. 1991).

Under Upper Watershed Alternative A, Tacoma Water would continue to comply with its Forest Management Plan that maintains riparian functions, which in turn protects surface waters. Thermal energy inputs to surface waters would be mitigated by retaining trees in riparian buffers along Type 1, 2, and 3 waters and in buffers surrounding Type A, B, and C wetlands (Tables 2-13a and 2-13b). The width of these buffer zones would vary from 25 to 200 feet, depending on the type classification of the stream or wetland. A reduction in thermal inputs to streams and wetlands would maintain water temperatures and dissolved oxygen concentrations. The filtering action of these forested buffers would also reduce the transport of fine sediment, nutrients, and dissolved solids from harvested areas to surface waters. Reducing sediment inputs would result in a decreased frequency and duration of high turbidity, and would reduce the amount of fine sediment deposited in pools and substrate interstices. Filtering of nutrients such as nitrogen and phosphorus could alter primary productivity, although few studies have documented substantial changes in productivity as a result of forest management activities (MacDonald et al. 1991).

Forest Roads

Roads primarily affect water quality by delivering fine sediment and dissolved solids to surface waters and by altering the flow paths and rate of runoff from precipitation and snowmelt (Swanson et al. 1987). Fine sediment and dissolved solids are delivered to surface waters as a result of runoff from road surfaces, failure of road segments or stream-crossing structures, and drainage extensions by road systems (Bilby et al. 1989; Reid and Dunne 1984; Sidle et al. 1985). In each case, material inputs may increase turbidity and suspended solid levels in streams and impair beneficial use of surface waters by altering stream clarity and chemical composition.

Sediment delivery due to runoff from road surfaces is influenced by the method of road construction, the intensity and timing of road use, and characteristics of the pathway linking the road to a surface water (Bilby et al. 1989; Packer 1967; Sidle et al. 1985). For example, delivery would be greatest if a road is surfaced with dirt, is heavily used during the rainy season, and is linked to a stream by a drainage ditch.

Sediment delivery due to failure of road segments or stream-crossing structures is influenced by road location, road construction method, and the design and capacity of stream-crossing structures (Bilby et al. 1989; Sidle et al. 1985). For example, delivery would be greatest if a road crosses a potentially ~~unstable soils~~ unstable slope near a stream, or if a bridge or culvert are too small to accommodate a severe (50-year or 100-year) flood.

Sediment delivery due to drainage extension may occur when the road surface and any associated ditch intercepts surface or subsurface flow and acts as a stream channel during precipitation events typically associated with 2- to 10-year recurrence interval floods. Water flows to existing stream channels more rapidly, and has greater capacity to transport sediment into those channels because of the road system. This commonly occurs in drainages where roads account for more than 8 percent of the watershed area. Drainage extension due to roading also increases the rate of runoff. This may cause larger peak flows in streams with shorter flood duration compared to drainages that do not contain road networks (King and Tennyson 1984; Megahan 1972; Montgomery 1994).

Under Upper Watershed Alternative A, Tacoma Water would implement measures to minimize sediment delivery associated with forest roads systems as required by Watershed Analysis prescriptions. Those prescriptions require that sediment inputs be reduced to less than 50 percent of the estimated background sediment delivery rate within 5 years. Tacoma Water would abandon road systems no longer needed for watershed management or forestry operations. Tacoma Water-controlled roads that present a potential impact to water quality would be closed to heavy truck traffic. No new roads would be constructed during wet weather across landforms identified as unstable through Watershed Analysis. Tacoma Water would work with other landowners to develop site-specific measures for roads to minimize impacts at stream crossings. Reducing road-related sediment inputs to less than 50 percent of background is expected to decrease the amount of sediment stored in pools and substrate interstices in upper watershed channels.

4.3.4.2 Upper Watershed Alternative B: Proposed Action

Under Upper Watershed Alternative B, Tacoma Water would implement watershed protection measures that would not occur under Upper Watershed Alternative A (Section 2.0, Alternatives). Compared to Upper Watershed Alternative A, protections implemented under Upper Watershed Alternative B would: 1) reduce the amount of sediment delivered to streams, and 2) reduce variability in streamflow and water quality, most notably turbidity, total dissolved solids, and nutrient levels.

Management measures developed in completed Watershed Analyses covering Tacoma-owned watershed land would be implemented as described for Upper Watershed Alternative A. These measures would specifically address those factors that degrade surface waters and exceed Tacoma Water's Forest Management Plan protections to reduce fine sediment inputs to streams. Such measures would improve water quality by reducing turbidity, total dissolved solids, and nutrient levels.

Under Upper Watershed Alternative B, Tacoma Water would participate in the development of a Road Hazard Reduction Plan, describing road maintenance, improvement, and abandonment activities that would be implemented to reduce road sediment inputs to streams. Tacoma Water would prepare plans to abandon unnecessary roads within 2 years and would prioritize the schedule for abandonment. Unnecessary roads identified in the plan would be abandoned by HCP Year 5 following ITP issuance.

Gravel surfacing would be maintained on all mainline, primary, and secondary roads managed by Tacoma Water. New road construction across potentially unstable landforms identified through Watershed Analysis would comply with all prescriptions, restrictions, or recommendations developed through site-specific evaluation. The net effect of these provisions, relative to Upper Watershed Alternative A, would be to reduce sediment and dissolved solid delivery to streams resulting from road runoff or bridge or culvert failure. Such measures would enhance water quality by reducing turbidity and total dissolved solid levels in streams as compared to Upper Watershed Alternative A.

4.3.4.3 Upper Watershed Alternative C: No Commercial Timber Harvest

Under Upper Watershed Alternative C, water quality conditions would be improved compared to conditions under Alternative A. Sediment inputs to streams under Alternative C would be less relative to Alternative B because no commercial harvesting would occur in the upper watershed, no new roads would be constructed, and traffic on existing roads would be reduced. In addition, abnormal increases in runoff, total annual streamflow, and seasonal streamflow variation would decrease because of the overall increased hydrologic maturity (i.e., increased acreage of mature timber stands across the landscape) provided under Alternative C as compared to Alternative A.

4.3.5 Vegetation

4.3.5.1 Background

The occurrence of a plant species or association of plant species is controlled by many factors, including habitat type, condition of habitat, moisture regime, soil conditions, elevation, level of exposure (sun, wind), and competition with other species, including non-native species. The three alternatives for managing the upper watershed Action Area would impact vegetation primarily by altering the total area and spatial distribution of forested and shrub habitat types within the Action Area through harvest management, road construction, and road abandonment. Management practices may affect various habitat types by: 1) altering the size, age, and distribution of forested stands, 2) altering conditions within shrub-dominated communities, wetlands, and meadows, or 3) converting roadbeds to native plant communities.

4.3.5.2 Upper Watershed Alternative A: No Action

Management of Tacoma's lands in the upper watershed under Upper Watershed Alternative A would provide considerable protection for existing plant communities. The upper watershed is closed to the public to protect the water supply for public consumption. This practice limits human impact on plant communities to harvest practices and road management prescriptions primarily contained in the Forest Land Management Plan (Ryan 1996) and agreements the City of Tacoma has with the Muckleshoot Indian Tribe.

Within all of Tacoma's lands, no-cut buffers are provided along streams and wetlands that meet or exceed Forest Practices Rules requirements. This would provide protection for the most suitable habitat within the Action Area that could support the several plant species of special interest (tall bugbane, water lobelia, Choris' bog orchid) described in subsection 3.6.4, Plant Species of Special Interest.

Thirty-nine percent of Tacoma lands in the upper watershed Action Area are designated to Natural Zone management. Only limited harvest for habitat improvement and salvage are allowed in the Natural Zone. Thirty-five percent of Tacoma's lands in the upper watershed occur within Tacoma's Conservation Zone. No even-aged harvesting would be allowed in conifer-dominated stands, and only salvage harvest would occur in conifer-dominated stands over 100 years old. Therefore, no harvest or limited tree removal for habitat improvement or salvage would occur on 74 percent of Tacoma's forested lands in the upper watershed, which would allow for the development of mature and old-growth stands of timber on approximately 7,812 acres. The remaining 3,218 acres in the Natural and Conservation Zones are non-forested (e.g., rock, water, powerline right-of-way and meadow) and will never develop into forest even under protective management.

Twenty-six percent of Tacoma's lands in the upper watershed are managed as Commercial Zone timber. Forest stands in the Commercial Zone would be managed on 70-year, even-aged rotation with no more than 40 acres harvested per year, and efforts would be made to convert hardwood stands to conifer on suitable growing sites. This would reduce the deciduous tree component of the forest stands in the Commercial Zone and establish Douglas-fir as the primary conifer species in the Commercial Zone.

Most of the state- and federal-listed plant species that could potentially occur within the Action Area are associated with unique habitats, primarily wetland, riparian areas, and lakeshore areas (tall bugbane, water lobelia, and choris' bog orchid) and/or in forested habitats (tall bugbane, stalked moonwort) (Table 3-4). Therefore, these species would receive protection from the land management practices provided under Tacoma's Forest Land Management Plan that meet or exceed Forest Practices Rules.

4.3.5.3 Upper Watershed Alternative B: Proposed Action

Plant communities occurring on unstable landforms would receive more protection under this alternative than under Upper Watershed Alternative A. Roads would be abandoned at a more accelerated schedule than under Upper Watershed Alternative A, allowing conversion of these areas to native plant communities sooner. Wetland and riparian plant communities would also have reduced probability of being impacted by sediment input from unstable landforms and roads. Riparian and wetland plant communities would also benefit from the HCP measures that would be implemented in riparian areas (Habitat Conservation Measure 3-03) in selected areas of the lower, middle, and upper watershed as described in subsection 2.2.3, Water Withdrawal Alternative B (Habitat Conservation Measures 2-03, 2-07, and 2-10) as well as the wildlife Habitat Conservation Measures.

4.3.5.4 Upper Watershed Alternative C: No Commercial Timber Harvest

There would be no alteration of plant communities due to timber harvest under this alternative as no commercial harvest would be conducted under Alternative C. Salvage harvesting would only be conducted under this alternative to maintain safety along roads in the watershed. Roads would be abandoned, and potential reduction of sediment input to streams and wetlands would be the same as proposed under Alternative B. Returning sediment inputs to levels that more closely approximate those of an unmanaged forest would reduce the risk that excess sediments would accumulate on aquatic habitats and wetlands. Overall, the existing plant communities on all Tacoma-owned lands would be unaltered and would provide protection for all of the sensitive plant species that could occur on these lands (Table 3-4). Because no harvest would occur under Upper Watershed Alternative C, all plant communities would be provided more protection than under Upper Watershed Alternative A.

4.3.6 Fish and Aquatic Habitat

The effects of each upper watershed alternative on fish habitat in the Upper Green River Watershed would occur primarily as the result of forest management activities associated with timber harvesting; road use, maintenance and construction; the failure of either culverts, bridges, or ~~unstable soils~~ unstable slopes as a result of past or future road construction and maintenance; and from public recreational use in the unrestricted portions of the entire watershed. Forest management activities within the Action Area may influence: 1) the quality and quantity of available habitat and habitat features, 2) passage of fish up and downstream, 3) biological productivity of aquatic habitat, and 4) fish reproductive success. These effects may occur as the result of :

- increased delivery of sediment to stream channels;
- increased stream temperatures;
- barriers associated with forest road crossings;
- alteration of peak flows or summer low flows;
- alteration of stream bed or bank stability;
- changes in the distribution, frequency or input rate of special habitat features (e.g., pools, substrate characteristics, LWD, nutrients, shade);
- alteration of water quality; and
- interruption of food chain support from forest stands adjacent to the stream channel.

Such watershed disturbances can affect fish production by: 1) reducing embryo survival and fry emergence due to excessive fine sediment in spawning gravels (McNeill and Ahnell 1964; Koski 1966; Bjornn 1969; Hall and Lantz 1969; Koski 1975; Tappel and Bjornn 1983; Chapman 1988), 2) reducing the carrying capacity of streams for juvenile salmonids during the summer by reducing the volume of pools due to deposition of fine or coarse sediment (Bjornn et al. 1977; Platts et al. 1989), 3) reducing the amount or quality of habitat available to overwintering fish by filling interstitial spaces with sediment, (Bjornn et al. 1977), 4) preventing access to off-channel or tributary habitat (Lister and Finnegan 1997) and by reducing the number of pools with abundant LWD cover (Bisson et al. 1987) used by many salmonids for winter rearing, and 4) elevating temperatures to levels that stress or kill juvenile fish or cause adult fish to avoid spawning areas by reducing the amount of shade provided by riparian stands (Holtby 1988; Beschta et

al. 1987). The potential effects on fish habitat and fish species are discussed separately for each upper watershed alternative in the following sections.

4.3.6.1 Upper Watershed Alternative A: No Action

<u>Effects on Fish Habitat</u>

Under Upper Watershed Alternative A, Tacoma Water would continue management of upper watershed Tacoma-owned lands according to its existing Forest Land Management Plan (Ryan 1996), agreements with the Muckleshoot Indian Tribe, participation in and implementation of Watershed Analyses prescriptions, and Forest Practices Rules where those rules exceed protection provided by the Forest Land Management Plan or MIT/TPU Agreement. The objective of Tacoma land management in the upper watershed is to protect water quality for municipal use, and this objective is generally complementary with protection of fish and wildlife habitat.

Erosion and Sedimentation

Forest management activities, including logging and road building, can increase sediment production in managed watersheds as compared to natural levels of hillslope erosion and mass wasting (Swanston and Swanson 1976). As described in subsection 4.3.2, Geology and Soils, sediment delivery associated with management-related mass wasting and surface erosion would be expected to drop below levels experienced in recent decades as a result of implementation of prescriptions developed through Watershed Analysis, although improvements could occur slowly. Bank stability would remain a concern on smaller fish-bearing (Type 3) and non-fish-bearing (Type 4 and 5) streams, but would be adequately protected on Type 1 and 2 streams (subsection 4.3.2, Geology and Soils). Over time, reducing management-related sediment inputs would be expected to benefit fish by reducing substrate embeddedness and the amount of fine sediment (less than 0.85 mm) in spawning gravels, particularly in low to moderate gradient channels.

Woody Debris

Woody debris has important biological and physical functions in fish-bearing streams. Large pieces of wood form pools, retain sediment and organic matter, provide shelter from predators and peak stream flows, and influence channel structure, including the development of side channels (Sedell and Swanson 1984; Bisson et al. 1987; Beschta 1991) (subsection 3.8.2.2, Current Fish Habitat Conditions). Both large and small woody debris modify water quality and serve as a food source for macroinvertebrates (Bilby and Likens 1980). Conifers are the most important source of LWD to streams, as they are generally larger and decay more slowly than hardwoods, thus remaining functional for a longer period of time (Harmon et al. 1976).

Buffers of at least 100 feet are generally required to provide adequate LWD recruitment to stream channels. Andrus and Lorenson (1992) found that approximately 90 percent of LWD originates from within 66 feet of the stream. McDade et al. (1990) found that in mature conifer forests, 50 percent of LWD recruitment originated from within 33 feet of the stream bank, and over 90 percent of LWD originated from within 100 feet of the streambank. In stream reaches where mass wasting is not a primary geomorphic process, virtually all of the LWD supplied to the stream enters from within one site-potential tree-height of the CMZ, or is transported in from upstream reaches (Spence et al. 1996). However, in landscapes such as the upper watershed, where mass wasting is an important geomorphic process, landslides may also carry substantial amounts of LWD to stream channels (Spence et al. 1996).

Under Tacoma's existing Forest Land Management Plan (Ryan 1996) and the MIT/TPU Agreement, no-harvest riparian buffers along fish-bearing streams would range from 50 to 200 feet in width (Tables 2-13a and 2-13b). Harvest could, therefore, occur within the area known to supply the majority of LWD to stream channels, reducing LWD recruitment levels to below that expected in an unmanaged forest. Mass wasting prescriptions developed through Watershed Analysis generally require leaving trees on potentially ~~unstable soils~~ unstable slopes, and these or comparable prescriptions would be applied on a watershed wide-basis since they become state regulations when approved by the DNR. For this reason, landslides that do occur under Upper Watershed Alternative A would be expected to supply more LWD to channels than comparable failures have over the past few decades. In addition, Tacoma's Forest Land Management Plan and the MIT/TPU Agreement require 25-to 50-foot no-harvest buffers on non-fish-

bearing streams, which should increase the amount of LWD available for transport downstream during floods or debris flows.

Surveys conducted by the USFS and for Watershed Analysis indicate that both instream levels of LWD and pool frequencies are currently low in many reaches (U.S. Forest Service 1996; Plum Creek Timber Company 1996a-Section 4F; Plum Creek Timber Company 1997-Section 4F). Although the majority of riparian stands in the Action Area are more than 50 years old (Table 3-3) and are approaching the age at which they will begin to supply functional LWD, near-term recruitment is considered low in many other parts of the upper watershed (e.g., Plum Creek Timber Company 1997-Section 4D). Under Upper Watershed Alternative A, the amount of in-channel LWD is expected to slowly increase over the long-term; however, near-term decreases of in-channel LWD could occur as material currently within the channel decays.

As the amount of in-channel LWD increases, the number and quality of pools and refuge sites is expected to increase in all channel types, and the amount of gravel suitable for spawning is expected to increase, particularly in moderate-to high-gradient channels.

Nutrients/Litter Input

Low primary and secondary productivity in streams can limit salmonid production (Martin 1985). Leaves, needles, twigs, and other small woody debris originating from trees in the riparian zone contribute much of the organic matter that is available for processing by primary producers in forested headwater streams (Sedell et al. 1974). Fish populations are supported by both aquatic insects that feed directly on organic particulate mater (Murphy and Meehan 1991) as well as terrestrial invertebrates that fall into the stream from overhanging branches. Although there are few studies examining litter fall contributions as a function of distance from the stream, the U.S. Forest Service and U.S. Bureau of Land Management (1994) suggest that particulate organic matter contribution declines rapidly at distances greater than one-half tree height from the channel.

Upper Watershed Alternative A could result in timber harvesting within less than one-half tree height of small, Type 3 fish-bearing waters. These impacts are not expected to cause direct mortality of fish, but could impact long-term productivity.

Shade

Water temperature can be influenced by the amount of solar radiation reaching the stream (Beschta et al. 1987; Sullivan et al. 1990) (subsection 3.8.2.2, Current Fish Habitat Conditions). Riparian canopy cover can intercept much of this energy, resulting in lower average stream temperatures and smaller diel fluctuations as compared with a fully exposed stream channel (Beschta et al. 1987; Holtby 1988; Hall and Lantz 1969). The U.S. Forest Service and U.S. Bureau of Land Management (1994) note that in the Oregon Coast Range and western Cascades, riparian buffers of 100 feet or more may provide as much shade as an undisturbed, late-successional/old-growth forest.

Maintenance of cool water temperatures is important in both fish-bearing (Type 1, 2, and 3) and non-fish-bearing (Type 4 and 5) streams. In general, salmonids prefer temperatures between 50°F to 57°F (10°C to 14°C) during the summer rearing period (Bjornn and Reiser 1991). Stream temperatures exceeding 66°F (19°C) have been reported to slow the metabolism of salmonid fishes and affect their growth (Hickman and Raleigh 1982; Bell 1991). Upper lethal temperatures are around 73°F (23°C) to 79°F (26°C) depending on the species and acclimation temperatures (U.S. Environmental Protection Agency 1986; Bjornn and Reiser 1991). Fish may be able to tolerate higher temperatures for short-periods or to find refuge from elevated temperatures within cooler sites in the stream such as deep pools or areas of upwelling groundwater (Nielsen and Lisle 1994; Murphy 1995).

The primary concern related to temperature occurs during the summer months when young fish are rearing (Hicks et al. 1991). Within the Action Area, water temperatures typically do not reach limits that would stress or be lethal to anadromous salmonids. The highest temperature recorded at a variety of sites over 20 years of annual monitoring (1965 to 1995) during the month of August was 67°F (19°C) in the North Fork Green River; most of the high temperatures recorded at other sites in the upper watershed were around 62°F to 63°F (U.S. Forest Service 1996). More recently, maximum temperatures as high as 65°F

(18.3°C) were measured in tributaries in the Upper Green-Sunday WAU between 1990 and 1995 (Plum Creek Timber Company 1997-Section 4G); however, most of the maximum temperatures in that data set were less than or equal to 61°F (16°C).

Instream temperatures in forestlands in western Washington undergo daily fluctuations, occasionally peaking for 2 or 3 hours at temperatures above the optimal range for anadromous salmonids. During these times, fish may seek out areas of thermal refugia (i.e., isolated cold water pockets in deep pools, upwelling groundwater, or cool incoming tributaries) where they hold until the stream cools.

Under Upper Watershed Alternative A, harvest of trees from the riparian areas around smaller fish-bearing (Type 3) and non-fish-bearing (Type 4 and 5) could affect stream temperatures. However, all streams would be protected by no-harvest riparian buffers at least 25 feet wide, thus effects of temperature increases are expected to be small.

<u>Effects on Fish Species</u>

Salmon, Steelhead, and Coastal Cutthroat Trout

Chinook salmon, coho salmon, and steelhead trout juveniles have been planted in the Upper Green River Watershed by the Muckleshoot Indian Tribe and WDFW. In 1998, the Tribe planted a total of 582,000 coho salmon juveniles in tributaries of the upper watershed during the first week of May, a total of 555,000 chinook in tributaries of the upper watershed in mid-March, and a total of 40,000 steelhead trout juveniles in the upper watershed during the first half of August (Hickey, pers. comm., 8 July 1999). Juvenile salmon would be expected to be found primarily in the tributaries where they are planted, as well as in the mainstem river. Adult steelhead have been trapped at Tacoma Water's Headworks since 1992 using a temporary trap-and-haul facility. Between 7 and 130 steelhead have been trapped each year to date, with native adults released into the upper watershed (HCP subsection 7.7.1). At least some of these adults likely attempt to spawn in the mainstem Green River and its tributaries. Resident cutthroat trout are presently found in mainstem sections and most tributaries of the Upper Green River Watershed (U.S. Forest Service 1996).

Salmon and trout spawn in stream sections containing cool, clean water with relatively clean spawning substrates. Chinook salmon fry, juvenile coho salmon, and juvenile and adult cutthroat trout prefer to rear in slow-moving backwater areas with abundant cover, including LWD and bank cover, and deep pools. Steelhead trout prefer to rear in fast riffle and run that possess abundant habitat cover, including large cobbles and boulders, LWD, or deep pools. Continuation of Tacoma's watershed management measures under its existing Forest Land Management Plan (Ryan 1996), as provided under Upper Watershed Alternative A, would be expected to maintain and improve rearing habitat for juvenile chinook salmon, coho salmon, and steelhead trout, and spawning habitat for all resident salmonid species including cutthroat trout.

Mass wasting prescriptions provided under Upper Watershed Alternative A are expected to reduce the frequency of landslides that deliver sediment and initiate dam break floods. Management-related contributions of fine sediment would be reduced to less than 50 percent over background under the Road Sediment Reduction Plan. These measures are expected to result in a decrease in embeddedness, which will be especially beneficial to species such as steelhead and cutthroat trout that overwinter in interstitial spaces.

Bull Trout/Dolly Varden

Bull trout/Dolly Varden occupy a variety of habitat types during their life, but typically are found in cool headwater streams associated with pools and LWD structure (subsection 3.8.1.2, Proposed and Candidate Species for Federal Listing). Young-of-the-year are primarily bottom dwellers in shallow, slow backwater areas with LWD (Shepard et al. 1984; Elliot 1986). Juvenile bull trout/Dolly Varden move to deep and fast water, such as runs and mainstream pools, but are typically associated with obstructive debris (McPhail and Murray 1979). Adults show a strong preference for deep, cold pools (Moyle 1976) and are seldom found in streams with temperatures exceeding 64°F (18°C) to 68°F (20°C) (Allan 1980; Shepard et al. 1984; Buchanan and Gregory 1997). Bull trout/Dolly Varden, if present in the upper Green River, are likely to be found in the upper reaches of tributaries, or in those dominated by cool groundwater inflows, since they prefer cold water temperatures.

Under Upper Watershed Alternative A, Tacoma's watershed management activities in the upper Green River would impact bull trout/Dolly Varden (if present) spawning in ways similar to chinook salmon, since both species are fall spawners. Continuation of Tacoma's watershed management measures under its existing Forest Land Management Plan (Ryan 1996) would have a positive effect on bull trout/Dolly Varden spawning and incubation in the upper Action Area. Implementation of mass wasting prescriptions and the Road Sediment Reduction Plan developed through Watershed Analysis is expected to reduce management-related contributions of fine sediment to less than 50 percent over background. This may result in a decrease in the proportion of fine sediment contained by spawning gravels and could result in increased survival to emergence.

Reestablishment of riparian forest dominated by coniferous trees greater than 50 years old in no-harvest buffers ranging from 50 to 200 feet in width (Tables 2-13a and 2-13b) would result in a gradual increase in the recruitment of LWD to approximately 30 to 100 percent of the expected recruitment from stream-adjacent stands under natural conditions (This assumes that LWD recruitment is proportional to the percent of the site potential tree height represented by the width of the buffer. On the west side, the maximum site potential tree height is 200 feet).

4.3.6.2 Upper Watershed Alternative B: Proposed Action

<u>Effects on Fish Habitat</u>

Forest management activities in the Action Area under Upper Watershed Alternative B would be similar to those described for Upper Watershed Alternative A. Prescriptions to reduce mass wasting and surface erosion would be developed through Watershed Analysis. Riparian buffers would be larger than those required by the Forest Land Management Plan, MIT/TPU Agreement, or State Forest Practices Rules.

Erosion and Sedimentation

Prescriptions developed through Watershed Analysis, which were designed to reduce erosion and sedimentation, would be implemented as under Upper Watershed Alternative A. However, under Upper

Watershed Alternative B, Tacoma Water would make a commitment to complete Watershed Analysis-type assessments of mass wasting and surface erosion on the remaining lands within the Action Area owned by Tacoma Water in the unlikely event that draft Watershed Analysis Prescriptions and Assessment Reports are not available for all WAUs in the upper watershed within 2 years of ITP issuance. In addition, Tacoma Water would complete an ownership-wide inventory of fish passage barriers, and treat sites as required within 5 years of issuance of the ITP.

The effects of implementing Upper Watershed Alternative B would be similar to those described for Upper Watershed Alternative A; over time, sediment delivery associated with management-related mass wasting and surface erosion would be expected to drop below levels experienced in recent decades. Reductions in sediment delivery over time would be expected to benefit salmon and steelhead by reducing substrate embeddedness and the amount of fine sediment in spawning gravels, particularly in low to moderate gradient channels.

Woody Debris

Riparian buffers provided under Upper Watershed Alternative B would be substantially larger than those provided under Upper Watershed Alternative A. The width of no-harvest riparian buffer strips would increase to 200 feet on all Type 1 and 2 streams, and would more than double on Type 3 streams (Tables 2-13a and 2-13b). In addition, an outer 50-foot partial-harvest buffer would be applied to Type 3 streams, bringing the total buffer width to 200 feet on all fish-bearing streams. All Type 4 streams would be protected by at least a 50-foot no-harvest buffer, and up to a 100-foot no-harvest buffer around special habitats such as headwalls, confluences, and springs and seeps (Tables 2-13a and 2-13b). A partial-harvest buffer of 25 feet would be left in addition to the 25 foot no-harvest buffer adjacent to Type 5 streams (Tables 2-13a and 2-13b).

The net result of the increased buffer widths as compared to Upper Watershed Alternative A would be to increase LWD recruitment, particularly in Type 3 streams. Over the long term, Upper Watershed Alternative B would be expected to result in greater improvements in the quantity and quality of pools in all channel types, as well as increase the amount of available spawning habitat in moderate-to-high gradient streams as compared to Upper Watershed Alternative A.

Nutrients/Litter Inputs

Under Upper Watershed Alternative B, the larger riparian buffers would be expected to provide greater amounts of organic material to streams as the vegetation matures compared to Upper Watershed Alternative A. Litter fall would increase in both fish-bearing and non-fish-bearing streams, particularly the smaller Type 3 and Type 5 streams, which export organic matter to downstream reaches. Increased direct litter fall and organic matter inputs from upstream would improve productivity in all streams in the Action Area, particularly small fish-bearing waters.

Shade

Upper Watershed Alternative B would provide more riparian shade along small Type 3 streams and non-fish-bearing tributaries over the long term compared to Upper Watershed Alternative A. No-harvest buffer widths along fish-bearing streams would be at least 150 feet wide, sufficient to provide the 60 to 80 percent shade believed necessary to maintain water temperature (Knutsen and Neef 1997). Increasing buffers along non-fish-bearing Type 4 and 5 streams to at least 50 feet would further moderate temperatures ensuring that such streams do not contribute warm water to downstream channels that contain fish. In addition, source areas such as springs, seeps, and perennial stream sources would receive wider buffers, providing additional thermal protection to groundwater inflows. This would improve habitat suitability for salmonid fishes relative to conditions under Upper Watershed Alternative A.

<u>Effects on Fish Species</u>

Salmon, Steelhead, and Coastal Cutthroat Trout

Reestablishment of riparian forests dominated by coniferous trees greater than 50 years old under Upper Watershed Alternative B would result in a gradual increase in the recruitment of LWD compared to that occurring under Upper Watershed Alternative A (Tables 2-13a and 2-13b). As in-channel LWD increases, the frequency of pools would also be expected to increase. Pool cover would improve as a result of the additional LWD. The net result would be an increase in the quality and quantity of pool habitat available for juvenile steelhead, juvenile coho salmon, and juvenile and adult cutthroat trout for summer

rearing and winter refuge habitat. As riparian stands mature, the number of large conifers capable of acting as barrier trees during dam-break floods would increase. The increased abundance of barrier trees, combined with the decreased frequency of mass wasting would be expected to reduce the risk of dam-break floods that can kill or injure juvenile salmonids overwintering in the substrate.

Under Upper Watershed Alternative B, stream crossing culverts on Tacoma-owned lands would be inventoried and repaired or replaced as required within 5 years of issuance of the ITP. Stream crossings would be maintained in passable condition for the duration of the ITP. This measure would increase the amount of tributary and off-channel habitat that is accessible to steelhead for use as off-channel rearing habitat, although steelhead are less likely than salmon to utilize such habitat. The magnitude of that increase cannot be estimated until the inventory is complete. These activities would not be conducted under Upper Watershed Alternative A.

Bull Trout/Dolly Varden

The benefits to spawning and rearing habitat described for steelhead and cutthroat trout that would occur under Upper Watershed Alternative B compared to Upper Watershed Alternative A would also apply to bull trout/Dolly Varden. Particular benefits would result from those measures that increase the amount of tributary and off-channel rearing habitat, which are important for maintaining the interconnection among isolated populations of resident and fluvial bull trout/Dolly Varden.

Under Upper Watershed Alternative B, reestablishment of riparian forests dominated by coniferous trees greater than 50 years old in buffers where the width would equal or exceed one site potential tree height would result in a gradual increase in the recruitment of LWD to levels that approximate the expected recruitment from stream-adjacent stands under natural conditions (Tables 2-13a and 2-13b). In addition, the increased abundance of late-seral stands is expected to ensure that at least some of the LWD that enters the stream system is large enough to function as key pieces, which are especially important for forming stable flow obstructions in larger channels. The net result should be an increase in in-channel LWD and an associated increase in the availability of spawning gravel compared to Upper Watershed Alternative

A. Bull trout/Dolly Varden would benefit from increased spawning gravel availability in moderate to high gradient tributary streams.

4.3.6.3 Alternative C: No Commercial Timber Harvest

Effects on Fish Habitat

Since no timber harvest would be conducted under Upper Watershed Alternative C, Tacoma Water's management activities would not adversely affect aquatic habitat in the Action Area. Tacoma Water would continue to participate in Watershed Analysis and cooperative road management, thereby helping to reduce road-related sediment inputs.

Riparian functions such as LWD recruitment, litter fall and nutrient inputs, and shade would slowly recover to levels found in late-successional and old-growth stands. Over time, habitat in channels bordered by lands owned by Tacoma Water might be expected to achieve the range of conditions commonly observed in old-growth forests. However, forest management, transportation, and recreational activities on other ownerships would continue to influence habitats within the Action Area, which could preclude complete recovery of aquatic habitats.

Effects on Fish Species

Salmon, Steelhead, and Coastal Cutthroat Trout

Those benefits described for anadromous and resident fish species under Upper Watershed Alternative B, including improved spawning and rearing habitat; improved access to tributaries and side channels; and decreased risks of mass wasting, sediment impacts, and flooding, would increase under Upper Watershed Alternative C. However, the improvements to fish habitat conditions and production realized in those lowland areas owned by Tacoma Water under Upper Watershed Alternative C could be constrained by forest management activities conducted by other public and private landowners located upstream of Tacoma's holdings.

Bull Trout/Dolly Varden

Upper Watershed Alternative C would provide habitat conditions closer to optimal for bull trout/Dolly Varden compared to Upper Watershed Alternative A. Bull trout/Dolly Varden require cold water and near-pristine habitat conditions, which would ultimately be provided by the mature forest habitat conditions under Upper Watershed Alternative C (Table 2-12). The quality of aquatic habitat within Tacoma's predominantly lowland holding would remain potentially limited by the land-management activities (including logging) of upstream landowners.

4.3.7 Wildlife

The following analysis addresses the effects of Upper Watershed Alternatives on wildlife in and around the Action Area. Effects will be limited, for the most part, to wildlife habitats and species within the upper watershed. Some effects, such as improvements to anadromous fish habitat that would result from improved riparian management and Watershed Analysis, may have benefits or impacts beyond the upper watershed, and these are noted where appropriate in the following discussion. All 21 wildlife species proposed for coverage under the HCP are included in this analysis.

4.3.7.1 Upper Watershed Alternative A: No Action

<u>Effects on Wildlife Habitats</u>

Under this alternative, Tacoma Water would continue to manage its lands in the Upper Green River Watershed according to the Forest Land Management Plan initially developed in 1996 (Ryan 1996). This plan takes a conservative approach to forest land management, placing primary emphasis on water quality and habitat for fish and wildlife, and secondary emphasis on commercial timber harvest. The overall effects of continued management under the Forest Land Management Plan on wildlife habitat would be:

- an increase in the total acreage of coniferous forest over 100 years old;

- an increase in the average age of all coniferous forest;

- a decrease in the total acreage of hardwood forest, and corresponding increase in the total acreage of coniferous forest;
- an increase in the number of residual live trees, snags, and logs within coniferous forest;
- development and maintenance of mature forest conditions along all streams and around all wetlands in the Action Area; and

- more than 11,000 acres of forest maintained with little or no disturbance (i.e., limited or no commercial timber harvest) in the Natural Zone, Conservation Zone, Upland Management Areas (UMAs) of the Commercial Zone, and riparian buffers of the Commercial Zone.

Trends in habitat over the next 50 years (i.e., the term of the ITP) would be similar to those described for Tacoma Water's proposed HCP, as illustrated in HCP Figures A, B, C, E, G, and I, Chapter 7. Species that inhabit mature coniferous forest (over 100 years old) would experience an increase in habitat of more than 10-fold over the next 50 years. Species that utilize residual live trees and/or snags within coniferous forest would have habitat availability on nearly all forested acres in the Action Area by the end of 50 years. Habitat for riparian species would improve continuously as forest in riparian areas matured. Species associated with hardwood forest would see a decrease in the total area of available habitat, but this type of habitat would persist in areas where it occurs naturally (e.g., UMAs and areas of frequent disturbance along streams). Species associated with forest edges would also see a decrease in total habitat, but edges would continue to be created on a sustainable basis within the managed uplands of the Commercial Zone. It is not anticipated that hardwood forest or edge habitat would become limiting within the Action Area or the Upper Green River Watershed as a whole.

Effects on Wildlife Populations

Continued management of Tacoma Water forestlands under Upper Watershed Alternative A would cause minimal disturbance to wildlife populations in and near the Action Area. Commercial timber harvest and

road use would continue, but restrictions would be placed on potentially disruptive activities near the nests or dens of federally listed species consistent with current Forest Practices Rules. The only listed species currently known to occur near Tacoma Water lands in the upper watershed is the northern spotted owl (see discussion below), but other listed species could occur in the area in the future, and these would be similarly protected, although Tacoma Water would not take specific measures to create or enhance habitat for these species.

Unlisted species would be periodically disrupted and/or displaced by timber harvest activities under Upper Watershed Alternative A, but the low rate of timber harvest (Table 2-12) and long rotation (70 years) would minimize disturbance impacts. Species with low mobility, such as small mammals and amphibians, could be crushed during timber harvest operations, but again this impact would be minimized by the extensive system of reserves and riparian buffers, and the low overall rate of harvest. No wildlife species would be extirpated from Tacoma Water lands under Upper Watershed Alternative A, and no species would experience a substantial decrease in local population.

<u>Effects on Wildlife Species of Special Interest</u>

Federally Listed Species

Gray Wolf *(Canis lupus)*

Upper Watershed Alternative A would have little or no effect on the gray wolf. Like the grizzly bear, the gray wolf is extremely rare in the Green River Watershed. It is unlikely that Tacoma Water would encounter it during watershed management activities. Deer and elk are favored prey of the gray wolf, and these ungulates would benefit from the protection of mature forest in the Natural Zone and Conservation Zone and long rotations in the Commercial Zone. Restrictions on public access in the watershed would also improve habitat conditions for this elusive species, but it is unlikely these habitats would ever be used. In the unlikely event that the species dens on Tacoma-owned land in the future, Tacoma Water would be restricted by the federal ESA and Washington Forest Practices Rules from conducting certain activities near active gray wolf dens in the watershed.

Peregrine Falcon *(Falco peregrinus)*

The peregrine falcon would not be affected by Upper Watershed Alternative A. The species currently does not nest in the Action Area, and any future nests would be protected from disturbance under the federal ESA and current Washington Forest Practices Rules. Hunting by peregrine falcons nesting outside the Action Area, which could occur occasionally over Howard Hanson Reservoir, would not be affected by Tacoma Water activities under this alternative. No potentially suitable nesting habitat (i.e., cliffs) or hunting habitat (e.g., lakes and wetlands) would be altered under this alternative. Human disturbance to nesting peregrine falcons would be limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed.

Bald Eagle *(Haliaeetus leucocephalus)*

Upper Watershed Alternative A would have positive effects on the bald eagle. While there is currently no known nesting or winter roosting by bald eagles in the upper Action Area, the potential for nesting in the future would increase. Mature forest that would develop and be retained in the Natural Zone, Conservation Zone, and riparian buffers of the Commercial Zone, would provide opportunities for both bald eagle nesting and roosting. Improvements in fish habitat as a result of riparian management could also increase the food supply for bald eagles in the upper watershed, providing additional incentive for both summer and winter use of the area. All known nests and winter roosts would be protected from disturbance by the federal ESA (until the species is de-listed), the Federal Bald and Golden Eagle Protection Act, and Washington State laws and regulations (even after de-listing). Human disturbance to nesting and roosting bald eagles would be further limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed.

Marbled Murrelet *(Brachyramphus marmoratus)*

Upper Watershed Alternative A would have no effects on the marbled murrelet. This robin-sized sea bird nests in large trees up to 50 miles inland, and is known to nest in at least small numbers in the Upper Green River Watershed (Cummins, pers. comm., 22 June 1999). No suitable marbled murrelet nesting habitat would be harvested by Tacoma Water under Upper Watershed Alternative A. Any harvesting proposed by Tacoma Water that would be near or adjacent to occupied marbled murrelet nesting habitat would have to comply with the federal ESA and current Washington Forest Practices Rules, which require both seasonal and permanent buffers to protect nesting habitat.

Northern Spotted Owl *(Strix occidentalis caurina)*
The spotted owl would benefit from Upper Watershed Alternative A. Existing spotted owl activity centers within 1.8 miles of the Action Area would be protected from disturbance by Tacoma Water in accordance with the federal ESA and current Forest Practices Rules. Tacoma Water would not be allowed to harvest existing suitable habitat within 1.8 miles of these activity centers unless the total amount of habitat available to each activity center exceeded state and federal guidelines for maintaining viable nests. Additional suitable habitat would be maintained by Tacoma Water in the Natural Zone and Conservation Zone (beyond 1.8 miles from any known activity centers), and new habitat would become available over time in all three forest management zones because of Tacoma Water's forest management. The amount of habitat and the number of spotted owls would likely increase in the Action Area under this alternative. Private, state, and federal conservation programs on adjacent lands (i.e., the Plum Creek Timber Company HCP, the Northwest Forest Plan for federal lands, and the DNR HCP for state lands) would result in similar increases in habitat throughout the upper watershed. The spotted owl is highly likely to persist in the Green River Watershed and to increase in numbers over the next 50 years.

Grizzly Bear *(Ursus arctos)*
Upper Watershed Alternative A would have little or no effect on the grizzly bear. This species is extremely rare in the Green River Watershed, Tacoma Water would not likely encounter it during watershed management activities. Habitat management under this alternative would favor grizzly bear prey, such as deer and elk, and restrictions on public access in the watershed would improve overall habitat conditions for the grizzly bear, but it is unlikely these habitats would ever be used. Tacoma Water would be restricted by the federal ESA and Washington Forest Practices Rules from conducting certain activities near active grizzly bear dens in the watershed.

Canada Lynx *(Lynx canadensis)*
Upper Watershed Alternative A would reduce the amount of habitat for the Canada lynx in the Action Area, but the effect of this would be minimal because this species is extremely rare in western Washington. The lynx is associated with a mixture of mature and young coniferous forest where it is heavily dependent on its primary prey, the snowshoe hare. The Green River Watershed has snowshoe hare, but not in sufficient numbers to support lynx. Management of the Action Area under Upper Watershed Alternative A would increase the amount of mature coniferous forest and thereby reduce the amount of potential snowshoe hare habitat. This could decrease the potential for lynx to use the Action Area in the future.

Federally Unlisted Species

Cascade Torrent Salamander *(Rhyacotriton cascadae)*
This species would benefit from Upper Watershed Alternative A. This is a species closely associated with cold mountain streams, where it is found in or directly adjacent to the water. It is sensitive to increases in temperature and solar radiation that can occur after forest clearing. The maintenance of wide forested buffers along all streams in the Action Area under Upper Watershed Alternative A would protect existing habitat for the Cascade torrent salamander, and would allow new habitat to develop in areas where past logging resulted in the removal of trees adjacent to the stream. Few individuals would be impacted during harvest operations because the species rarely is found farther from streams than the buffers would extend. This species could become more abundant in the Action Area over the next 50 years under this alternative.

Van Dyke's Salamander *(Plethodon vandykei)*
Upper Watershed Alternative A would benefit this species because it, like the Cascade torrent salamander, is a species of cold headwater mountain streams. Riparian protection measures, particularly those on smaller streams in the Action Area, would maintain existing habitat for the Van Dyke's salamander and allow new habitat to develop along streams in young second-growth forest. Individuals would be protected during timber harvest operations because few salamanders would move up hill beyond riparian buffers. This species could increase in abundance as a result of Upper Watershed Alternative A.

Larch Mountain Salamander *(Plethodon larselli)*
Individual Larch Mountain salamanders could be impacted during timber harvest operations under Upper Watershed Alternative A, but much of the potential habitat for this species would be protected from harvest in the Natural Zone, Conservation Zone, and UMAs. This species finds habitat in talus and coarse rocky upland soils, often beneath dense forest canopy. Ground-based yarding during timber harvest could crush individual salamanders, and the removal of the forest cover could make the habitat unsuitable for future occupancy. Harvesting would be limited, however, to the Commercial Zone and young stands in the Conservation Zone, and would occur on only a small number of acres per year (Table 2-12). Sufficient habitat should remain in the Action Area to allow this species to persist.

Tailed Frog *(Ascaphus truei)*

Upper Watershed Alternative A would affect the tailed frog much the same as it would affect the Cascade torrent salamander and Van Dyke's salamander. All three species are associated with cold headwater streams, and all are sensitive to increases in temperature and solar radiation that can occur from overstory removal. Riparian buffers under this alternative would protect most of the habitat and most of the individuals of the tailed frog in the Action Area. Unlike the salamanders, however, adult tailed frogs can occasionally be found several hundred feet from streams. Tailed frogs in uplands within the Commercial and Conservation Zones could, therefore, be directly impacted during timber harvest activities, although these would represent a small segment of the tailed frog population in the Action Area. This type of impact would be relatively infrequent, because of the low rate of harvest and long rotation age. Overall the tailed frog would be expected to persist, and possibly increase in abundance in the Action Area under this alternative.

Cascades Frog *(Rana cascadae)*

Lake and wetland buffers that would be implemented under Upper Watershed Alternative A would protect much of the potential habitat for the Cascades frog in the Action Area, but individual frogs using small seeps and pools in the Commercial Zone could be impacted during timber harvest operations. The Cascades frog is found in lakes, ponds, wetlands and bogs above 2,000 feet in elevation in the Cascade Mountains. Most of this habitat would be protected from disturbance under Upper Watershed Alternative A, but the Cascades frog can also be found in moist areas that would not otherwise be classified as wetlands and would not receive protection. A portion of the population is, therefore, vulnerable to impact during timber harvesting, although the impact would be minor because of the low rate of harvest and long rotation age that would occur under Upper Watershed Alternative A. The Cascades frog would persist in the Action Area under this alternative.

Oregon Spotted Frog *(Rana pretiosa)*

The Oregon spotted frog would not likely be affected by Upper Watershed Alternative A because it is not likely to occur in the upper watershed. This is a rare lowland species associated with ponds, shallow lakes, and calm backwaters of rivers. It has a slight chance of occurring in the middle and lower Green River Watershed, but virtually no chance of occurring in the upper watershed. Activities conducted in the upper

watershed under this alternative would not affect potential habitat for the Oregon spotted frog in the lower Green River area.

Northwestern Pond Turtle *(Clemmys marmorata)*

Like the spotted frog, the pond turtle would not be affected by Upper Watershed Alternative A because it does not occur in the upper watershed. This is a lowland species associated with calm waters below 1,000 feet in elevation. It has a slight chance of occurring in the middle and lower Green River Watershed, but virtually no chance of occurring in the upper watershed. Activities conducted in the upper watershed under this alternative would not affect potential habitat for the Northwestern pond turtle in the lower Green River area.

Common Loon *(Gavia immer)*

Nesting habitat for the common loon in the Action Area would be protected under Upper Watershed Alternative A. The single documented location of this species in the Action Area, and the only place it is likely to occur, is Howard Hanson Reservoir. The Natural Zone that would be maintained under Upper Watershed Alternative A would provide a forested buffer around the reservoir, eliminating any potential for timber harvest operations, or other watershed management activities, to disturb nesting loons. The reservoir would remain as suitable habitat for loons. Human disturbance would also be limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed.

Vaux's Swift *(Chaetura vauxi)*

This species could be negatively affected in the short term under Upper Watershed Alternative A, but would benefit in the long term. This species is highly dependent on the presence of hollow trees or snags for nesting and roosting. These large "chimney" snags are created infrequently in the natural forest, and they take several decades to develop. Trees of sufficient size are rarely available in managed forest, and those that are available and become snags are often felled for safety reasons. Timber harvesting in the Conservation and Commercial Zones could decrease the number of suitable snags for swifts in the short term, reducing the amount of habitat in the Action Area. The snag and residual live tree program under this alternative would eventually lead to the creation of replacements for the lost snags, but this replacement process could take several decades. In the interim, potential habitat for Vaux's swifts would be reduced.

Pileated Woodpecker *(Dryocopus pileatus)*
Upper Watershed Alternative A would benefit the pileated woodpecker. This species is associated with mature coniferous forest, where it nests and roosts in cavities in medium-to large-size trees.

The amount of mature coniferous forest would increase substantially under this alternative, as would the number of residual live trees and snags. All forested acres in the Natural Zone and Conservation Zone would eventually function as potential habitat for the pileated woodpecker, as would many of the older managed stands in the Commercial Zone (due to the long rotation age of 70 years). This species would persist throughout the Action Area and surrounding public forest under Upper Watershed Alternative A.

Olive-sided Flycatcher *(Contopus borealis)*
Habitat for the olive-sided flycatcher could decrease under Upper Watershed Alternative A, but a certain amount of habitat would always be available, and the species would likely persist in the Action Area. The olive-sided flycatcher is found along the edges of mature forest, where it nests in the forest and hunts insects over open areas. The protection of large blocks of coniferous forest in the Natural Zone and Conservation Zone would decrease the amount of edge habitat, as would long rotations and low harvest rates in the Commercial Zone. Edge habitat would remain in the Action Area where mature forest abuts Howard Hanson Reservoir and the existing powerline rights-of-way. These permanent edges would provide a stable source of habitat for the olive-sided flycatcher, allowing it to persist in the watershed.

California Wolverine *(Gulo gulo luteus)*
This wide-ranging mammal is not common in the Green River Watershed, but its movement patterns create the potential for individuals to enter the basin occasionally. Were it to occur in the watershed, it would likely use high-elevation forest near the east end of the watershed, and not lands within the Action Area. Management of the Action Area under Upper Watershed Alternative A would, therefore, have little effect on the wolverine.

Pacific Fisher *(Martes pennanti pacifica)*
The Pacific fisher is rare in the Green River Watershed, but it could den and hunt in large tracts of coniferous forest along the major streams and benefit from forest management measures under Upper

Watershed Alternative A. The protection of mature coniferous forest along Howard Hanson Reservoir and along the upper Green River in the Natural Zone and Conservation Zone would provide the specific type of habitat lacking for this species throughout much of the region. It is unlikely that appreciable numbers of fishers would be present in the Green River Watershed in the short- to mid-term, but management under Upper Watershed Alternative A would create conditions that would favor any fisher that disperse into the area over the long term.

Northern Goshawk *(Accipiter gentilis)*

Habitat for the northern goshawk would increase in the Action Area under Upper Watershed Alternative A, and although individual nests of the goshawk could be disturbed during timber harvest activities, the number of goshawks using the Action Area would likely increase over time. This is a species that nests and hunts in large tracts of mature coniferous forest. It is thought to be impacted by loss and fragmentation of its forested habitat under commercial forest management, although it is known to nest in some intensively managed areas (Bosakowski and Vaughn 1996).

Protection of large, contiguous blocks of coniferous forest in the Natural and Conservation Zones would provide habitat for the northern goshawk not typically available in managed forest landscapes. The long rotation and riparian buffers in the Commercial Zone would result in a large percentage of this zone functioning as goshawk hunting habitat at any time over the next 50 years. Individual nests could be inadvertently felled in the Commercial Zone and Conservation Zone during timber harvest activities, but sufficient numbers of alternate nest trees would be available in protected areas. The snag and log retention program under Upper Watershed Alternative A, which would exceed current Forest Practices Rules, would provide improved habitat conditions for woodpeckers and grouse, two of the principal prey species of the northern goshawk. This species would be highly likely to persist over time in the upper watershed under Upper Watershed Alternative A.

4.3.7.2 Upper Watershed Alternative B: Proposed Action

<u>Effects on Wildlife Habitats</u>

Under Upper Watershed Alternative B, Tacoma Water would continue to manage its lands in the Upper

Green River Watershed according to the Forest Land Management Plan initially developed in 1996 (Ryan 1996). In addition, Tacoma Water would implement specific measures to further enhance and protect habitats for fish and wildlife. The specifics of this alternative are described in Tacoma Water's HCP. The overall effects of the HCP on wildlife habitat would be:

- an increase in the total acreage of coniferous forest over 100 years old;
- an increase in the average age of all coniferous forest;
- a decrease in the total acreage of hardwood forest, and corresponding increase in the total acreage of coniferous forest;
- an increase in the number of residual live trees, snags, and logs within coniferous forest;
- development and maintenance of mature forest conditions along all streams and around all wetlands in the Action Area; and
- more than 11,000 acres of forest maintained with little or no disturbance (i.e., limited or no commercial timber harvest) in the Natural Zone, Conservation Zone, Upland Management Areas (UMAs) of the Commercial Zone, and riparian buffers of the Commercial Zone.

Trends in habitat over the term of the HCP would be as illustrated in HCP Figures A, B, C, E, G, and I, Chapter 7. Species that inhabit mature coniferous forest (over 100 years old) would experience an increase in habitat of more than 10-fold over the next 50 years. Species that utilize residual live trees and/or snags within coniferous forest would find habitat on virtually every forested acre in the HCP Area by the end of 50 years. Habitat for riparian species would improve continuously as forest in riparian areas matured. Species associated with hardwood forest would see a decrease in the total area of available habitat, but this type of habitat would persist in areas where it occurs naturally (e.g., UMAs and areas of frequent disturbance along streams). Species associated with forest edges would also see a decrease in total habitat, but edges would continue to be created on a sustainable basis within the managed uplands of

the Commercial Zone. It is not anticipated that hardwood forest or edge habitat would become limiting within the Action Area or the Upper Green River Watershed as a whole. Compared to Upper Watershed Alternative A, the Proposed Action would result in slightly more timber harvest in the Commercial Zone in the short term (due to relaxed restrictions near spotted owl activity centers) and less harvest in the Conservation Zone and Natural Zone (due to increased restrictions on salvage harvest). The general amounts and availability of various habitat types would be comparable under the two alternatives.

Effects on Wildlife Populations

Management of Tacoma Water forestlands under the Proposed Action would cause minimal disturbance to wildlife populations in and near the Action Area. Commercial timber harvest and road use would continue, but specific restrictions would be placed on potentially disruptive activities near the nests or dens of federally listed species. The only listed species currently known to occur near Tacoma Water lands in the upper watershed is the northern spotted owl (see discussion below in this section), but other listed species could occur in the area in the future and these would be similarly protected through specific Habitat Conservation Measures.

Unlisted species would be periodically disrupted and/or displaced by timber harvest activities, but the low rate of timber harvest (Table 2-12) and long rotation (70 years) would minimize disturbance impacts. Species with low mobility, such as small mammals and amphibians, could be crushed during timber harvest operations, but again this impact would be minimized by the extensive system of reserves and riparian buffers and the low overall rate of harvest. No wildlife species would be extirpated from Tacoma Water lands under Upper Watershed Alternative B, and no species would experience a substantial decrease in local population. Protection of wildlife populations under this alternative would be comparable to protection under Upper Watershed Alternative A.

Effects on Wildlife Species of Special Interest

Federally Listed Species

Gray Wolf *(Canis lupus)*

Similar to conditions under Upper Watershed Alternative A, Upper Watershed Alternative B would have little or no effect on the gray wolf. Like the grizzly bear, the gray wolf is extremely rare in the Green River Watershed. It is unlikely that Tacoma Water would encounter it during watershed management activities. Deer and elk are favored prey of the gray wolf, and these ungulates would benefit from the protection of mature forest in the Natural Zone and Conservation Zone and long rotations in the Commercial Zone. Restrictions on public access in the watershed would also improve habitat conditions for this elusive species. Tacoma Water would be restricted by specific measures in the proposed HCP from conducting certain activities near active gray wolf dens on Tacoma-owned lands in the watershed, in the unlikely event that the species dens there in the future. The effects of Upper Watershed Alternative B on the gray wolf would be comparable to the effects of Upper Watershed Alternative A.

Peregrine Falcon *(Falco peregrinus)*

Upper Watershed Alternative B would provide slightly more protection of potential peregrine falcon nesting habitat than Upper Watershed Alternative A, and a comparable level of protection of active peregrine falcon nests. Upper Watershed Alternative A would only protect occupied habitat, whereas Upper Watershed Alternative B would also protect potential habitat. The species currently does not nest in the Action Area, but potential nest habitat and any future nests would be protected from disturbance by specific measures in the proposed HCP. Hunting by peregrine falcons nesting outside the Action Area, which could occur occasionally over Howard Hanson Reservoir, would not be affected by Tacoma Water activities under this alternative. No potentially suitable nesting habitat (i.e., cliffs) or hunting habitat (e.g., lakes and wetlands) would be altered under this alternative. Human disturbance to nesting peregrine falcons would be limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed.

Bald Eagle *(Haliaeetus leucocephalus)*

As under Upper Watershed Alternative A, Upper Watershed Alternative B would have positive effects on the bald eagle. While there is currently no known nesting or winter roosting by bald eagles in the upper Action Area, the potential for nesting in the future would increase. Mature forest that would develop and be retained in the Natural Zone, Conservation Zone, and riparian buffers of the Commercial Zone would provide opportunities for both bald eagle nesting and roosting. Improvements in fish habitat as a result of riparian management also could increase the food supply for bald eagles in the upper watershed, providing additional incentive for both summer and winter use of the area. All known nests and winter roosts would be protected from disturbance under specific Habitat Conservation Measures in the proposed HCP. Human disturbance to nesting and roosting bald eagles would be further limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed. The effects of Upper Watershed Alternative B on the bald eagle would be comparable to the effects of Upper Watershed Alternative A.

Marbled Murrelet *(Brachyramphus marmoratus)*

The effects of Upper Watershed Alternative B on the marbled murrelet would be comparable to the effects of Upper Watershed Alternative A. Upper Watershed Alternative B would have no effects on the marbled murrelet. This robin-sized sea bird nests in large trees up to 50 miles inland, and is known to nest in at least small numbers in the Upper Green River Watershed (Cummins, pers. comm., 22 June 1999). The murrelet can be impacted by timber harvest that removes suitable nesting habitat, and harvest-related activities that disturb active nests. No suitable marbled murrelet nesting habitat would be harvested by Tacoma Water under Upper Watershed Alternative B, and no harvest would occur adjacent to occupied habitat on other ownerships.

Northern Spotted Owl *(Strix occidentalis caurina)*

Upper Watershed Alternative B would have slightly more negative effect on the northern spotted owl than Upper Watershed Alternative A in the short term, and comparable benefits over the long term. Tacoma Water could harvest up to 675 acres of existing suitable habitat within 1.8 miles of nine known spotted owl activity centers, 348 acres of which lie within 0.7 mile of one or more of these activity centers (see Chapter 7 of the HCP for a more detailed discussion). At the same time, suitable spotted owl habitat would be maintained by Tacoma Water in the Natural Zone and Conservation Zone (beyond 1.8 miles from any known activity centers), and new habitat would become available over time in all three forest management

zones because of Tacoma Water's forest management. The total area of coniferous forest over 75 years old would increase under Upper Watershed Alternative B from approximately 3,500 acres in 1998 to almost 5,000 acres in 2048, and the average age of the forest would increase to well over 100 years (see HCP Chapter 7, Effects of Tacoma Water Withdrawal and Conservation Measures). The number of spotted owls would likely increase as well. Private, state, and federal conservation programs on adjacent lands (i.e., the Plum Creek Timber Company HCP, the Northwest Forest Plan for federal lands, and the DNR HCP for state lands) would result in similar increases in habitat throughout the upper watershed. The spotted owl is highly likely to persist in the Green River Watershed and to increase in numbers over the next 50 years.

Grizzly Bear *(Ursus arctos)*

Upper Watershed Alternative B would have little or no effect on the grizzly bear as under Upper Watershed Alternative A. This species is extremely rare in the Green River Watershed, and it is unlikely that Tacoma Water would encounter it during watershed management activities. Habitat management under this alternative would favor grizzly bear prey, such as deer and elk, and restrictions on public access in the watershed would improve overall habitat conditions for the grizzly bear, but it is unlikely these habitats would ever be used. Tacoma Water would be restricted by specific measures in the proposed HCP from conducting certain activities near active grizzly bear dens in the watershed. The effects of Upper Watershed Alternative B on the grizzly bear would be comparable to the effects of Upper Watershed Alternative A.

Canada Lynx *(Lynx canadensis)*

The effects of Upper Watershed Alternative B on the Canada lynx would be comparable to the effects of Upper Watershed Alternative A. Upper Watershed Alternative B would reduce the amount of habitat for the Canada lynx in the Action Area similar to Upper Watershed Alternative A, but the effect of this would be minimal because the species is extremely rare in western Washington. The lynx is associated with a mixture of mature and young coniferous forest where it is heavily dependent on its primary prey, the snowshoe hare. The Green River Watershed has snowshoe hare, but not in sufficient numbers to support lynx. As under Upper Watershed Alternative A, management of the Action Area under Upper Watershed Alternative B would increase the amount of mature coniferous forest and thereby reduce the amount of potential snowshoe hare habitat. This could decrease the potential for lynx to use the Action Area in the

future. If the lynx did occur in the upper watershed, Tacoma Water would be restricted by measures in the proposed HCP from conducting potentially disturbing activities in the vicinity of active den sites.

Federally Unlisted Species

Cascade Torrent Salamander *(Rhyacotriton cascadae)*

As under Upper Watershed Alternative A, this species could become more abundant in the Action Area over the next 50 years under Upper Watershed Alternative B. However, Upper Watershed Alternative B would have considerably more benefit to the Cascade torrent salamander than Upper Watershed Alternative A because of increased buffering along HCP-Area streams that this species inhabits (Tables 2-13a and 2-13b). This species would benefit from Upper Watershed Alternative B. This is a species closely associated with cold mountain streams, where it is found in or directly adjacent to the water. It is sensitive to increases in temperature and solar radiation that can occur after forest clearing. Similar to Upper Watershed Alternative A, the maintenance of wide forested buffers along all streams in the Action Area under from Upper Watershed Alternative B would protect existing habitat for the Cascade torrent salamander, and would allow new habitat to develop in areas where past logging resulted in the removal of trees adjacent to the stream. Few individuals would be impacted during harvest operations because the species rarely is found farther from streams than the buffers would extend.

Van Dyke's Salamander *(Plethodon vandykei)*

This species could increase in abundance as a result of Upper Watershed Alternative B. However, Upper Watershed Alternative B would have considerably more benefit to the Van Dyke's salamander than Upper Watershed Alternative A because of increased buffering along the HCP-Area streams that this species inhabits (Tables 2-13a and 2-13b). Upper Watershed Alternative B would benefit this species because it, like the Cascade torrent salamander, is a species of cold headwater mountain streams. Riparian protection measures, particularly those on smaller streams in the Action Area, would maintain existing habitat for the Van Dyke's salamander and allow new habitat to develop along streams in young second-growth forest. Individuals would be protected during timber harvest operations because few salamanders would move up hill beyond riparian buffers.

Larch Mountain Salamander *(Plethodon larselli)*

Individual Larch Mountain salamanders could be impacted during timber harvest operations under Upper Watershed Alternative B, but much of the potential habitat for this species would be protected from harvest in the Natural Zone, the Conservation Zone, UMAs, and ~~unforested talus fields of 0.5 acre and larger~~ other occupied habitat (see Habitat Conservation Measure 3-04U of the proposed HCP). This species finds habitat in talus and coarse rocky upland soils, often beneath dense forest canopy. Road construction and ground-based yarding during timber harvest could crush individual salamanders, and the removal of the forest cover could make the habitat unsuitable for future occupancy. Harvesting would be limited, however, to a small number of acres per year in the Commercial Zone and young stands in the Conservation Zone (Table 2-12), and no harvest or road construction would occur ~~in talus fields of 0.5 acre or larger~~ in potential habitat without prior surveys. Sufficient habitat should remain in the Action Area to allow this species to persist. More potential habitat would be protected under Upper Watershed Alternative B than under Upper Watershed Alternative A, because of restrictions in the proposed HCP on the disturbance of ~~talus fields~~ occupied habitat.

Tailed Frog *(Ascaphus truei)*

Upper Watershed Alternative B would have considerably more benefit to the tailed frog than Upper Watershed Alternative A because of increased buffering along HCP-Area streams that this species inhabits (Tables 2-13a and 2-13b). Upper Watershed Alternative B would affect the tailed frog much the same as it would affect the Cascade torrent salamander and Van Dyke's salamander. All three species are associated with cold headwater streams, and all are sensitive to increases in temperature and solar radiation that can occur from overstory removal. Increased riparian buffers under this alternative (as compared to Upper Watershed Alternative A) would protect most of the habitat and Action Area. Adult tailed frogs can occasionally be found several hundred feet from streams, and tailed frogs in uplands within the Commercial and Conservation Zones could be directly impacted during timber harvest activities. This type of impact would be minimized, however, by the wide riparian buffers proposed in the HCP, and would be relatively infrequent because of the low rate of harvest and long rotation age. Overall the tailed frog would be expected to persist, and possibly increase in abundance in the Action Area under this alternative.

Cascades Frog *(Rana cascadae)*

The effects of Upper Watershed Alternative B on the Cascades frog would be comparable to the effects of Upper Watershed Alternative A. Lake and wetland buffers that would be implemented under Upper Watershed Alternative B would protect much of the potential habitat for the Cascades frog in the Action Area, but individual frogs using small seeps and pools in the Commercial Zone could be impacted during timber harvest operations. The Cascades frog is found in lakes, ponds, wetlands, and bogs above 2,000 feet in elevation in the Cascade Mountains. Most of this habitat would be protected from disturbance under Upper Watershed Alternative B, but the Cascades frog can also be found in moist areas that would not otherwise be classified as wetlands and would not receive protection. A portion of the population is, therefore, vulnerable to impact during timber harvesting, although the impact would be minor because of the low rate of harvest and long rotation age that would occur under Upper Watershed Alternative B. The Cascades frog would persist in the area under this alternative.

Oregon Spotted Frog *(Rana pretiosa)*

The effects of Upper Watershed Alternative B on the Oregon spotted frog would be comparable to the effects of Upper Watershed Alternative A. As under Upper Watershed Alternative A, the Oregon spotted frog would not likely be affected by Upper Watershed Alternative B because it is not likely to occur in the upper watershed. This is a rare lowland species associated with ponds, shallow lakes, and calm backwaters of rivers. It has a slight chance of occurring in the middle and lower Green River Watershed, but virtually no chance of occurring in the upper watershed. Activities conducted in the upper watershed under this alternative would not affect potential habitat for the Oregon spotted frog in the lower Green River area.

Northwestern Pond Turtle *(Clemmys marmorata)*

The effects of Upper Watershed Alternative B on the Northwestern pond turtle would be comparable to the effects of Upper Watershed Alternative A. Like the spotted frog, the pond turtle would not be affected by Upper Watershed Alternative B because it does not occur in the upper watershed. This is a lowland species associated with calm waters below 1,000 feet in elevation. It has a slight chance of occurring in the middle and lower Green River Watershed, but virtually no chance of occurring in the upper watershed. Similar to Upper Watershed Alternative A, activities conducted in the upper watershed under this alternative would not affect potential habitat for the Northwestern pond turtle in the lower Green River area.

Common Loon *(Gavia immer)*

The effects of Upper Watershed Alternative B on the common loon would be comparable to the effects of Upper Watershed Alternative A. Nesting habitat for the common loon in the Action Area would be protected under Upper Watershed Alternative B. The single documented location of this species in the Action Area, and the only place it is likely to occur, is Howard Hanson Reservoir. The Natural Zone that would be maintained under Upper Watershed Alternative B would provide a forested buffer around the reservoir, eliminating any potential for timber harvest operations, or other watershed management activities, to disturb nesting loons. As under Upper Watershed Alternative A, the reservoir would remain suitable habitat for loons. Human disturbance would also be limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed.

Vaux's Swift *(Chaetura vauxi)*

Upper Watershed Alternative B would provide more protection and more habitat for the Vaux's swift than Upper Watershed Alternative A because Upper Watershed Alternative A would not provide protection of nest or roost trees unless the species were listed. This species could be negatively affected in the short term under Upper Watershed Alternative B, but would benefit in the long term. This species is highly dependent on the presence of hollow trees or snags for nesting and roosting. These large "chimney" snags are created infrequently in the natural forest, and they take several decades to develop. Trees of sufficient size are rarely available in managed forest, and those that are available and become snags are often felled for safety reasons. Although Habitat Conservation Measure 3-04T in the proposed HCP would give preference to protecting Vaux's swift snags during timber harvesting in the Conservation and Commercial Zones, some snags could be felled for worker safety. The snag and residual live tree program under this alternative would eventually lead to the creation of replacements for the lost snags, but this replacement process could take several decades. In the interim, potential habitat for Vaux's swifts would be reduced.

Pileated Woodpecker *(Dryocopus pileatus)*

Upper Watershed Alternative B would provide more protection and more habitat for the pileated woodpecker than Upper Watershed Alternative A. This species is associated with mature coniferous forest, where it nests and roosts in cavities in medium-to large-size trees. The amount of mature coniferous forest would increase substantially over time, as compared to current conditions, under this alternative, as would the number of residual live trees and snags. All forested acres in the Natural Zone and Conservation

Zone would eventually function as potential habitat for the pileated woodpecker, as would many of the older managed stands in the Commercial Zone (due to the long rotation age of 70 years). The snag and residual live tree program (Habitat Conservation Measure 3-01G) and pileated woodpecker snag protection measure (Habitat Conservation Measure 3-04S) under the proposed HCP would protect existing snag habitat and lead to the creation of more snags. This species would persist throughout the Action Area and surrounding public forest under Upper Watershed Alternative B.

Olive-sided Flycatcher *(Contopus borealis)*

The effects of Upper Watershed Alternative B on the olive-sided flycatcher would be comparable to the effects of Upper Watershed Alternative A. Similar to conditions under Upper Watershed Alternative A, habitat for the olive-sided flycatcher could decrease under Upper Watershed Alternative B, but a certain amount of habitat would always be available, and the species would likely persist in the area. The olive-sided flycatcher is found along the edges of mature forest, where it nests in the forest and hunts insects over open areas. The protection of large blocks of coniferous forest in the Natural Zone and Conservation Zone would decrease the amount of edge habitat, as would long rotations and low harvest rates in the Commercial Zone. As under Upper Watershed Alternative A, edge habitat would remain in the Action Area, however, where mature forest abuts Howard Hanson Reservoir and the existing powerline rights-of-way. These permanent edges would provide a stable source of habitat for the olive-sided flycatcher, allowing it to persist in the watershed.

California Wolverine *(Gulo gulo luteus)*

The effects of Upper Watershed Alternative B on the California wolverine would be comparable to the effects of Upper Watershed Alternative A. This wide-ranging mammal is not common in the Green River Watershed, but its movement patterns create the potential for individuals to enter the basin occasionally. Were it to occur in the watershed, it would likely use high-elevation forest near the east end of the watershed, and not lands within the Action Area. Management of the Action Area under Upper Watershed Alternative B would, therefore, have little effect on the wolverine. If the wolverine did occur in the upper watershed, Tacoma Water would be restricted by measures in the proposed HCP from conducting potentially disturbing activities in the vicinity of active den sites.

Pacific Fisher *(Martes pennanti pacifica)*
The Pacific fisher is rare in the Green River Watershed, but it could den and hunt in large tracts of coniferous forest along the major streams and benefit from forest management measures under Upper Watershed Alternative B, as under Upper Watershed Alternative A. The protection of mature coniferous forest along Howard Hanson Reservoir and along the upper Green River in the Natural Zone and Conservation Zone would provide the specific type of habitat lacking for this species throughout much of the region. It is unlikely appreciable numbers of fishers will be present in the Green River Watershed in the short- to mid-term, but management under Upper Watershed Alternative B would create conditions that would favor any fisher that disperse into the area over the long term. If the fisher did occur in the upper watershed, Tacoma Water would be restricted by measures in the proposed HCP from conducting potentially disturbing activities in the vicinity of active den sites. The effects of Upper Watershed Alternative B on the Pacific fisher would be comparable to the effects of Upper Watershed Alternative A.

Northern Goshawk *(Accipiter gentilis)*
Upper Watershed Alternative B would provide more protection for the northern goshawk than Upper Watershed Alternative A because Alternative A would not provide protection of active goshawk nests unless the species becomes listed at the state or federal level. Upper Watershed Alternative B would provide a comparable level of habitat to Upper Watershed Alternative A.

As under Upper Watershed Alternative A, habitat for the northern goshawk would increase in the Action Area under Upper Watershed Alternative B. Additionally, individual nests of the goshawk would be protected by specific Habitat Conservation Measures in the proposed HCP that would not occur under Upper Watershed Alternative A unless the species becomes listed. The number of goshawks using the Action Area would likely increase over time under Alternative B. This is a species that nests and hunts in large tracts of mature coniferous forest. It is thought to be impacted by loss and fragmentation of its forested habitat under commercial forest management, although it is known to nest in some intensively managed areas (Bosakowski and Vaughn 1996). Protection of large, contiguous blocks of coniferous forest in the Natural and Conservation Zones would provide habitat for the northern goshawk not typically available in managed forest landscapes. The long rotation and riparian buffers in the Commercial Zone would result in a large percentage of this zone functioning as goshawk hunting habitat at any time over the next 50 years, and individual nests would be protected by Habitat Conservation Measures 3-04Q and

3-04R during timber harvest activities. The snag and log retention program under Upper Watershed Alternative B, which would exceed current Forest Practices Rules, would provide improved habitat conditions for woodpeckers and grouse, two of the principal prey species of the northern goshawk. This species would be highly likely to persist over time in the upper watershed.

4.3.7.3 Upper Watershed Alternative C: No Commercial Timber Harvest

Effects on Wildlife Habitats

Under Upper Watershed Alternative C, Tacoma Water would conduct no commercial timber harvesting in the Upper Green River Watershed. All existing forested habitats would continue to develop naturally, eventually into mature coniferous forest unless natural disturbance or plant competition prevented coniferous trees from becoming established. Lands within the Action Area already dedicated to non-forest uses, such as powerline rights-of-way or wildlife forage enhancement areas, would be maintained in those alternate uses and not allowed to revert back to forest. No specific measures would be implemented to avoid disturbance-related impacts to listed or Covered Species, since the overall level of human activity by Tacoma Water would be low, and would be limited mostly to tasks necessary for the safe operation of the water supply project. This alternative would protect more existing mature coniferous forest than Upper Watershed Alternative A, and provide more coniferous forest in the long term. It would also result in the retention and long-term presence of hardwood forest, as there would be no program to convert hardwood stands to conifers or to accelerate the rate of forest succession in stands already containing conifers.

Effects on Wildlife Populations

Management of Tacoma Water forestlands under Upper Watershed Alternative C would cause minimal or no disturbance to wildlife populations in and near the Action Area. No harvest activities would occur in occupied habitats, and no individual wildlife would be disrupted or physically impacted by logging. No wildlife species would be extirpated from Tacoma Water lands under Upper Watershed Alternative C, and no species would experience a substantial decrease in local population. This alternative would provide more protection of wildlife populations than Upper Watershed Alternative A.

<u>Effects on Wildlife Species of Special Interest</u>

Federally Listed Species

Gray Wolf *(Canis lupus)*

Upper Watershed Alternative C would have little or no effect on the gray wolf as under Upper Watershed Alternative A. Like the grizzly bear, the gray wolf is extremely rare in the Green River Watershed. It is unlikely that Tacoma Water would encounter it during watershed management activities. Deer and elk are favored prey of the gray wolf, and these ungulates could benefit from the protection of all mature forest in the Action Area. Restrictions on public access in the watershed would also improve habitat conditions for this elusive species. The effects of Upper Watershed Alternative C on the gray wolf would be comparable to the effects of Upper Watershed Alternative A.

Peregrine Falcon *(Falco peregrinus)*

Upper Watershed Alternative C would provide slightly more protection of potential peregrine falcon nesting habitat than Upper Watershed Alternative A because Upper Watershed Alternative A would not protect suitable, yet unoccupied habitat. Upper Watershed Alternative C would also provide a comparable level of protection of active peregrine falcon nests. The species currently does not nest in the Action Area, but potential nest habitat and any future nests would be protected from disturbance. Hunting by peregrine falcons nesting outside the Action Area, which could occur occasionally over Howard Hanson Reservoir, would not be affected by Tacoma Water activities under this alternative. No potentially suitable nesting habitat (i.e., cliffs) or hunting habitat (e.g., lakes and wetlands) would be altered under this alternative. Human disturbance to nesting peregrine falcons would be limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed.

Bald Eagle *(Haliaeetus leucocephalus)*

As under Upper Watershed Alternative A, Upper Watershed Alternative C would have positive effects on the bald eagle. While there is currently no known nesting or winter roosting by bald eagles in the upper Action Area, the potential for nesting in the future would increase. Mature forest that would develop and be retained in the Action Area would provide opportunities for both bald eagle nesting and roosting. Improvements in fish habitat as a result of riparian management could also increase the food supply for bald

eagles in the upper watershed, providing additional incentive for both summer and winter use of the area. All known nests and winter roosts would be protected from disturbance. Human disturbance to nesting and roosting bald eagles would be further limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed. The effects of Upper Watershed Alternative C on the bald eagle would be comparable to the effects of Upper Watershed Alternative A.

Marbled Murrelet *(Brachyramphus marmoratus)*

The effects of Upper Watershed Alternative C on the marbled murrelet would be comparable to the effects of Upper Watershed Alternative A. Upper Watershed Alternative C would have no effects on the marbled murrelet. This robin-sized sea bird nests in large trees up to 50 miles inland, and is known to nest in at least small numbers in the Upper Green River Watershed (Cummins, pers. comm., 22 June 1999). The murrelet can be impacted by timber harvest that removes suitable nesting habitat, and harvest related activities that disturb active nests. No suitable marbled murrelet nesting habitat would be harvested by Tacoma Water under Upper Watershed Alternative C, and no harvest would occur adjacent to occupied habitat on other ownerships.

Northern Spotted Owl *(Strix occidentalis caurina)*

Upper Watershed Alternative C would have more benefit to the northern spotted owl than Upper Watershed Alternative A. Management under Upper Watershed Alternative C would benefit the spotted owl by protecting existing habitat, avoiding disturbance to active nests, and allowing new habitat to develop in the future. The amount of suitable habitat in the Action Area would increase substantially over the term of the HCP, and the number of spotted owls would likely increase as well. Private, state, and federal conservation programs on adjacent lands (i.e., the Plum Creek Timber Company HCP, the Northwest Forest Plan for federal lands, and the Washington Department of Natural Resources HCP for state lands) would result in similar increases in habitat throughout the upper watershed. The spotted owl is highly likely to persist in the Green River Watershed and to increase in numbers over the next 50 years.

Grizzly Bear *(Ursus arctos)*

The effects of Upper Watershed Alternative C on the grizzly bear would be comparable to the effects of Upper Watershed Alternative A. Upper Watershed Alternative C would have little or no effect on the grizzly bear. This species is extremely rare in the Green River Watershed and it is unlikely that Tacoma Water would encounter it during watershed management activities. The protection of existing forest could

favor grizzly bear prey, such as deer and elk, and restrictions on public access in the watershed would improve overall habitat conditions for the grizzly bear.

Canada Lynx *(Lynx canadensis)*

The effects of Upper Watershed Alternative C on the Canada lynx would be comparable to the effects of Upper Watershed Alternative A. Upper Watershed Alternative C would reduce the amount of habitat for the Canada lynx in the Action Area, but, as under Upper Watershed Alternative A, the effect of this would be minimal because the species is extremely rare in western Washington. The lynx is associated with a mixture of mature and young coniferous forest where it is heavily dependent on its primary prey, the snowshoe hare. The Green River Watershed has snowshoe hare, but not in sufficient numbers to support lynx. Protection of the Action Area under Upper Watershed Alternative C would increase the amount of mature coniferous forest and thereby reduce the amount of potential snowshoe hare habitat. This could decrease the potential for lynx to use the Action Area in the future.

Federally Unlisted Species

Cascade Torrent Salamander *(Rhyacotriton cascadae)*

Upper Watershed Alternative C would have considerably more benefit to the Cascade torrent salamander than Upper Watershed Alternative A. This is a species closely associated with cold mountain streams, where it is found in or directly adjacent to the water. It is sensitive to increases in temperature and solar radiation that can occur after forest clearing. The maintenance of all existing forest would protect all cover along streams in the Action Area, protecting existing habitat for the Cascade torrent salamander, and allowing new habitat to develop in areas where past logging resulted in the removal of trees adjacent to the stream. No individuals would be impacted during harvest operations. The species could become more abundant in the Action Area over the next 50 years under this alternative.

Van Dyke's Salamander *(Plethodon vandykei)*

Upper Watershed Alternative C would have considerably more benefit to the Van Dyke's salamander than Upper Watershed Alternative A. Protection of all forested areas would maintain existing habitat for the Van Dyke's salamander and allow new habitat to develop along streams in young second-growth forest.

Individuals would be protected from timber harvest operations. This species could increase in abundance as a result of Upper Watershed Alternative C.

Larch Mountain Salamander *(Plethodon larselli)*
More potential habitat for the Larch Mountain salamander would be protected under Upper Watershed Alternative C than under Upper Watershed Alternative A. This species would benefit from cessation of timber harvest in the Action Area. This species finds habitat in talus and coarse rocky upland soils, often beneath dense forest canopy. Road construction and ground-based yarding during timber harvest could crush individual salamanders, and the removal of the forest cover could make the habitat unsuitable for future occupancy. Elimination of timber harvest, and limitation of road construction to the small amount that would be necessary to protect and patrol the watershed, would protect most of the potential habitat for this species in the Action Area. Sufficient habitat should remain in the Action Area to allow this species to persist.

Tailed Frog *(Ascaphus truei)*
Upper Watershed Alternative C would have considerably more benefit to the tailed frog than Upper Watershed Alternative A. Upper Watershed Alternative C would affect the tailed frog much the same as it would affect the Cascade torrent salamander and Van Dyke's salamander. All three species are associated with cold headwater streams, and all are sensitive to increases in temperature and solar radiation that can occur from overstory removal. Protection of existing forest would protect the habitat and individuals of the tailed frog in the Action Area. Overall the tailed frog would be expected to persist, and possibly increase in abundance in the Action Area under this alternative.

Cascades Frog *(Rana cascadae)*
Upper Watershed Alternative C would provide more protection for the Cascades frog than Upper Watershed Alternative A. Lakes and wetlands that would be protected under Upper Watershed Alternative C would include much of the potential habitat for the Cascades frog in the Action Area. Individual frogs using small seeps and pools that would go unnoticed during normal timber harvesting would also be protected under this alternative. The Cascades frog is found in lakes, ponds, wetlands, and bogs above 2,000 feet in elevation in the Cascade Mountains. All of this habitat would be protected from disturbance under Upper Watershed Alternative C. The Cascades frog would persist in the area under this alternative.

Oregon Spotted Frog *(Rana pretiosa)*

The Oregon spotted frog would not likely be affected by Upper Watershed Alternative C because it is not likely to occur in the upper watershed. This is a rare lowland species associated with ponds, shallow lakes, and calm backwaters of rivers. It has a slight chance of occurring in the middle and lower Green River Watershed, but virtually no chance of occurring in the upper watershed. Activities conducted in the upper watershed under this alternative would not affect potential habitat for the Oregon spotted frog lower in the Green River. Consequently, the effects of Upper Watershed Alternative C on the Oregon spotted frog would be comparable to the effects of Upper Watershed Alternative A.

Northwestern Pond Turtle *(Clemmys marmorata)*

As under Upper Watershed Alternative A, the pond turtle would not be affected by Upper Watershed Alternative C because it does not occur in the upper watershed. This is a lowland species associated with calm waters below 1,000 feet in elevation. It has a slight chance of occurring in the middle and lower Green River Watershed, but virtually no chance of occurring in the upper watershed. Activities conducted in the upper watershed under this alternative would not affect potential habitat for the Northwestern pond turtle lower in the Green River. The effects of Upper Watershed Alternative C on the Northwestern pond turtle would be comparable to the effects of Upper Watershed Alternative A.

Common Loon *(Gavia immer)*

Nesting habitat for the common loon in the Action Area would be protected under Upper Watershed Alternative C. The single documented location of this species in the Action Area, and the only place it is likely to occur, is Howard Hanson Reservoir. Existing forest that would be maintained under Upper Watershed Alternative C would provide a buffer around the reservoir, eliminating any potential for other watershed management activities to disturb nesting loons. The reservoir would remain suitable habitat for loons. Human disturbance also would be limited by Tacoma Water's policy of prohibiting public access to the reservoir and surrounding watershed. The effects of Upper Watershed Alternative C on the common loon would be comparable to the effects of Upper Watershed Alternative A.

Vaux's Swift *(Chaetura vauxi)*

Upper Watershed Alternative C would provide more protection and more habitat for the Vaux's swift than

Upper Watershed Alternative A. The Vaux's swift is highly dependent on the presence of hollow trees or snags for nesting and roosting. These large "chimney" snags are created infrequently in the natural forest, and they take several decades to develop. Trees of sufficient size are rarely available in managed forest, and those that are available and become snags are often felled for safety reasons. The protection of all forest in the Action Area would protect existing snags and would allow new snags to develop. Elimination of measures to create snags, however, could reduce the number of new snags in the near future when compared to Upper Watershed Alternative B.

Pileated Woodpecker *(Dryocopus pileatus)*

Upper Watershed Alternative C would provide more protection and more habitat for the pileated woodpecker than Upper Watershed Alternative A. This species is associated with mature coniferous forest, where it nests and roosts in cavities in medium- to large-size trees. All existing habitat in the Action Area would be protected, and the amount of mature coniferous forest would increase substantially over time from amounts currently available under this alternative, as would the number of residual live trees and snags. Elimination of measures to create snags, however, could reduce the number of new snags in the near future when compared to Upper Watershed Alternative B. This species would persist throughout the Action Area and surrounding public forest under Upper Watershed Alternative C.

Olive-sided Flycatcher *(Contopus borealis)*

Upper Watershed Alternative C would result in less habitat for the olive-sided flycatcher than Upper Watershed Alternative A. The olive-sided flycatcher is found along the edges of mature forest, where it nests in the forest and hunts insects over open areas. Management to promote large blocks of coniferous forest over most of the Action Area would decrease the amount of edge habitat even more than under Upper Watershed Alternative A. As under Upper Watershed Alternative A, edge habitat would remain in the Action Area, however, where mature forest abuts Howard Hanson Reservoir and the existing powerline rights-of-way. These permanent edges would provide a stable source of habitat for the olive-sided flycatcher, allowing it to persist in the watershed.

California Wolverine *(Gulo gulo luteus)*

The effects of Upper Watershed Alternative C on the California wolverine would be comparable to the

effects of Upper Watershed Alternative A. This wide-ranging mammal is not common in the Green River Watershed, but its movement patterns create the potential for individuals to enter the basin occasionally. Were it to occur in the watershed, it would likely use high-elevation forest near the east end of the watershed, and not lands within the Action Area. As under Upper Watershed Alternative A, management of the Action Area under Upper Watershed Alternative C would, therefore, have little effect on the wolverine.

Pacific Fisher *(Martes pennanti pacifica)*

Upper Watershed Alternative C would benefit the Pacific fisher more than Upper Watershed Alternative A. The Pacific fisher is rare in the Green River Watershed, but it could den and hunt in large tracts of coniferous forest along the major streams and benefit from forest management measures under Upper Watershed Alternative C. As under Upper Watershed Alternative A, the protection of mature coniferous forest along Howard Hanson Reservoir and along the upper Green River would provide the specific type of habitat lacking for this species throughout much of the region. It is unlikely appreciable numbers of fishers will be present in the Green River Watershed in the short- to mid-term, but management under Upper Watershed Alternative C would create conditions that would favor any fisher that disperse into the area over the long term.

Northern Goshawk *(Accipiter gentilis)*

Upper Watershed Alternative C would provide more protection and more habitat for the northern goshawk than Upper Watershed Alternative A. Habitat for the northern goshawk would increase in the Action Area under Upper Watershed Alternative C, and individual nests of the goshawk would be protected. The number of goshawks using the Action Area would likely increase over time under this alternative. This is a species that nests and hunts in large tracts of mature coniferous forest. It is thought to be impacted by loss and fragmentation of its forested habitat under commercial forest management, although it is known to nest in some intensively managed areas (Bosakowski and Vaughn 1996). Protection of large, contiguous blocks of coniferous forest in the Action Area would provide habitat for the northern goshawk not typically available in managed forest landscapes. This alternative would also provide improved habitat conditions for woodpeckers, which are a principal prey of the northern goshawk. This species would be highly likely to persist over time in the upper watershed.

4.3.8 Recreation

Almost no recreational use occurs in the Upper Green River Watershed; therefore, all alternatives are analyzed together.

All Upper Watershed Alternatives

Tacoma Water's lands in the Upper Green River Watershed would remain closed to public use under all upper watershed alternatives; therefore, no impacts to recreation uses, including visible scenic qualities, would occur under any of the alternatives. Because there is little recreation use in the Upper Green River Watershed, the minor timber harvest acreage changes on the landscape of Tacoma Water's ownership under each of the upper watershed alternatives would have a limited or no effect on the quality of recreation experiences.

4.3.9 Visual Resources

All Upper Watershed Alternatives

Because there is little public use in the Upper Green River Watershed, and therefore limited access to key vantage points, the minor timber harvest acreage changes on the landscape of Tacoma Water's ownership under each of the upper watershed alternatives would have a limited or no effect on visual resources.

4.3.10 Social and Economic Conditions

4.3.10.1 All Upper Watershed Alternatives

Potential socioeconomic impacts of the three Upper Watershed Alternatives would be primarily associated with the revenue and costs of forest management activities. These activities would include timber harvest, road maintenance, planting, competing vegetation control, ~~animal damage control,~~ thinning, fire protection, and forest inventory. The following table describes costs and revenues associated with these activities

under each Upper Watershed Alternative:

Upper Watershed Alternatives	Costs[1]		Revenues[2]	
	Annual	50-year Total	Annual	50-year Total
A **No Action**	$45,000	$2,250,000	$700,000	$35,000,000
B **Proposed HCP**	$60,000	$3,000,000	$600,000	$30,000,000
C **No Harvest**	$25,000	$1,200,000	0	0

[1] Costs include tree planting, competing vegetation control, thinning, road maintenance, fire protection, and forest inventory.

[2] Revenues include the sale of timber.

Timber sale revenues that would be generated by Upper Watershed Alternatives A and B would be committed to improvements in the management and operation of the Green River Watershed. This could include new land purchases, facility improvements in the watershed, road and culvert improvements, and other activities.

Under the No Action Alternative (Upper Watershed Alternative A), Tacoma Water would continue to operate in accordance with its Forest Land Management Plan, and the Services would not issue incidental take coverage for the management of Tacoma Water lands in the Upper Green River Watershed. The Proposed Action (Upper Watershed Alternative B) would include the development of an HCP and federal issuance of an ITP. Upper Watershed Alternative C (No Harvest Alternative) would result in cessation of all commercial timber harvest within the Action Area and issuance of an ITP. Employment effects of forest management under each alternative are presented in Table 4-A.

Table *4-A.* Estimated employment by Upper Watershed Alternative.

Upper Watershed Alternative	Annual Forest Management		Annual Timber Harvest	
	Cost ($)	Direct Employment[1]	Volume (MBF)	Direct Employment[2]
A No Action	45,000	1	2,500	5
B Proposed HCP	60,000	2	2,380	4
C No Harvest	25,000	<1	0	0

[1]Annual employment based on $38,000 per employee labor cost, taken from Seattle Public Utilities Cedar River Watershed HCP and DEIS (1998).

[2]Annual employment based on 530 MBF harvested per employee, taken from Seattle Public Utilities Cedar River Watershed HCP and DEIS (1998).

MBF = Thousand Board Feet of timber volume harvested.

4.3.11 Cultural Resources

Upon review of the cultural resources documentation provided in subsection 3.1, Cultural Resources, it is unlikely that activities under any of the upper watershed alternatives would adversely impact cultural resources in the Upper Green River Watershed on Tacoma-owned lands. Tacoma limits public access to this area, and minor harvest activities would continue to be subjected to Washington State Forest Practices Approval review, including a cultural resources review for potential site disturbances.

Prior to any timber harvest or road construction, Tacoma Water would apply for a DNR Forest Practices Application (FPA). The DNR would then review the application to determine if the proposed forest practice would be conducted on lands that contain cultural, historical or archaeological resources that may be on or are eligible for listing on the National Register of Historic Places; or have been identified to the DNR as being of interest to an affected Indian tribe.

The FPA application is also reviewed by the affected Indian tribe and other interested parties (e.g., WDFW, Ecology) who may provide comments to the DNR concerning cultural resources as well as other concerns regarding the proposed FPA. The DNR may then condition the FPA to address the comments received prior to approval.

If the FPA impacts identified cultural resources, Tacoma Water would meet with the affected Indian tribe(s) or other affected parties to agree on a plan for protecting the archaeological or cultural value of sensitive areas. The DNR may then condition the FPA in accordance with the plan.

If in implementing the approved FPA an unidentified archaeological or cultural site is discovered, work would stop immediately, and the DNR would be notified. Tacoma Water would meet with the DNR, any affected Indian tribe, or other affected party to develop a plan for protecting the newly found cultural site and the FPA would be modified.

Most of the identified and potential cultural resource sites on Tacoma Water-owned lands are located in close proximity to streams, lakes, or wetlands. These areas have been designated in the HCP as either the Natural Management Zone, or in a stream or wetland buffer where no timber harvest would take place. Therefore, there is a minimal chance that Tacoma Water's forest management activities would impact any cultural sites under any of the upper watershed alternatives. Potential impacts to unknown cultural resources would be minor or nonexistent under Upper Watershed Alternative C because no harvest activities would occur.

4.4 Cumulative Effects

4.4.1 Introduction

NEPA defines cumulative effects as "the impact on the environment which results from the incremental impact of the Action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal on non-federal) or person undertakes such other actions (40 CFR 1508.7). For the purposes of this discussion, the terms "effects" and "impacts" will be considered synonymous with consequences, and consequences may be positive or negative.

This section presents an analysis of the cumulative effects (positive and negative) of the proposed HCP, in the context of other private, state, and federal land management activities in western Washington. Regional impacts of the Proposed Action are described for each of the federally listed species and their habitats covered by the proposed HCP and ITP. These analyses are supported by computer-based mapping analyses of land type and fish-bearing stream miles in this geographic region. In the case of forestlands, management strategies can be further stratified by ownership, allowing a quantitative discussion of cumulative effects. In other land types, management strategies are more complex, and regulations often apply across multiple ownerships; thus, the discussion of cumulative impacts is more qualitative.

Scope of Analysis

Geographic

The geographic scope of the analyses focuses on the Action Area as well as three graduated, geographic boundaries in western Washington (Figure 4-10). Two intermediate analysis area boundaries were chosen to lend specificity to the analysis; the boundaries of these intermediate areas differ slightly for fish species as compared to wildlife species.

Covered wildlife species primarily utilize forested habitats in the upper watershed. For these species, the Southwest Cascades Physiographic Province west of the crest of the Cascade Mountain Range (modified from Franklin and Dyrness 1973) constitutes the intermediate boundary. Plant and animal species are substantially different east of the crest within the Province, and this refinement encompasses a region more tuned to the species covered by the Tacoma Water HCP. For the purposes of this analysis, this smaller geographic unit is labeled the Southwest Cascades Physiographic Province (Province).

In contrast, the proposed HCP and other actions affect covered fish species not only in the upper watershed, but also in the mainstem Green River downstream of Tacoma's Headworks. For this reason, cumulative effects on fish are described for the Action Area and at the basin-wide scale as defined by Water Resource Inventory Area 9 (WRIA 9), the Green/Duwamish River basin.

Figure 4-10. Geographic scope of the cumulative effects analysis areas.

PLACEHOLDER

The range of the northern spotted owl in Washington constitutes the outer analysis area for both fish and wildlife species. The outer analysis boundary was chosen because of: 1) its fairly uniform, moist, mild coastal climate; 2) its fairly uniform flora and fauna; 3) its overlap with the geographic scope of the Northwest Forest Plan; and 4) the availability of generally high quality GIS data for this region.

Substantive

The substantive scope of this cumulative effects analysis focuses on the anticipated impacts of the Proposed Action to ESA-fish and wildlife species and their habitats covered by the proposed HCP and ITP (Table 2-1). Habitat for the purposes of this discussion consists of: 1) forestland as wildlife habitat (distribution, quantity, and quality); and 2) fish-bearing streams and rivers as fish habitat (distribution, quantity, and quality). These two variables constitute the components of the affected human environment most directly influenced by the Proposed Action of issuing the City of Tacoma a permit to incidentally take fish and wildlife species protected by the ESA.

A number of present or reasonably foreseeable resource management strategies will affect fish and wildlife populations in the Action Area, in addition to the proposed Tacoma Water HCP. A general description of the most important of these programs follows.

Endangered Species Act. The 1973 ESA provides for the conservation of ecosystems upon which threatened and endangered species of fish, wildlife, and plants depend. The ESA, among other things, also: 1) authorizes the determination and listing of species as endangered and threatened; 2) requires the development of a recovery plan for listed species; 3) prohibits unauthorized taking, possession, sale, and transport of endangered and threatened species; and, 4) requires federal agencies (including USFWS and NMFS) to ensure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of a listed species.

Magnuson-Stevens Fishery Conservation and Management Act. This Act governs management of commercial offshore fishing activities as well as the riverine and offshore habitat used by commercially harvested species. In 1996, the Act was reauthorized and changed extensively by amendments called the

Sustainable Fisheries Act to emphasize the importance of habitat protection by designation of "Essential Fish Habitat." Once Essential Fish Habitat has been identified, federal agencies and other entities funded by federal dollars will be required to consult with NMFS regarding planned federal activities and to respond to NMFS comments in writing within 30 days, outlining the measures proposed to avoid, mitigate, or offset impacts to Essential Fish Habitat.

Washington Department of Fish and Wildlife Priority Species and Habitats. The WDFW identifies habitats and species determined to be priorities, maps the known locations of priority habitats, provides recommendations on the conditions required to maintain healthy populations of priority species and viable functioning priority habitats, and provides consultation and guidance on land use issues.

Water Resources Management. Water Resources Management activities evaluated for the purpose of this analysis will include actions initiated under the following:

- The Flood Control Act of 1936 extended the USACE authority for flood damage reduction to the entire country, to address the solution of flooding problems affecting the public interest that were too large or complex to be handled by state or local governments. Actions conducted under this Act that are relevant to the cumulative effects analysis include construction and maintenance of flood control levees and revetments, and construction and operation of dams used to regulate flood flows.

- The Water Supply Act of 1958 authorized the USACE to provide additional storage in its reservoirs for municipal and industrial water supply. The USACE may also provide water for irrigation under terms of the Flood Control Act of 1944. The Water Resources Development Act of 1986 authorized the USACE to propose modifications of its existing projects for environmental improvement.

- The 1967 Minimum Water Flows and Levels Act (Chapter 90.22 RCW) directed Ecology to adopt regulations to establish minimum flows (or levels) on streams and lakes to protect "fish, game, birds, and other wildlife, recreational or aesthetic values or to preserve water quality".

- The 1999 Watershed Management Act (Engrossed Substitute House Bill SHB 2496) established a process for local governments in the state of Washington to conduct watershed planning. This planning will be used to address water quality, water quantity, and salmon habitat issues.

Development. Development for the purposes of this analysis is defined as the conversion of agricultural or forestland to urban industrial or residential areas. Development is controlled primarily at the state level, but federal permits are needed in some cases. Plans regulating development considered for this analysis include:

- U.S. Army Corps of Engineers Section 404 permitting. This program is the principal way in which the federal government protects wetlands and other aquatic environments. The USACE is required by law to consider all factors involving the public interest, including (but not limited to) economics, environmental concerns, historical values, fish and wildlife, water supply and water quality.

- Growth Management Act. In 1990, the state of Washington passed the GMA, which requires all cities and counties to plan for growth while protecting natural resources. All jurisdictions must classify and designate natural resource lands (like agricultural and forestland) and critical areas. These jurisdictions must also adopt regulations such as zoning, subdivision ordinances, and other land use controls to protect the critical areas. This Act also requires that applications for building permits must include evidence of adequate water supply for the intended use.

- Shorelines Management Act. The state Shorelines Management Act protects and regulates management that could impact shorelines of the state. Shorelines of the state include streams with a mean annual flow of more than 20 cfs and lakes larger than 20 acres. Associated shorelines include lands within 200 feet of the ordinary high water mark and wetlands or river deltas associated with the streams. Activities proposed within shorelines of the state must comply with permitting and development requirements set forth in the Shoreline Master Program and Shoreline Regulations. Policies and regulations

governing shorelines of the state are currently under review, and are expected to be revised in the near future to increase the protection afforded these areas.

Development undertaken or approved by cities, counties, and regional government entities in the future that would affect listed species is also subject to take prohibitions under the ESA. The Section 4(d) rule adopted by NMFS in June 2000 exempts certain municipal, commercial, and industrial development from take prohibitions. Take prohibitions do not apply to municipal, commercial, and industrial developments conducted pursuant to city, county, or regional ordinances or plans that NMFS has determined adequately protect listed species. NMFS will evaluate plans submitted using 12 criteria. According to those criteria, approved plans must:

- avoid unstable slopes, wetlands, and areas of high habitat value;
- adequately avoid stormwater discharge impacts to water quality, water quantity, or the hydrograph, including peak and baseflows;
- adequately protect riparian areas to attain or maintain properly functioning conditions around all streams, estuaries, or lakes;
- avoid stream crossings by roads wherever possible;
- protect stream meander patterns and channel migration zones and avoid hardening banks and shoreline;
- protect wetlands and wetland functions;
- preserve the hydrologic capacity of streams to pass peak flows;
- include adequate provisions for landscaping with native species to reduce the need for watering, fertilization, and pesticides;

- **#** include adequate provisions to prevent erosion and sediment delivery during construction;

- **#** ensure that water supply demands can be met without impacting flows either directly or through groundwater withdrawals;

- **#** provide necessary enforcement, funding, reporting, and implementation mechanisms and formal plan evaluations at 5-year intervals; and

- **#** comply with all other state and federal laws and permit requirements.

Forest Management. Forest management activities for the purpose of this analysis are defined based on the intensity of management activities. Forest management strategies considered for this analysis include the following:

- **#** Federal Reserve Areas. These areas include forestlands in national parks, congressionally withdrawn wilderness areas, and national forestlands designated as Late Successional Reserves under the Northwest Forest Plan. These areas generally have few habitat-altering activities, relatively low density of human use, few or no roads, and often support undisturbed native vegetation. These areas provide the greatest conservation benefit for fish and wildlife.

- **#** Federally Managed Areas. These forestlands include national parks and areas designated as Adaptive Management Areas and Matrix lands under the Northwest Forest Plan and other managed federal forestlands. These areas are managed for relatively light extractive purposes, with an emphasis on minimizing negative effects to native flora and fauna. Their primary mission is generally biodiversity protection, with human uses that are compatible with sustaining ecosystem health.

- **#** State and County Parks. State and county parks often contain forestlands that are typically not managed for timber extraction, but that may have a great deal of visitor use

and contain campgrounds and other recreational and maintenance facilities. Their value as wildlife habitat is lower as compared to larger and less intensively used national parks and wilderness areas.

HCPs. Lands currently covered by HCPs consist primarily of forestlands. Forestlands covered by HCPs are managed for timber production primarily, and fish and wildlife protection secondarily. Forest management, as directed by the terms and conditions of HCPs in Washington, is considerably more attentive to the needs of fish and wildlife species than current forest practices alone would require. There is an emphasis on providing for the needs of healthy aquatic and riparian ecosystems through improved road management, reduced landsliding, and increased riparian buffer widths along streams, ponds and wetlands. There is also an emphasis on replacing lost structures important to upland wildlife in managed stands, such as increasing the size and number of wildlife trees, snags and downed logs, and increasing the amount of older forest across the landscape. For the purposes of this analysis, this ~~This~~ category has been broken down into completed HCP lands, City of Tacoma lands in the Upper Green River Watershed, and other in-progress HCP lands. In-progress is defined as an HCP: 1) for which a notice has been published in the Federal Register announcing the initiation of a NEPA review of the proposal; and 2) that is expected to be submitted to the Services with a formal application for an ITP by the end of calendar year 1999.

Tribal. These forestlands are managed in a variety of ways, depending on location and tribal leadership. Tribal lands are experiencing much of the same pressures that private lands are experiencing elsewhere in western Washington. Tribal lands in the Puget Trough are undergoing land use conversions and urbanization, whereas those in more remote areas of western Washington are managed primarily for commodity production. Many tribal lands have their own forest management regulations that are often comparable to or slightly better than state regulations at protecting fish and wildlife.

Other Private. These lands include all of the remaining forestland in western Washington (not in one of the previous five management strategies) and are primarily under private

ownership. While some of these lands may not be actively managed for timber production, any timber harvest that does occur must be managed according to Forest Practices Rules. Of the six management categories, these areas provide the least conservation benefit for fish and wildlife.

Methods

Computer-based Mapping Analysis

The computer-based mapping analysis combined several GIS data sets to identify and quantify land type, forest management strategies and fish-bearing stream miles in western Washington, the Southwest Cascades Physiographic Province, and WRIA 9.

Land Type. Land use/land type data was obtained from the Combo 100 coverage (U.S. Fish and Wildlife Service 1997). The outer analysis area (western Washington) covers approximately 21.3 million acres. The Southwest Cascades Physiographic Province and WRIA 9 are subsets of the total, containing 2.8 million acres and 338,000 acres, respectively. Land type designations within these geographic boundaries used in this analysis (minimum mapping polygon of 100 square meters or 2.5 acres) include the following:

- Forestland – includes late seral, mid-seral, early seral and hardwood/other forest;
- Agricultural Land – includes cropland, pastures, orchards, groves, vineyards, nurseries, confined feeding operations, rangelands, and other agricultural lands;
- Wetland – includes streams, canals, lakes, reservoirs, bays and estuaries, forested wetlands, and non-forested wetlands;
- Barren Land – includes dry salt flats, beaches, other sandy areas, bare exposed rock, strip mines, quarries, gravel pits, tundra, perennial snowfields, and glaciers; and
- Developed Land – includes residential, commercial, industrial, transportation, communications, mixed urban, and built-up urban areas.

Fish-bearing streams. Comprehensive, high quality digital data depicting the location and extent of streams used by each covered fish species are not available for the geographic range used in this analysis. As a surrogate for fish distribution data, Streamnet, a 1:100,000-scale river and stream database (Washington Department of Fish and Wildlife 1997) was used. These data are at a fairly low level of resolution, and underestimate total stream mileage, especially in smaller streams. While the WDFW data are known to be an under-representation of the actual extent of streams that fish use, the degree of underestimation is believed to be consistent across all geographic scales used for this analysis. While Streamnet does contain data on the estimated extent and location of streams used by many of the individual species covered by the Tacoma Water HCP, examination of the data for WRIA 9 indicated that the database assumed streams upstream of Howard Hanson Dam currently support anadromous chinook salmon. The upstream migration of adult chinook salmon is presently stopped by Tacoma's Headworks and Howard Hanson Dam. Since the species-specific data for this portion of the analysis area was known to overestimate the length of stream used by some species, the cumulative effects analysis conducted for this EIS is not broken up by species, and utilizes only data based on the total length of fish-bearing streams.

Management strategies. The spatial extent of the various forest management strategies employed in the analysis area can be quantitatively estimated based on digital ownership data (U.S. Fish and Wildlife Service 1997). The spatial extent of other management activities (outside forestlands) considered in this analysis cannot be quantified based on ownership alone. For this reason the cumulative effects of these actions are analyzed qualitatively based on known associations with general land types (e.g., Section 404 permitting and activities regulated under the GMA are most prevalent in the developed and agricultural land types) and narrative descriptions of specific projects or trends.

4.4.2 Context

This subsection presents graphic information to provide context to the cumulative effects discussions in subsection 4.4.3 below. These cumulative effects are considered in the context of land cover, management strategies, and fish-stream distribution, which may affect the ESA-listed fish and wildlife species covered by the proposed HCP and ITP, within the geographic scope of the Southwest Cascades Physiographic Province and western Washington.

Six data sets are presented for each of the three geographic boundaries, for a total of 18 data sets (Figures 4-11 through 4-28). Each set of six is divided into two series. The first series illustrates: 1) land type (forestland, agriculture, wetlands, barren, developed) distribution; and 2) fish-bearing stream distribution within each of the land types. The second series focuses only on forestland land type and includes: 1) distribution of forestland management strategy (federal no-harvest areas, federal harvest areas, state and county parks, HCP, tribal, other private); 2) distribution of old forests by management strategy; 3) distribution of fish-bearing streams by management category; and 4) distribution of fish streams in old forests by management category. Old forest is defined for the purposes of these analyses as nesting, roosting, foraging, and some marginal nesting, roosting, foraging owl habitat (Types A, B, and some Type C habitat [U.S. Fish and Wildlife Service 1997]). The analyses did not include non-fish-bearing streams because the resolution of currently available GIS data limits the detection of smaller streams, effectively preventing the detection of non-fish-bearing streams, which are primarily small streams.

Southwest Cascades Physiographic Province

Land Type

Figure 4-11 depicts land type distribution in the Southwest Cascades Physiographic Province. A significant majority of the Province is composed of Forestland.

Fish-bearing Streams by Land Type

Figure 4-12 depicts fish-bearing stream distribution, by land type, within the Southwest Cascades Physiographic Province. A significant majority of the fish-bearing streams within the Province occur on Forestland.

Forest Area by Management Strategy

Figure 4-13 depicts the distribution of management strategies on the forestlands within the Southwest Cascades Physiographic Province. Forestland within the Province is composed primarily of Federal Reserve Areas (approximately 37% and Private Lands). Private ownership of forestland where timber management is subject to Forest Practices Rules is the second most common management strategy (approximately 29%) within the Province. A total of 15 percent of the land within the Province is covered by completed or in-progress HCPs, including the Tacoma Water HCP.

Figure 4-11. Land Type: Southwest Cascades Physiographic Province.

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Figure 4-12. Fish streams by Land Type: Southwest Cascades Physiographic Province.

PLACEHOLDER

Figure 4-13. Forest Area by Management Strategy: Southwest Cascades Physiographic Province.

PLACEHOLDER

Old Forest by Management Strategy

Figure 4-14 depicts the distribution of management strategies in old forest within the Southwest Cascades Physiographic Province. There are approximately 724,000 acres of old forest in the Southwest Cascades Physiographic Province, representing about 28 percent of all forestlands. Federal Reserve Areas and Federally Managed Areas contain the greatest abundance of old forest (approximately 76% combined). Lands covered by completed HCPs contain the second greatest abundance of old forest (approximately 11%). Private ownership where timber management is subject to Forest Practices Rules composes the third greatest abundance of old forest within the Province (approximately 8%). Approximately 3,582 acres of old forest occurs in the Action Area (on Tacoma's ownership), which equates to 0.5 percent of the old forest in the Province.

Fish-bearing Streams by Management Strategy

Figure 4-15 depicts the distribution of fish-bearing streams on forestland, by management strategy, within the Southwest Cascades Physiographic Province. Federal Reserve Areas contain the greatest concentration (approximately 40%) of fish-bearing streams; private ownership where timber harvest is subject to Forest Practices Rules contain the second greatest concentration of fish streams (approximately 25%). Lands covered by completed or in-progress HCPs (including the Action Area) contain the third greatest concentration of fish-bearing streams in the Province (approximately 14%). Approximately 89 miles of fish-bearing streams occur in the Action Area, which equates to approximately 2 percent of the total miles of fish-bearing streams in the Province.

Fish-bearing Streams in Old Forests by Management Strategy

Figure 4-16 depicts the distribution of fish-bearing streams in old forests, by management strategy, within the Southwest Cascades Physiographic Province. Federal Reserve Areas contain the greatest concentration of fish-bearing streams (approximately 52%) in old forests, and Federally Managed Areas contain the second greatest concentration (approximately 27%). Lands covered by completed or in-progress HCPs, including the Action Area, contain the third greatest concentration (approximately13%). Other private lands where timber harvest is subject to Forest Practices Rules contain approximately 7 percent.

Figure 4-14. Old Forest by Management Strategy: Southwest Cascades Physiographic Province.

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Figure 4-15. Fish Streams by Management Strategy: Southwest Cascades Physiographic Province.

PLACEHOLDER

Figure 4-16. Fish Streams in Old Forest: Southwest Cascades Physiographic Province.

PLACEHOLDER

Water Resource Inventory Area 9

Land Type

The majority of WRIA 9 is composed of Forestland (63%) (Figure 4-17). However, approximately 25 percent of the basin is developed; developed areas are concentrated in the lower basin downstream of Howard Hanson Dam and the Tacoma Diversion Headworks.

Fish-bearing Streams by Land Type

Figure 4-18 depicts fish-bearing stream distribution, by land type, within WRIA 9. The majority of the fish-bearing streams within WRIA 9 occur on Forestland (~~71~~ 72%). However, 16 percent of the fish-bearing streams occur on Developed Lands and 11 percent of the fish-bearing streams occur on Agricultural Lands.

Forest Area by Management Strategy

Figure 4-19 depicts the distribution of management strategies on the forestlands within WRIA 9. Forestland within WRIA 9 is composed primarily of privately owned lands (approximately 45%) where timber management is subject to Forest Practices Rules. Lands covered by completed or in-progress HCPs, including ~~the Action Area~~ Tacoma Water's HCP, are the second most common management strategy (approximately 36%) within WRIA 9. Federal Reserve and Federally Managed Areas comprise only 15 percent of the land within WRIA 9.

Old Forest by Management Strategy

Figure 4-20 depicts the distribution of management strategies in old forest within WRIA 9. There are approximately 43,000 acres of old forest in WRIA 9, representing approximately 20 percent of all forestlands there. Completed HCPs, including the Washington DNR and Plum Creek HCPs, contain the greatest abundance of old forest (approximately 39%). Federally Managed and Federal Reserve Areas contain the second greatest abundance of old forest (approximately 27%). Private ownership where timber management is subject to Forest Practices Rules comprises the third greatest abundance of old forest within WRIA 9 (approximately 21%). Approximately 3,582 acres of old forest occurs in the Action Area (on Tacoma's ownership), which equates to just over 8 percent of the old forest in WRIA 9.

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Figure 4-17. Land Type: WRIA 9.

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Figure 4-18. Fish Streams by Land Type: WRIA 9.

PLACEHOLDER

Figure 4-19. Forest Area by Management Strategy: WRIA 9.

PLACEHOLDER

Figure 4-20. Old Forest by Management Strategy: WRIA 9.

PLACEHOLDER

Fish-bearing Streams by Management Strategy

Figure 4-21 depicts the distribution of fish-bearing streams on forestland, by management strategy, within WRIA 9. Completed HCPs contain the greatest concentration (approximately 29%) of fish-bearing streams, and the Action Area contains the second greatest concentration of fish streams (approximately 26%). Federally Managed Areas and Federal Reserve Areas are concentrated in the basin headwaters, and contain only about 16 percent of the fish-bearing streams in WRIA 9. Approximately 89 miles of fish-bearing streams occur in the Action Area, which equates to approximately 18 percent of the total miles of fish-bearing streams in WRIA 9.

Fish-bearing Streams in Old Forests by Management Strategy

Figure 4-22 depicts the distribution of fish-bearing streams in old forests, by management strategy, within WRIA 9. Completed HCPs contain the greatest concentration of fish-bearing streams (approximately 33%) in old forests, and Federally Managed and Federal Reserve Areas contain the second greatest concentration (approximately 33%). The Action Area contains 13.2 percent of all fish-bearing streams in old forest. Other private lands where timber harvest is subject to Forest Practices Rules contain approximately 16 percent.

<u>Western Washington</u>

Land Type

Figure 4-23 depicts land type distribution in western Washington. The majority of this analysis area is composed of Forestland (78%). Agricultural lands make up 9 percent of the total, while Barren Lands (6%), Developed Lands (4%) and Wetlands (3%) comprise the remainder.

Fish-bearing Streams by Land Type

Figure 4-24 depicts fish-bearing stream distribution, by land type, within western Washington. A significant majority of the fish-bearing streams within western Washington occur on Forestland (83%).

Figure 4-21. Fish Streams by Forest Management Strategy: WRIA 9.

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Figure 4-22. Fish Streams in Old Forest: WRIA 9.

PLACEHOLDER

Figure 4-23. Land Type: Western Washington.

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Figure 4-24. Fish Streams by Land Type: Western Washington.

PLACEHOLDER

Forest Area by Management Strategy

Figure 4-25 depicts the distribution of management strategies on the forestlands within western Washington. Forestland within western Washington is primarily on privately owned land where timber management is subject to Forest Practices Rules (approximately 36%) and in Federal Reserve Areas (approximately 35%).

Old Forest by Management Strategy

Figure 4-26 depicts the distribution of management strategies in old forest within western Washington. Approximately 23 percent of all forestlands in western Washington support old forest. Federal Reserve Areas contain the greatest abundance of old forest (approximately 51%); Federally Managed Areas and Completed HCPs contain the second greatest abundance of old forest (approximately 11% and 14%, respectively). Private ownership where timber management is subject to Forest Practices Rules comprises approximately 13 percent of old forest within western Washington. The Action Area represents less than 1 percent of old forest in western Washington.

Fish-bearing Streams by Management Strategy

Figure 4-27 depicts the distribution of fish-bearing streams on forestland, by management strategy, within western Washington. The greatest concentration of fish-bearing streams is located on Federal Reserve Areas (approximately 36%), and on privately owned lands where timber harvest is subject to Forest Practices Rules (approximately 35%). Completed HCPs and Federally Managed Areas contain the third greatest concentration of fish-bearing streams (approximately 10% and 9%, respectively) in western Washington. The Action Area includes less than 1 percent of fish-bearing streams on forestlands in western Washington.

Fish-bearing Streams in Old Forests by Management Strategy

Figure 4-28 depicts the distribution of fish-bearing streams in old forests, by management strategy, within western Washington. Federal Reserve Areas contain the greatest concentration of fish-bearing streams in old forests (approximately 59%). Federally Managed Areas and Completed HCPs contain the next greatest concentration (approximately 12% and 13%, respectively). Privately owned land where timber harvest is subject to Forest Practices Rules contain approximately 13 percent of fish-bearing streams in old forests within western Washington. The Action Area includes less than 1 percent of all streams in old forest within western Washington.

Figure 4-25. Forest Area by Management Strategy: Western Washington.

PLACEHOLDER

Figure 4-26. Old Forest by Forest Management Strategy: Western Washington.

PLACEHOLDER

Figure 4-27. Fish Streams by Forest Management Strategy: Western Washington.

PLACEHOLDER

Figure 4-28. Fish Streams in Old Forest: Western Washington.

PLACEHOLDER

THE CUMULATIVE EFFECTS ANALYSES HAVE BEEN EXPANDED IN RESPONSE TO PUBLIC COMMENTS. MANY OF THE FOLLOWING SUBSECTIONS CONTAIN NEW TEXT; HOWEVER, FOR READABILITY THIS HAS NOT BEEN PREPARED IN UNDERLINE/STRIKEOUT FORMAT

4.4.3 Cumulative Effects Discussions

This subsection presents cumulative effects discussions for the fish and wildlife species covered by the proposed HCP and ITP. These effects are considered in the context of land type, forestland management strategies, and fish-bearing stream distribution, which may affect Covered Species within the geographic scope of the Southwest Cascades Physiographic Province and western Washington. Species-specific management plans, such as the North Cascades Ecosystem Recovery Plan for the Grizzly Bear (U.S. Fish and Wildlife Service 1997), are taken into account in addition to the management strategies listed above. The goal of these cumulative effects discussions is to analyze and determine the cumulative, regional "conservation contribution" (positive and/or negative) that would result from the Proposed Action for each of the ESA-listed fish and wildlife species covered by the proposed HCP and ITP. This subsection is divided into two discussions: 1) Fish and Aquatic Habitat and 2) Wildlife.

4.4.3.1 Fish and Aquatic Habitat

The following discussion is presented as three separate topics: 1) Management Activities Affecting Fish and Aquatic Habitat, 2) Direct and Indirect Impacts of the Proposed Action on Covered Fish Species, and 3) Analysis of Cumulative Effects on Covered Fish Species and Aquatic Habitat.

Management Activities Affecting Fish and Aquatic Habitat

A number of specific projects, policies, and programs that have been or will be initiated at the federal, state, and local levels affect the covered fish species in the Action Area, WRIA 9, and western Washington. These plans, policies, and programs are listed in Table 4-9 and discussed in the following text.

Table 4-9. Management Plans/Programs Affecting Salmonids and Salmonid Habitat in the Tacoma HCP Cumulative Effects Analysis Area.

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Federal Plans, Policies, and Programs

Federal management plans or activities influencing fish or their habitat in the cumulative effects analysis area include the ESA 4(d) Rules, ESA Section 7 Consultations, USACE flood control and water storage, environmental improvement projects, and implementation of the federal Northwest Forest Plan.

Endangered Species Act

4(d) Rules. In June 2000, the NMFS adopted a rule prohibiting the "take" of 14 groups of salmon and steelhead listed as threatened in accordance with Section 4(d) of the ESA. This rule prohibits anyone from taking a listed salmon or steelhead, except in cases where the take is associated with an approved program. The 4(d) rule also exempts certain existing state and local programs from take prohibitions under the ESA and creates a means for NMFS to exempt additional programs if they meet specified standards set out in the rule.

The 4(d) rule covers 14 Evolutionarily Significant Units (ESUs) of salmon and steelhead in Idaho, Washington, Oregon, and California. The rule follows the standard practice of prohibiting the killing or injuring of a listed species (i.e., "take") without specific written authorization; that is its principal function. The rule applies to ocean and inland areas, and to any authority, agency, or private individual subject to United States jurisdiction. Activities or developments not likely to kill or harm protected species are not affected by the rule. The rule does not prohibit actions or programs; it simply defines which actions are likely to lead to unauthorized take. The 4(d) rule became effective on September 8, 2000 for steelhead ESUs; it will become effective on January 6, 2001 for salmon ESUs. Adoption of the 4(d) rule does not mandate or require that specific actions be carried out by water providers, it simply defines take and thereby motivates water providers to examine their practices to ensure take will not occur.

ESA Section 7 Consultations. Federal agencies are required under Section 7 of the ESA to ensure that their actions do not jeopardize the continued existence of threatened and endangered species or result in the destruction or adverse modification of critical habitat for listed species. If an agency finds that a proposed action may affect a listed species or its critical habitat, that agency is obligated to consult on the action with the NMFS or USFWS. If the NMFS or USFWS find the proposed action is not likely to adversely affect a listed species, they provide written concurrence, and the action is considered to be in

compliance with Section 7 of the ESA. Conversely, if either the NMFS or USFWS finds the action may have an adverse effect on a listed species, they enter formal consultation and prepare a Biological Opinion to assess whether the effect would result in jeopardy to the listed species or adverse modification of critical habitat. If the Services find no jeopardy and no adverse modification of critical habitat, then the action can proceed. In such cases, the Services provide the federal agency undertaking the action with an Incidental Take Statement specifying the level of impact that would occur, the reasonable and prudent measures considered necessary to minimize the impact, and any other terms and conditions considered necessary. If the action is found to cause jeopardy or result in the adverse modification of critical habitat, it cannot proceed without an exemption under Section 7(g) of the ESA.

The USACE is currently conducting formal consultation with the Services on operation and maintenance of Howard Hanson Dam, including implementation of the Additional Water Storage Project. Operation of Howard Hanson Dam has the potential to affect listed species, such as Puget Sound chinook salmon and bull trout, by altering flows in the Green River, interrupting the downstream transport of wood and sediment, and isolating critical habitat upstream of the dam. A recent programmatic biological assessment of the USACE's Howard Hanson Dam operations indicated that a number of conservation measures, designed to address transport of large woody debris and sediment, and upstream and downstream fish passage, would be required to avoid take of listed fish species (U.S. Army Corps of Engineers 2000). Monitoring of the effectiveness of those conservation measures would also be required.

As part of a 1995 agreement between the Muckleshoot Indian Tribe and City of Tacoma, the City agreed to provide for the passage of adult fish upstream around its Headworks and Howard Hanson Dam. Downstream fish passage facilities at Howard Hanson Dam, and measures designed to partially restore transport of large woody debris and gravel-sized sediments below Howard Hanson Dam, would be provided as part of the Additional Water Storage Project. In the absence of the MIT/TPU Agreement and the Additional Water Storage Project, it is unlikely that federal funding would be available to provide upstream and downstream fish passage at Howard Hanson Dam (U.S. Army Corps of Engineers 1998).

In addition to providing for passage of adult fish upstream around its Headworks and the USACE's Howard Hanson Dam, Tacoma Water is the local sponsor of the proposed Additional Water Storage Project. Tacoma Water is providing a portion of the funding for this project, and many of the actions proposed under the Additional Water Storage Project are covered activities under its HCP; thus, the Additional Water Storage Project and Tacoma Water HCP are considered interdependent activities. A complete description of the actions to be undertaken as part of the Additional Water Storage Project, the effects of those actions, and the proposed mitigation and monitoring program is provided in the USACE DEIS for the project completed in 1998 (U.S. Army Corps of Engineers 1998). Those effects are summarized in the following section.

U.S. Army Corps of Engineers Flood Control Act and Water Resources Development Act

Section 1135 Project. Under the authority of Section 1135 of the Water Resources Development Act of 1986, the USACE conducted a study in 1996 of potential modification of Howard Hanson Dam operations to increase the opportunity of flow augmentation to benefit downstream aquatic resources and to mitigate associated impacts to fish and wildlife habitat within the reservoir. In April 1997, approval was granted to increase the volume of summer conservation storage contingent upon signing of the Local Cooperation Agreement by the project local sponsor, the City of Tacoma.

The Section 1135 Project provides for storage of up to 5,000-acre feet of storage for flow augmentation. This will increase the maximum pool elevation behind Howard Hanson Dam from 1,141 feet MSL to 1,147 feet MSL. Water stored under the Section 1135 Project is currently targeted for use only during drought years (estimated frequency of storage is once every 5 years), but can be stored on an annual basis under adaptive management provisions of the Section 1135 Project.

A complete description of the effects and restoration/mitigation measures to be implemented under the Section 1135 Project is provided in the NEPA Environmental Assessment completed by the USACE and Tacoma Public Utilities in 1996 (HDR Engineering, Inc. and Beak Consultants Inc. 1996). Storage of 5,000-acre feet of water at a rate of 250 cfs per day would reduce flows downstream of Howard Hanson Dam for approximately 10 days each spring. Flow reductions that occur under the Section 1135 Project have the potential to delay and increase mortality of juvenile salmonids outmigrating during the spring refill period. The redds of early spawning steelhead could also be dewatered during the refill period. Storage

of additional water would increase the length of riverine habitat inundated between mid-May and early August by approximately 1,100 feet on the mainstem Green River, and by a total of approximately 1,700 feet in nine tributaries. Seasonal inundation of riverine habitat would likely reduce macroinvertebrate production (HDR Engineering, Inc. and Beak Consultants Inc. 1996) and has been shown to reduce habitat quality (Wunderlich and Toal 1992). Such impacts currently occur as a result of surcharging the inundation pool to facilitate debris removal, but would have a greater duration under the Section 1135 Project.

Adaptive management of the volume and frequency of storage and the pattern of refill and flow release would minimize the adverse effects of the Section 1135 Project on downstream aquatic resources. Water stored under the Section 1135 Project would be adaptively managed to augment low summer flows or otherwise released to benefit downstream resources. In addition, a series of restoration and mitigation measures would be implemented to maintain or improve newly inundated habitat behind Howard Hanson Dam. Mitigation and restoration projects implemented under the Section 1135 Project would increase wood and vegetation cover within the reservoir and along the inundated portion of nine tributaries. The construction of floating log islands will benefit rearing salmonids by providing cover and structure, but could also increase predation by species such as loons (Warner, pers. comm., 14 February 2000). Removal of barriers would improve or restore fish passage at two sites, increasing the amount of habitat accessible to salmonid fishes by approximately 1 mile. Habitat in the currently inaccessible reaches is considered to be of moderate quality (Ging 1996).

Additional Water Storage Project. The USACE is proposing an Additional Water Storage Project to provide up to an additional 32,000 acre-feet of water storage behind Howard Hanson Dam by raising the existing summer conservation pool to elevation 1,177 feet. The Additional Water Storage Project would be implemented in two phases. In Phase I, a downstream fish passage facility would be constructed at the dam, and water storage would be increased by up to 20,000-acre-feet for municipal use. Storage of water under the Section 1135 Project would be conducted annually under the Additional Water Storage Project. In addition to construction of a downstream fish passage facility, Phase I would include a number of habitat restoration and mitigation projects.

In Phase II, an additional 12,000-acre-feet of storage would be added over and above the Phase I conditions (9,600-acre-feet would be available for fisheries and 2,400-acre-feet for municipal and industrial water supply). The acceptance of Phase II storage will be based on the successful performance of Phase

I as determined through monitoring. Monitoring will also determine the adequacy of Phase II mitigation and restoration as currently proposed.

Tacoma is the local sponsor of the Additional Water Storage Project. Water stored for municipal use represents an exercise of Tacoma's Second Diversion Water Right. As local sponsor, Tacoma is contributing funding for mitigation and restoration projects and monitoring. A number of the mitigation/restoration projects and monitoring activities would be covered activities under the ITP.

While Tacoma Water is the local sponsor for the Additional Water Storage Project, the USACE is the lead federal agency. As a federal action, the Additional Water Storage Project cannot be covered by the ITP that Tacoma Water is requesting under Section 10 of the ESA. Consequently, the effects of the Additional Water Storage Project are not addressed in Tacoma Water's HCP. Incidental take coverage for the Additional Water Storage Project will be secured by the USACE through the process prescribed in Section 7 of the ESA. The USACE will prepare the necessary documentation and consult with the Services, who will then determine whether incidental take coverage can be provided, and under what conditions.

Tacoma Water is dependent on the Additional Water Storage Project to allow water withdrawn under Tacoma's Second Diversion Water Right in early spring to be stored behind Howard Hanson Dam for use in early spring to be used in the late summer and early fall. This storage and release would not occur unless and until the USACE obtains incidental take coverage for the Additional Water Storage Project. Similarly, the conservation measures in the HCP related to the impacts of the Additional Water Storage Project would not occur unless and until the Additional Water Storage Project receives all federal approvals, including incidental take coverage under Section 7 of the ESA. These mitigation measures include construction and operation of downstream passage facilities and implementation of certain fish and wildlife habitat restoration activities. This interdependence between Tacoma and the USACE will ensure that the environmental effects of all activities will be addressed, and incidental take coverage will be secured for any and all anticipated take of federally listed species before the Additional Water Storage Project is implemented.

The proposed Additional Water Storage Project has been subjected to extensive agency review; the effects are described in detail in an EIS prepared by the USACE (U.S. Army Corps of Engineers 1998). Because

Tacoma Water's HCP and the Additional Water Storage Project are interdependent, changes in the flow regime resulting from storage and release of up to 20,000-acre-feet of water for municipal use and up to 5,000-acre-feet of water stored for downstream flow augmentation under the Section 1135 Project were also analyzed in the HCP. Under the combined actions, flows at Auburn would generally be reduced by up to 400 cfs during March through mid-April, increased by up to 400 cfs for sustained periods from mid-April through mid-June, and increased during the late summer and fall by 20 to 120 cfs. Detailed descriptions of the effects of these changes on the Covered Species are provided in subsection 4.2 of this FEIS.

Storage of water under the Additional Water Storage Project is a USACE Action, and thus was not addressed in the HCP. The primary effect of storing an additional 25,000-acre-feet of water under Phase I would be to inundate approximately 281 acres of terrestrial habitats (including 79 acres of riparian) and 1.9 miles of riverine habitat (11.5 acres). Based on a study of the existing inundation zone, riverine habitats would be expected to experience substantial reductions in vegetative cover, bank stability and pool habitats, and an increase in fine sediments within riffles (Wunderlich and Toal 1992). Mitigation measures will ameliorate some, but not all, of these effects.

A number of fisheries mitigation and restoration projects would be implemented under the Additional Water Storage Project. As local sponsor, Tacoma Water will contribute funding and may assist with the implementation of all mitigation and restoration projects implemented as part of the Additional Water Storage Project. All of these projects are therefore considered covered activities under Tacoma's HCP, and the effects are described fully in Chapter 7 of the HCP and in subsection 4.2 of this FEIS.

Monitoring and adaptive management are important components of the Additional Water Storage Project. Tacoma is also providing funds for monitoring and adaptive management component, thus those actions are considered covered activities under the HCP, and were included in the effects analysis as described in FEIS subsection 4.2. In addition to the research monitoring program to be implemented under the Additional Water Storage Project and HCP, the USACE is developing a basin-wide monitoring coordination program designed to facilitate communication between the various resource management agencies and other entities conducting habitat restoration projects within the Green River Watershed. This program will ensure that monitoring is efficient and cost effective and will prevent duplication of efforts.

Green/Duwamish Ecosystem Restoration Project. In 1995, a group of agencies, municipalities, and tribes in the Green/Duwamish River Basin recognized the need to improve the natural resources in the basin. While many of these entities had worked together on individual restoration projects, it became apparent that a more comprehensive approach to restoration was needed. The U.S. Army Corps of Engineers Restoration Policy (ER 1165-2-501) provided a convenient mechanism to take a broad view of the basin and its needs. The USACE and King County brought together a study team to conduct an Ecosystem Restoration Study designed to resolve ecosystem problems within the Green River Basin. During 1995 and 1996, the Ecosystem Restoration Study Team prepared a General Investigation Reconnaissance Phase Report (U.S. Army Corps of Engineers 1997). A draft programmatic EIS has been prepared as part of implementing the Ecosystem Restoration Program (Jones and Stokes 2000). The following text and information are drawn directly from those documents.

The Ecosystem Restoration Study provides the context, framework, and priorities for a basin-wide capital improvement program. The draft Restoration Plan is intended to improve the overall health of the Green Duwamish River Ecosystem for fish and wildlife species by increasing the quantity, quality, diversity, and connectivity of available habitat. Examples of activities to be conducted as part of the Restoration Plan include:

- reducing barriers to fish passage;
- improving habitat forming processes;
- increasing channel diversity;
- improving estuarine habitat; and
- increasing streamside vegetation.

Candidate projects have been identified and evaluated by the Ecosystem Restoration Study Team, which consists of a panel of biologists and other technical staff from the USACE, King County, the Muckleshoot Indian Tribe Fisheries Department, WDFW, USFWS, and representatives of several cities within the Green River basin. A feasibility analysis of the top-rated projects was conducted after evaluation and ranking of projects. The feasibility analysis included biological considerations as well as design, cost, permitting, access, and land purchase factors.

Several of the candidate restoration projects identified and evaluated by the Ecosystem Restoration Study Team may be partially funded under Tacoma Water's HCP. Examples include the placement of gravel and large woody debris in the mainstem downstream of the Headworks Dam. Other projects, such as replacement of culverts on Gale, Boundary, Sweeney, Olsen, May, Maywood, Gold, and North East Creeks would complement conservation measures implemented under Tacoma's HCP by providing access to additional habitat for anadromous salmonids released in the Upper Green River Watershed. Coordination between the Additional Water Storage Project and Green Duwamish Ecosystem Restoration Project is ongoing; however, additional coordination between Tacoma Water and the Ecosystem Restoration Study Team will be necessary to avoid duplication of efforts.

Overall, the projects implemented under the Green/Duwamish Ecosystem Restoration Project are expected to benefit aquatic habitat in the Green River basin. Placement of gravel and LWD, removal or modification of levees, reconnection and development of off-channel habitat, and planting of native riparian vegetation will help reestablish natural geomorphic processes and restore fish habitat to more natural conditions over the long term. Construction activities associated with some projects would result in localized and temporary disturbance to soils, surface water flow patterns, water quality, and rearing or migrating fish. Mitigation measures will be implemented to eliminate or reduce adverse impacts. Mitigation measures to be implemented under the Green/Duwamish Ecosystem Restoration Project include surveys to locate sensitive species, implementation of Best Management Practices for erosion control, air quality and noise, development of transportation plans for all restoration sites, and notification of local boating clubs and fishing groups regarding the location of LWD placement locations.

Northwest Forest Plan. Implementation of the aquatic conservation strategy under the federal Northwest Forest Plan in 1994 provided increased protection of aquatic habitat via a combination of riparian reserves designed to buffer streams and to protect unstable areas; designation of key watersheds that currently provide high quality habitat and serve as refugia for at-risk species; watershed analysis to evaluate geomorphic and ecological processes operating at a landscape scale; and a comprehensive program of watershed restoration to restore watershed health, riparian ecosystems, and fish habitats. This conservation strategy continues to serve as the cornerstone for aquatic habitat protection on federal forestlands.

State Plans, Policies, and Programs

Wild Salmon Policy

In response to the ESA listing of chinook and proposed listing of several other fish species, the state of Washington has implemented or is in the process of implementing a number of programs designed to support recovery plans developed by NMFS. A Joint Natural Resources Cabinet and Salmon Recovery Office has been established to develop a statewide strategy to address the listing of chinook and other salmonid species. A draft Wild Salmonid Policy was developed in cooperation with the western Washington Treaty Tribes, and adopted on 5 December 1997. The goal of the Wild Salmonid Policy is to protect, restore, and enhance the productivity, production, and diversity of wild salmonids and their ecosystems to sustain ceremonial, subsistence, commercial, and recreational fisheries (Washington Department of Fish and Wildlife 1997). Enforcement of laws against poaching, habitat destruction, water pollution and water withdrawal without a permit will be intensified by hiring additional staff. Water quality and quantity problems will be addressed by: 1) setting TMDLs for waterbodies that do not meet federal Clean Water Act standards; 2) installing additional stream gauges to monitor flows and to regulate water use; 3) making decisions on water rights; and 4) purchasing existing water rights to return water to streams.

Washington Department of Wildlife Priority Habitats and Species Program

The Washington Department of Wildlife has developed statewide riparian management recommendations to protect aquatic habitats and priority fish species. These recommendations cover major land use activities commonly conducted within or adjacent to stream channels including agriculture, chemical treatments, grazing, watershed management, roads, stream crossings, recreation, forest practices, urbanization and habitat restoration and enhancement.

Hatchery/Harvest

The state of Washington and Washington Treaty Tribes have co-management responsibilities for fisheries resources. Under the 1997 Wild Salmonid Policy, fisheries will be managed to: 1) maintain or increase genetic diversity within and among stocks; 2) maintain wild salmonid stocks at levels that naturally sustain ecosystem processes and diverse indigenous species; 3) meet the spawning escapement policy; 4) protect,

rehabilitate and reestablish naturally spawning populations using integrated principals of genetic conservation, ecology, hatchery production and fish management; and 5) use programs of stable, cost-effective artificial production to provide significant fishery benefits while having no significant adverse impacts on the long-term productivity of natural salmonids (Washington Department of Fish and Wildlife 1997).

Water Rights

Instream Flows. In 1980, Ecology established instream flow restrictions on the mainstem Green River at USGS gauge stations near Auburn (12113000) and Palmer (12106700) (WAC 173-509). Instream flow recommendations were developed based on a study conducted by the USGS that correlated low summer flows with adult salmon and steelhead returns (Swift 1984). Required instream flows at Auburn range from 300 cfs during the late summer to 650 cfs from 1 December through 14 June (Table 4-B), and are intended to protect steelhead spawning habitat in the Middle Green River (Caldwell and Hirschey 1989). Instream flows at Palmer range from 150 cfs to 300 cfs (Table 4-B).

In 1988, the Ecology completed an instream flow study using the USFWS Physical Habitat Simulation [PHABSIM] methodology that identified potential benefits associated with providing instream flows higher than required by the existing instream flow requirements (Caldwell and Hirschey 1989). However, the minimum flow requirements under Chapter 173-509 WAC have not yet been formally adjusted by Ecology to reflect the higher recommended flows.

Tacoma's First Diversion Water Right claim of 113 cfs is not constrained by these minimum instream flow requirements. In recent years, Tacoma Water has attempted to work cooperatively with resource agencies and the Muckleshoot Indian Tribe to reduce impacts of water withdrawals on fish and other instream resources. The 1995 MIT/TPU Agreement and Tacoma Water's proposed HCP would formalize Tacoma's commitment to maintain minimum flows that exceed those required by Ecology (see HCP subsection 5.1.2).

Table 4-B. Instream flow requirements at the USGS gauge at Auburn (USGS # 12113000) and Palmer (USGS # 12106700) under Ecology's Instream Resource Protection Program. These requirements may be modified during critical drought years (<1 in 10 low-flow frequency) as specified in WAC 173-509.

Surface Water Withdrawals. The Green River and its tributaries have been closed to further appropriations since 1980 (WAC 173-509). A total of 500 surface water rights have been issued in the Green River basin, and 717 claims were filed during the claims registration period (Culhane et al. 1995). The total quantity of surface water allocated by existing water rights is 195.2 cfs (Culhane et al. 1995). Excluding Tacoma Water's Second Diversion Water Right of 100 cfs, the principal water uses in the Green River basin are irrigation and domestic water supply, which respectively account for 57 percent and 18 percent of the remaining allocated water rights. The actual amount of water currently withdrawn under these water rights is not known. Water right claims amount to an additional 444.9 cfs; however, it is unknown how many of these claims will be granted or perfected in the future.

Declining trends in the average 7-day low flows have been detected in both Soos and Newaukum Creeks (Culhane et al. 1995). The most likely causes of the declines in both basins include decreased precipitation, increased ground water development and an increased percentage of impervious surfaces (Culhane et al. 1995).

Groundwater Withdrawals. The Green River basin has been closed to groundwater appropriations since 1980 (WAC 173-509). A total of 360 groundwater rights have been issued in the Green River basin, and 2,613 additional claims were filed during the claims registration period (Culhane et al. 1995). The total quantity of groundwater allocated by existing water rights amounts to approximately 350 cfs (Culhane et al. 1995). Rights to an additional 96 cfs of groundwater were claimed during the filing period. Municipal water use by entities other than Tacoma Water accounts for 60 percent of the groundwater permits, excluding Tacoma Water's North Fork Wellfield groundwater permit for 139 cfs (Culhane et al. 1995). Domestic use is the second largest water use.

Approximately 25 percent of the population of South King County draws water from small systems with five or fewer connections (South King County Groundwater Advisory Committee 1989). Small systems are exempt from water right permits. Rural development is increasing, and thus the number of small systems is expected to increase in the future, and could further reduce flow contributions to the Green River from tributary streams.

Watershed Management Act and Salmon Recovery Planning Act

The 1998 legislature passed the Watershed Management Act (ESHB 2514) and the Salmon Recovery Act (ESHB 2496) to set a framework for addressing the state's water resource and water quality issues as well as establishing instream flows and addressing salmon habitat needs. The Salmon Recovery Planning Act requires lead entities to use a critical pathways methodology to develop a habitat protection plan. The methodology must include a limiting factors analysis (which may have substantial overlap with a watershed management plan), identify local habitat project sponsors, determine how projects will be monitored and evaluated, and develop an adaptive management strategy. If a lead entity has completed a limiting factors analysis or a watershed management plan for a planning area, participating state agencies agree to use this analysis or plan as a factor in awarding grants for watershed planning and salmon recovery where possible, subject to statutory constraints. If watershed planning group includes a habitat element in its plan, state agencies will encourage lead entities under the Salmon Recovery Planning Act and watershed planning groups under the Watershed Management Act to jointly develop habitat projects. The limiting factors analysis for WRIA 9 is being developed jointly by the Washington Conservation Commission and a technical sub-committee of groups responsible for developing the WRIA 9 Conservation Plan.

Washington Department of Natural Resources Habitat Conservation Plan

The DNR HCP covers a number of anadromous salmonids. Under its HCP, the DNR will protect fish and aquatic habitat by maintaining riparian buffers on all Type 1 through 4 waters (as defined by WAC 222-16-030 and the Water Type Emergency Rule); by protecting Type 5 waters that flow through areas with a high risk of mass wasting; by allowing no overall net loss of naturally occurring wetland acreage and function; and by improving the design, construction, control of use, and maintenance of roads (Washington Department of Natural Resources 1997). The DNR HCP also covers several aquatic and upland wildlife species with a network of habitat reserves, seasonal disturbance buffers, and extended timber harvest rotations.

Washington Forest Practices Rules (WAC 222)

Existing Forest Practices Rules contain measures designed to protect aquatic habitats including standards and guidelines for road construction and maintenance; timber harvest on ~~unstable soils~~ unstable slopes;

riparian buffer requirements; and restrictions on the handling, storage, and application of forest chemicals. In addition, there are currently two emergency rules in effect: Water Type and Salmonid. The Water Type Emergency Rule establishes presumptions for determining fish use in the absence of field verification and is a prelude to updating the water type rules and associated riparian protection. The Salmonid Emergency Rule:

- extends the designation of Class IV special forest practices to harvest, road construction and related activities, and pesticide application within 100 to 200 feet of fish-bearing streams in geographic areas containing federally listed salmonids [WAC 222-16-050(1)(j) and WAC 222-16-080(1)(k)];

- requires the landowner to submit additional information prepared by a qualified expert that is specific to channel migration zones, channel condition, bank stability, sediment delivery and mass wasting, shade and LWD recruitment, and protection of the RMZ from windthrow; the landowner must also identify specific mitigation measures designed to reduce adverse impacts and mitigate for riparian area disturbance (WAC 222-10-020 and WAC 222-10-043);

- requires the DNR to consult with the WDFW, Ecology, local governments, and affected Indian tribes when evaluating the proposed application [WAC 222-10-020(2); WAC 222-10-040(1); WAC 222-10-043(4)];

- requires landowners owning more than 500 acres within listed ESUs to prepare road maintenance plans when notified, and subjects road maintenance and abandonment plans to annual review (WAC 222-24-050); and

- requires additional shade along Type 4 and 5 streams as needed, according to the temperature prediction method described in the Forest Practices Board Manual, except where landowners have an approved HCP that includes salmonid protection (WAC 222-30-040).

The Washington Forest Practices Board is in the process of adopting new Forest Practices Rules (Proposed Rules) based on the April 1999 Forests and Fish Report. The Forests and Fish Report is a set of riparian and upland management measures intended to protect and enhance water quality and fish habitat on Washington's non-federal forestlands (see subsection 2.5.2). State requirements for riparian protection, road management, assessment of ~~unstable soils~~ unstable slopes, and other aspects of watershed management would generally become more restrictive. If adopted, the Proposed Rules would become effective some time in 2001.

Hydraulic Project Approval

Hydraulic Project Approvals (HPAs) are permits issued by the WDFW to any person, organization, or government agency proposing to conduct activities that change, obstruct, or divert the bed or flow of fresh and salt waters of the state. An HPA is either approved, conditioned, or denied based solely on protection of fish life, which includes all fish and shellfish at all stages of development.

State agencies charged with administering laws that affect listed species have a responsibility to ensure that their proprietary and regulatory activities do not result in a take under the ESA. Issuance of Hydraulic Project Approvals that permit others to conduct such activities might constitute a violation of the take prohibition. If approving an HPA would result in take of a listed species, then WDFW would need an ITP from one or both of the Services prior to approving HPA actions. For this reason the WDFW, as administrator of the HPA program, is proposing to prepare a programmatic HCP covering issuance of HPAs. This state HCP would provide for the conservation of fish and shellfish species listed under the ESA and their habitats. At the same time it would provide long-term certainty for the WDFW to issue HPAs and for land owners seeking an HPA, and would allow incidental take of specified listed species. As currently envisioned, the proposed programmatic HCP would:

- be statewide, addressing both fresh and marine waters with threatened and endangered fish and shellfish species;

- address a comprehensive list of activities for which an Hydraulic Permit Approval is required;

- cover fish and shellfish only, since that is the limit of the Hydraulic Code authority; and

- be for the actual issuance of a Hydraulic Project Approval.

Ultimately, WDFW hopes to ensure an ongoing ability to issue Hydraulic Project Approvals, to comply with requirements of the ESA, and to have long-term certainty for the Hydraulic Project Approval program. Take authorization received by WDFW may be extended to the Hydraulic Project Approval recipient for that portion of the project covered by the Hydraulic Project Approval. Consequently, Hydraulic Project Approval recipients would not need to apply to the Services for their own take authorization.

Since last fall, six public scoping meetings across the state and a 74-day public scoping comment period for the Environmental Impact Statement have occurred. The WDFW is currently summarizing comments received and preparing a response document. The Department has also initiated a review of the Hydraulic Code rules (WAC 220-110) to identify possible gaps in compliance with the ESA. Identified gaps will be put into discussion drafts for review and dialogue with stakeholders, tribes, and the Services prior to initializing any formal rule adoption process.

Shoreline Management Act

In June 2000, Ecology released its proposed shoreline master program guidelines for public review and comment. Local governments in Washington would have to follow one of two "paths" established by Ecology regulating shoreline issues that include vegetation protection, bulkhead, and dock regulations; and restoration of shoreline ecological functions. Public comments were accepted through 7 August 2000. The proposed shoreline rules have been 5 years in the making, with drafting occurring in 1997 to update rules that were adopted in 1972. The new rules, which are not expected to be in effect until at least 2002, would apply to all marine waters, lakes more than 20 acres, and all rivers in the state flowing at an annual rate of 20 cubic feet per second or higher. Once they are in effect, the new rules are expected to increase the level of protection afforded to aquatic and riparian habitats.

Other Programs

Other state-level programs include the Conservation Reserve Enhancement Program, the Jobs for the Environment program, and grants to correct migration barriers caused by transportation projects and a buy-back of commercial fishing licenses. The Conservation Reserve Enhancement Program protects streams on agricultural lands by paying landowners to reserve streamside buffers ranging up to 150 feet wide and to improve salmon habitat. The Jobs for the Environment Program promotes the restoration and protection of salmon stocks by training displaced timber workers and fishermen to work on restoration projects that demonstrate a benefit to critical and depressed fish stocks.

Local Plans, Policies, and Programs

Other Tacoma Water Activities

Second Supply Project. Tacoma Water proposes to improve its supply system through the Second Supply Project, which requires construction of improvements at the existing Headworks diversion and construction of new transmission pipelines (Pipeline 5). Tacoma will construct two pipelines in association with the Second Supply Project. One will be a replacement for the 700-foot section of concrete pipe at the Headworks, and the other will be a new 33.5-mile pipeline to carry the additional water to Tacoma's distribution system. The Second Supply Project will serve the Tacoma Regional Water Supply Area (including parts of southern King County) to meet current and future municipal and industrial water needs.

Construction of Second Supply Project. Construction activities associated with proposed Second Supply Project would take place outside of the ITP Area defined by Tacoma Water's HCP. Activities associated with the Second Supply Project were subjected to ESA review prior to issuance of the Section 404 Permit under the Clean Water Act. Neither construction activities associated with the Second Supply Project nor operation of Pipeline 5 would be covered under Tacoma Water's ITP, thus neither were addressed in the HCP.

Raising the Headworks 6.5 feet will inundate an additional 1,800 feet of the mainstem Green River. This action will permanently alter habitat conditions there, converting existing free flowing riverine habitat to ponded habitat. Tacoma's proposed increase in the height of the Headworks Dam will not substantially

influence the downstream transport of sediment. Raising the Headworks Dam by 6.5 feet will result in the interception of approximately 43,000 cubic yards of sediment. Assuming that approximately 15 percent of this material was bedload (Olympic National Park 1986), the structure would intercept approximately 6,500 cubic yards of gravel. Howard Hanson Dam currently prevents the downstream transport of gravel-sized and larger sediments however, thus the actual composition of intercepted sediments is expected to be much smaller.

Construction of the 33.5-mile-long pipeline will require crossing streams and minor drainages at 15 locations, including 12 streams in the Green River basin (Table 4-C). Pipeline construction at the major stream crossings (the Green River near Palmer and near RM 29, and Big Soos Creek) will be accomplished by bridging or microtunneling, and will result in no direct impacts to the streams. Open trench construction will occur at six other streams that support anadromous and resident fish (Ginder Creek, Rock Creek, Covington Creek, North Fork Covington Creek, Soosette Creek and Mill Creek). Direct work in the channel can likely be avoided at Ginder Creek as the pipe will be buried under an existing culvert. Covington Creek typically has no surface flows in the late summer when construction would occur. Construction at the other sites could result in temporary increases in fine sediment delivery and turbidity. All waterway crossings with surface flows will be isolated with coffer dams, and fish will be removed from the construction sites prior to construction and released downstream of the project site. Construction will be scheduled for the late summer to avoid impacts to critical life stages of fish known or suspected to occur nearby. Erosion and sediment controls will be put in place prior to the initiation of any construction activities. The original channel contour, substrate, and riparian habitat conditions will be restored. All crossings will be designed to facilitate fish passage at all flows.

No new points of public access to the streams would be established through construction of the pipeline. However, implementation of a settlement agreement between the City of Tacoma, King County, and Friends of the Green River would result in a public access site being created for boaters near Tacoma's Headworks diversion. Recreational fishers already have access to the river in this area, thus creation of a more structured access for boaters is not expected to result in increased fishing pressure.

Approximately 9.6 acres of palustrine wetland habitat (at 51 locations) will be temporarily impacted during pipeline construction and restored after construction has been completed. The impacted wetland areas would include 2.1 acres of 18-year-old red alder-dominated forest habitat, 2.3 acres of scrub-shrub habitat, and 5.2 acres of emergent habitat. The only permanent wetland impact would be the loss of 0.02 acres of riparian wetland habitat at the Rock Creek stream crossing near Black Diamond.

Table 4-C. Green River basin watercourses that will be crossed during construction of Pipeline No. 5.

Temporary disturbance to wetlands and streams will be mitigated by on-site restoration at each location. On-site mitigation measures include: 1) contractor incentives to minimize disturbance; 2) required use of Best Management Practices (BMP's); 3) site-specific erosion and sedimentation control measures; 4) site-specific restoration of soils, streambed materials and contours, and large woody debris; and 5) implementation of revegetation plans.

Tacoma Water is also proposing to implement an off-site wetland and riparian restoration plan on approximately 31 acres located along the Green River near RM 33 (the Auburn Narrows site). The off-site mitigation project will rehabilitate approximately 26 acres of former floodplain and 5 acres of floodplain terrace. Under the off-site restoration plan, a swale would be excavated to allow high water to inundate the adjacent floodplain, native vegetation will be established on a total of 31 acres, and woody debris will be placed throughout the site (CH2M Hill et al. 1996). The Second Supply Project will also require independent construction monitoring and a 10-year post construction commitment and bonding to ensure the success of both on-site and off-site restoration measures.

Operation of Second Supply Project. Seattle Public Utilities and Tacoma Water, the City of Kent, the Covington Water District, and Lake Haven Utility District have developed a proposed agreement that addresses the allocation and management of water diverted under Tacoma's Second Diversion Water Right. Tacoma Water would be responsible for delivering treated water meeting drinking water quality regulations to the participants. Ownership and responsibility for operating facilities would rest with Tacoma; however, Seattle Public Utilities would own a share of the capacity of the various transmission pipelines used to deliver water.

Under the proposed agreement, a North Branch of the Second Supply Pipeline would be constructed to the Lake Youngs area in order to provide water to Seattle Public Utilities system. Kent and Covington would obtain water from taps off of the North Branch pipeline. The North Branch of the Second Supply Pipeline (also refereed to as the Tacoma-Seattle Intertie) would have a capacity of 40 million gallons per day and would be 36 to 42 inches in diameter.

Due to instream flow requirements on the Green River established as part of the MIT/TPU Agreement and the HCP, allowable diversions under the Second Diversion Water Right during the summer will be limited. Tacoma Water typically will be able to divert the full 100 cfs only from approximately mid-October to the

end of June. Under the Proposed Agreement, the 20,000-acre-feet of additional water stored behind Howard Hanson Dam for municipal and industrial water supply would be split three ways, with Tacoma Water, Seattle Public Utilities, and participating south King County water utilities each having a right to one-third of the storage (about 6,667-acre-feet apiece). To enhance the benefits of storage to Tacoma Water and Seattle Public Utilities, rules would be established for allocating water taken from storage at Howard Hanson Dam. Under these rules, Tacoma and Seattle Public Utilities could each with draw one-half of their shares of stored water (up to 3,333-acre-feet). Each utility's remaining share would be pooled into a variable storage allotment. Seattle Public Utilities would have first right to this variable storage. Seattle Public Utilities would have the right to 40 percent of the water allocated to variable storage in any 10 years prior to 2020. After 2020, Seattle Public Utilities would have the right to 30 percent of the water allocated to variable storage in any 10-year period.

A Draft Programmatic EIS on the proposed agreement that considers alternative means of achieving Seattle Public Utilities' objectives related to water supply has been completed (Seattle Public Utilities 2000). The effects of the proposed agreement include changes in the Green River Flow Regime and Howard Hanson Dam conservation pool discussed previously. In addition, implementation of the proposed agreement would:

- potentially result in the discharge of Green River Water to Lake Youngs and ultimately Little Soos Creek as water is delivered to the Seattle Public Utilities' Cedar Treatment Facility;

- potentially reduce diversions from the Tolt and Cedar Rivers; and

- potentially increase the rate of development within designated urban growth areas where inadequate water supply would otherwise constrain growth.

The proposed agreement would provide Seattle Public Utilities with flexibility to shape streamflows in the Cedar River in a manner that benefits fish.

A separate project-specific EIS on routing, design alternatives, and construction impacts for the North Branch pipeline would be prepared by Tacoma Water once the proposed agreement is formally authorized. Impacts from construction of the North Branch pipeline are expected to be similar to those resulting from construction of the Second Supply Pipeline described above.

To assure the availability of water to Seattle, Tacoma Water may need additional groundwater supply from its system. Tacoma Water may be able to obtain this supply from its existing wells in the Puyallup valley or Clover/Chambers Creek basin. If not, Tacoma Water estimates that four to five new wells could be required. Potential sources of additional groundwater are described in subsection 2.2.1.4.

MIT/TPU Agreement. In 1995, a written agreement was reached between the Muckleshoot Indian Tribe (MIT) and the City of Tacoma regarding the Green/Duwamish River system. The MIT/TPU Agreement is a substantial commitment by Tacoma directed toward implementation of a suite of measures that were considered by both parties to compensate for all impacts to the fishery resources associated with Tacoma's operations in the Green River, including the First Diversion Water Right claim and the Second Diversion Water Right. Although not included as part of the proposed HCP or ITP, Tacoma is committed to funding the development and construction of a fisheries restoration facility that will be owned and operated by the Muckleshoot Indian Tribe. The facility would be located next to the Green River, and would be designed to provide incubation and naturalized rearing facilities for steelhead trout, chinook salmon, and coho salmon. The juvenile fish produced at the restoration facility would be used to restore and enhance anadromous fish populations in the Green River, and could serve as the primary source for juveniles to be outplanted in the Upper Green River Watershed.

The transport and release of juvenile salmonids is contingent on a number of factors, including approval of the fish restoration facility and its intended uses by fisheries resource agencies, and issuance of the necessary water rights and permits for the facility. If the fish restoration facility cannot be permitted or is deemed infeasible, the Muckleshoot Indian Tribe will elect to either receive a lump sum of $12,000,000 into MIT's Fisheries Trust Fund to be used for fisheries enhancement within the Green/Duwamish River system, or will accept any and all unused funds originally targeted for the fish restoration facility into the Trust Fund to be used for fisheries enhancement within the Green/Duwamish River system.

King County Programs

Salmon Recovery Efforts. The Section 4(d) rules adopted by NMFS and USFWS identify specific activities that will harm salmon and their habitat. The rules will govern all aspects of land use affecting their habitat, including logging, development, fishing, hatcheries, and agriculture. NMFS intends to defer, when possible, to local and state recovery plans instead of implementing broad federal regulations through the 4(d) rules.

A Tri-County ESA group was formed in early 1998 when King, Snohomish, and Pierce Counties brought together cities, tribes, businesses, the environmental community, utilities, and other community groups to address recovery of the salmon and revitalization of the watersheds. Executives of each county oversee the Tri-County ESA group that has been working to develop a recovery plan since the chinook salmon was named a threatened species. Their work has been aimed at adoption of a Section 4(d) rule exemption for activities conducted according to standards outlined in the plan. Such a plan would allow salmon recovery while cities and counties continue to operate by using environmentally sensitive business practices.

The "Tri-County Initiative to Recover the Puget Sound Chinook" includes the conservation plan of each county and the cities within its boundaries. This multi-jurisdictional initiative for salmon restoration is the largest cooperative effort ever undertaken in the region's history. Through the Tri-County partnership, a strategy has been developed to conserve salmon, sustain the economy, and control the region's destiny. The King County contribution to the "Tri-County Initiative," entitled "Return of the Kings – Strategies for the Long-term Conservation and Recovery of the Chinook Salmon," illustrates both immediate and long-term commitments to salmon recovery through a description of past, continuing, and early conservation actions (King County 1999).

WRIA 9 Conservation Plan. In response to the passage of ESHB 2514 and 2496, King County Executive Ron Sims invited 24 elected officials and citizens to serve on a steering committee to respond to salmon listings under the ESA. Charged with using local scientific information to develop and see to the implementation of a recovery plan, the steering committee will identify, evaluate, and prioritize actions to protect and restore salmon populations, especially actions related to habitat. This conservation strategy will also lead to agreements that will guide future actions that affect salmon habitat. The plan will cover the

Green-Duwamish watershed and the Puget Sound drainages from Elliot Bay to Federal Way. This collective area is called Water Resource Inventory Area 9 (WRIA 9).

The steering committee has set a 5-year timeline to finish the plan. The 5-year timeline began with the issuance of the 4(d) rule by the federal government in June 2000. The first 2 years will be devoted to assessment including researching and compiling previous studies, determining data gaps, and conducting research to fill data gaps. The last 3 years will be spent converting this local scientific information into policies, coordinating with local jurisdictions and the federal government, seeking funding sources to perform necessary modifications and projects, and finalizing the implementation.

Tacoma Water officials and biologists are participating in the development of the WRIA 9 Conservation Plan. Conservation measures implemented under Tacoma Water's HCP will contribute to the overall WRIA 9 Conservation Plan, and will be coordinated with efforts by other entities implemented under the WRIA 9 Conservation Plan. The research monitoring program implemented jointly under Tacoma's HCP and the USACE Additional Water Storage Project will provide information to guide adaptive management for projects implemented under the WRIA 9 Conservation Plan as well as under Tacoma's HCP.

Levee Maintenance and Capitol Improvements. Much of the direction for the hydromodification of the Green River was systematized by Colonel Howard A. Hanson of the USACE in his publication, "More Land for Industry" (Hanson 1957). This document outlined an incremental scheme for the simplification, channelization, and dredging of the Duwamish estuary, and for ongoing flood containment for the lower Green River valley through a combined program of massive levee construction and the construction of the Howard A. Hanson Dam.

Prior to 1961, the historic agricultural levee system along the Green River was pursued in an orderly fashion by King County through acquisition of easements, design, and construction of a vast, cumbrous array of levees and revetments financed by municipal bonds. This construction effort was carried out by King County crews employing draglines to clear and shape the bank, place riprap, and remove large woody debris from the adjoining channel. This program was active from the early 1960s through the mid- to late 1970s. Rigorous suppression of recolonizing riparian plant communities was also performed in compliance

with guidelines for eligibility of local levee systems under the federal levee flood damage rehabilitation system administered by the USACE under Public Law (PL) 84-99. County compliance with this federal de-vegetation requirement was informally suspended in 1989, and formally addressed in the 1993 King County Council-adopted King County Flood Hazard Reduction Plan (FHRP) Policies FHR-10 and G-7 (King County, 1993). Project-by-project consideration of these policies with respect to Green River levee maintenance has resulted in incremental establishment of pioneer seral riparian shrub communities on several levee segments within the lower river, and the formal disqualification of these same segments from eligibility for federal rehabilitation assistance to repair flood damages.

In recent years, several projects that include setting back or removing levees have been initiated. Coniferous logs with attached rootwads and riparian revegetation have been incorporated into virtually all levee and revetment repairs on the Green River since 1990 to improve habitat quality. Information gathered on salmonid utilization at one of these sites demonstrates a significant increase in utilization by juvenile and adult salmonids (Peters et al. 1998). In addition, baseline monitoring of seven facilities proposed for repair in 2000 was conducted by King County and USFWS in 1999. Performance monitoring will be conducted for 5 years at these project sites. Monitoring results will be used to guide future levee removal or reconstruction projects implemented as part of the Green-Duwamish Ecosystem Restoration Projects and other programs.

King County Sensitive Areas Ordinance. Sensitive areas covered by King County's Sensitive Areas Ordinance include streams, wetlands, erosion hazard areas, landslide hazard areas, steep slopes, and flood areas. Development proposals affecting steep slopes, landslide hazard areas, streams, and wetlands must observe minimum buffer widths. Clearing and grading of erosion hazard areas may be limited, and must be conducted using an approved temporary erosion control plan.

King County Stormwater Management. King County's Stormwater Management Policy provides for comprehensive management of surface and stormwaters and erosion control. Development projects regulated by this code must discharge runoff to its natural location, control flood flows, erosion and sediment delivery, contain an analysis of offsite impacts, and provide water quality treatment facilities to treat polluted surface and stormwater runoff.

King County intends to undertake a comprehensive review of regulations relating to salmon and habitat through the watershed conservation planning process (King County 1999). For example, King County's Sensitive Areas Ordinance applies stringent standards across the entire unincorporated area, and is a fundamental element of stream protection in King County. To improve protections for salmon-bearing streams, King County is proposing to update the ordinances, increase enforcement of the regulations, and initiate an enhanced monitoring program to evaluate compliance and performance.

In the interim, King County will evaluate its use of State Environmental Policy Act authority to impose additional conditions and mitigation on development proposals to further protect salmon habitat (King County 1999). This use of State Environmental Policy Act substantive authority is consistent with existing County policies, does not require changes to the State Environmental Policy Act law, and can be accomplished within the general framework of permit review already in place.

King County Wastewater Treatment Plant Section 10 Coverage. King County's Wastewater Treatment Division, Environmental Compliance Unit, is preparing an HCP as part of King County's response to the listing of the chinook salmon and other species under the ESA. The focus of the HCP is to obtain an ITP for the present and future activities of the Wastewater Treatment Division, and to guide King County in addressing its impact on threatened and endangered species.

King County's HCP will be developed in phases, with the first phase covering the existing Wastewater Treatment Division operations and subsequent phases covering the siting of a new third treatment plant and marine outfall, or other major near-term capital improvements in the Council-adopted Regional Wastewater Services Plan. The proposed plant is part of the King County Executive's preferred plan in the Regional Wastewater Services Plan.

<u>Other Local Plans and Ordinances</u>

Local communities are also undertaking efforts to protect listed salmonids and their habitats. As mandated by the 1998 state Watershed Management Act (Engrossed Substitute House Bill 2514) and Salmon Recovery Planning Act (Engrossed Substitute House Bill 2496), counties are conducting watershed

planning to address water quality, water quantity, and salmon habitat issues. The State Conservation Commission is working with local governments and watershed stakeholders to complete an analysis of the factors within each Water Resource Inventory Area that limit salmon production. Local governments will receive grants to revise Shoreline Management Plans and Critical Area Ordinances, and are required to adopt a forest conversion ordinance.

Local cities are in the process of developing subbasin plans and revising city codes. Local plans typically focus on minimizing water quality- and stormwater-related impacts associated with development. Plans completed to date include:

- Plan and Final Environmental Impact Statement for the City of Renton East Side Green River Watershed Project (R. W. Beck 1997). This is an improvement plan that includes ways to minimize impacts to environmental resources and to enhance resources while providing flood protection in the City of Renton portion of the East Side Green River Watershed (also known as the Black River basin).

- Water Quality Management Plan – Black River Basin (R. W. Beck, et al. 1993). This plan identified existing and future surface water quality problems in the Black River basin and developed solutions to the identified problems. The study area included 5,800 acres in the Rolling Hills, Panther Creek, Springbrook Springs, Valley, and south Renton subbasins.

- Soos Creek Basin Plan (King County Department of Public Works 1990). This plan recommended watershed management measures to protect resources and respond to increasing hazards and property damage resulting from the rapid urbanization of the Soos Creek Basin Planning Area. Projects are recommended to reduce peak flows and flooding, erosion and resulting sedimentation, repair aquatic habitat damage, improve water quality, and mitigate human-caused damages. The plan covered the Soos, Jenkins, and Covington Creek Basins in south King County.

Plum Creek HCP and Land Exchange with the U.S. Forest Service

In 1996, Plum Creek Timber, L.P. completed an HCP covering approximately 170,000 acres of its land in the Cascade Mountains, including portions of the Green River basin. Under its HCP, Plum Creek focuses on providing supplemental stream protection to address resident and anadromous fish concerns, which complements the Northwest Forest Plan's Aquatic Conservation Strategy. The HCP designates riparian habitat areas and riparian leave tree areas where management activities would be reduced or eliminated as compared to current management activities. Road and mass wasting concerns are addressed through a commitment to complete Watershed Analyses.

On December 31, 1999, a transfer of deeds occurred between the USFS and Plum Creek Timber Co. involving more than 43,000 acres of forest land in the Cascade Mountains. The "I-90 Land Exchange" moved private lands with high environmental and recreational values into public ownership, in exchange for land better suited for timber management. The USFS received 31,713 acres of land in the Wenatchee and Mount Baker-Snoqualmie National Forests in exchange for 11,556 acres of land in the vicinity of three national forests: Wenatchee, Mt. Baker-Snoqualmie, and Gifford Pinchot. Plum Creek Timber Co. also donated an additional 838 forested acres to the government in Kittitas County near Lost Lake, Lake Cle Elum, and Mount Margaret. Within the Green River Watershed, Plum Creek realized a net gain of approximately 2,000 acres of former USFS land (Light, pers. comm., 28 September 2000). Future management actions on those lands will be conducted according to requirements of the Plum Creek HCP.

Re-opening of Burlington Northern Santa Fe Rail Line

In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the Ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad was reactivated and the line upgraded. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches.

Direct and Indirect Impacts of the Proposed Action on Covered Fish Species

Key habitat concerns for covered fish species and their habitat in the Action Area include: 1) barriers to habitat in the upper Green River; 2) interruption of the downstream movement of sediment and wood; 3) loss of side and off channel habitats in the Middle Green River; 4) high water temperatures in the lower Green River; and 5) low instream flows (Coccoli and Morgan 1996).

There are approximately 89 miles of fish-bearing streams in the Action Area. These include 50 miles of mainstem habitat from the Tacoma Headworks downstream to the tidal influence zone at RM 11, and approximately 39 miles of mainstem and tributary habitat on land owned by Tacoma in the upper watershed. Tacoma Water's primary management concern in the upper watershed has been protection of water quality, and for this reason, Tacoma Water lands in the upper watershed are concentrated around Howard Hanson Reservoir and adjacent to the mainstem Green River.

The impacts of the proposed HCP on aquatic habitat relative to the No Action Alternative are described in detail in subsections 4.2.6 and 4.3.6, Fish and Aquatic Habitat. Subsections 4.6 also include discussions of species-specific effects. The following is a summary of these anticipated impacts. Compared to the No Action Alternative, direct effects of the proposed HCP would include:

- withdrawal of water by Tacoma Water would increase by up to 100 cfs except when conditioned by minimum instream flow requirements;

- flows at Auburn would be reduced by up to 400 cfs during March through mid-April because of implementation of the Additional Water Storage Project, impacting spawning conditions for early steelhead spawners;

- flows at Auburn would be increased by up to 400 cfs for sustained periods from mid-April through mid-June, improving conditions for spring spawners such as steelhead;

- late summer and fall low flows would increase by 20 to 120 cfs as a result of restricting Second Diversion Water Right withdrawals to maintain higher instream flows and to benefit upstream migrating adult fish, fall spawning chinook, and juvenile, or resident fish rearing in the mainstem through the summer;
- late fall and winter flows would decrease by up to 100 cfs, reducing spawning habitat for winter spawners such as coho and chum;
- recruitment of gravel would increase as a result of placement below the Headworks Diversion;
- recruitment of large and small woody debris to the middle Green River would increase as a result of placement below the Headworks Diversion;
- the amount of side channel habitat would increase by approximately 4,500 linear feet (3.4 acres) as a result of reconnecting Signani Slough;
- access to and from the upper watershed would be restored by implementation of a trap-and-haul program, construction of a fish bypass facility at the Headworks Diversion, and construction and operation of a downstream fish passage facility at Howard Hanson Dam in cooperation with the USACE;
- habitat along reservoir margins and within the inundation zone would improve by retention of standing dead timber and rehabilitation of selected reaches;
- the amount of fine sediment delivered to stream channels would decrease because of additional no-harvest and partial-harvest riparian buffer requirements;
- LWD recruitment, litter and nutrient inputs, and shade would increase because of wider riparian buffers; and

- the amount of habitat available to fish in the upper watershed would increase due to replacement of impassable culverts.

Indirect effects of the Proposed Action would include:

- water quality in the estuary would improve slightly due to higher late summer and fall flows;
- the amount of spawning habitat would increase as a result of gravel nourishment and storage associated with LWD;
- the number and quality of pools would increase throughout the Action Area as a result of increased LWD inputs; and
- water temperatures in the upper watershed would be reduced as a result of increased shade;

Analysis of Cumulative Effects on Covered Fish Species and Aquatic Habitat

The cumulative effects of the policies, programs and projects described above are discussed separately for each of the intermediate analysis areas identified in subsection 4.4.1: the Action Area, WRIA 9, and the Southwest Cascades Physiographic Province. The discussion of cumulative effects is further subdivided by major geomorphic processes and channel types.

<u>Action Area</u>

<u>Flow Regime</u>

Tacoma Water's withdrawals from the Green River would increase by up to 100 cfs under its proposed HCP. However, Tacoma's commitment under the HCP and the 1995 MIT/TPU Agreement to maintain minimum instream flows at Palmer and Auburn that exceed current state requirements will result in a slight

increase in low summer flows. Downstream effects of the Additional Water Storage Project would be covered under the ITP, and the cumulative effects of those actions are described in detail in Chapter 7 of the HCP.

The USACE controls the storage and release of water at Howard Hanson Dam. Because the primary authorized project purpose is flood control, flows greater than 12,000 cfs in the mainstem Green River would continue to be prevented. Following the flood control season, a recommended release schedule is developed each year based on forecasting of seasonal precipitation patterns with input from the Muckleshoot Indian Tribe, WDFW and others as storage of the conservation pool progresses. Together, Tacoma Water's HCP, the 1995 MIT/TPU Agreement, the Additional Water Storage Project, and the Second Supply Project would result in up to a 400 cfs reduction in flows during the early spring (mid-February through March) due to increased storage behind Howard Hanson Dam (Table 4-D). Large, natural spring freshets would be truncated rather than completely captured, allowing flows to more closely approximate natural variability. Flows from mid-April to mid-June would increase by up to 400 cfs, and up to two artificial freshets could be released annually to facilitate the downstream migration of juvenile salmonids. Monitoring activities funded by Tacoma Water under its proposed HCP, and by other entities such as the USACE and King County, would be used to adaptively manage the Howard Hanson Dam flow release schedule. The cumulative effect of these actions would modify the flow regime so that it more closely matches natural flow variations in the Action Area relative to conditions under the No Action Alternative.

Table 4-D. Potential unavoidable adverse effects of actions implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs.

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Table 4-D. Potential unavoidable adverse effects of actions implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Table 4-D. Potential unavoidable adverse effects of actions implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Groundwater

During periods when turbidity is high in the Green River, Tacoma Water uses water withdrawn from a shallow aquifer that contributes to flow in the North Fork Green River. Under the HCP, Tacoma would restrict withdrawals from the North Fork Wellfield to periods when the turbidity in the North Fork Green River exceeds 5 NTU's. Since high turbidities in the Green River occur primarily in association with high flow events in both the North Fork Green River and mainstem Green River, flow reductions due to pumping from the Wellfield would have little effect on fish rearing or migrating through the North Fork Green River. Tacoma Water would also implement a study to identify the maximum rate a which water may be pumped from the Wellfield without resulting in stage reductions greater than 1 inch per hour. This would minimize potential stranding or trapping of juvenile fish in habitats that may become dewatered as a result of pumping.

Although the Green River Watershed has been closed to new groundwater permits since 1980, development of wells for domestic use or industrial purposes under 5,000 gallons per day do not require water rights permits. Data from the Soos Creek and Newaukum Creek gauges indicate that peak flows have increased, and summer low flows have decreased as a result of development in those basins. The effects of future growth on peak flows will be at least partially mitigated by more stringent regulations required under King County's Stormwater Management Policy and other measures implemented as a result of local subbasin plans. However, withdrawal of groundwater from domestic wells would continue to influence the hydrologic regime of tributary streams, and summer low flows may continue to decrease, thereby reducing contributions to the mainstem Green River. Tacoma Water's commitment to restrict its withdrawals to meet minimum flow requirements specified in the proposed HCP and the MIT/TPU Agreement means that minimum flows in the Action Area would be met even if groundwater withdrawals elsewhere in WRIA 9 reduce inflows from tributary streams such as Soos or Newaukum Creeks. The cumulative effect of the proposed HCP and the MIT/TPU Agreement would be an increase in summer low flows in the mainstem relative to the No Action Alternative.

Sediment Delivery

The upper watershed conservation measures to be implemented under the proposed HCP apply to all of Tacoma's forestlands within the Action Area. As described in subsection 4.2, the overall effect of implementing the upper watershed conservation measures under Tacoma's proposed HCP would be a decrease in the delivery of sediment from forest roads and management-related mass wasting within the Action Area.

Operation of Howard Hanson Dam has altered the routing of sediment through the mainstem Green River. Fine sediment has accumulated in the turbidity pool behind Hoard Hanson Dam, as suspended material settles out when water is impounded behind the dam. Sediment that settles in the reservoir may be remobilized as reservoir storage is released, effectively shifting peak turbidity downstream of the dam from flood peaks to declining flows that follow flood events. As a result of Section 7 consultation, the USACE will be required to develop a sediment management plan that, to the extent possible, results in a more natural pattern of suspended sediment transport.

Construction of both the Headworks Dam and Howard Hanson Dam interrupted the downstream movement of coarse sediment. Because of its small size, the available storage area behind the Headworks Dam filled with sediment within a few years, thus bedload is now effectively transported past the structure. Increasing the height of the diversion dam will result in the temporary disruption of downstream sediment transport, although the additional available storage is equivalent to less than 2 years of the estimated average annual sediment load. Operation of Howard Hanson Dam will continue to interrupt the downstream movement of bedload. These effects would be mitigated by placement of gravel into the mainstem Green River. Tacoma Water's HCP, the Additional Water Storage Project, and the Green-Duwamish Ecosystem Restoration Project all include measures that together would partially restore natural rates of sediment delivery downstream of Howard Hanson Dam (Table 4-E). Gravel to be placed under Tacoma Water's HCP represents approximately one-third of the total. Implementation of these projects is expected to improve spawning habitat for covered fish species in over 30 miles of the mainstem Green River relative to conditions under the No Action Alternative.

The gravel placement projects will be closely coordinated to ensure placement in appropriate locations and amounts. Modeling efforts undertaken as part of the Green-Duwamish Ecosystem Restoration Project will evaluate the potential effects of the combined projects, and will be used modify the final amount of gravel placed (if necessary). Monitoring will reduce the risk of increased flooding.

Riparian

Riparian communities in the Action Area will continue to be adversely affected by a number of ongoing or proposed actions. The Burlington Northern-Sante Fe Railroad and mainline logging roads are located within 200 feet of the Green River at a number of sites within the Action Area. The presence of these transportation corridors will continue to prevent development of mature riparian forest along approximately 5 miles of the mainstem Green River. The increased pool elevation resulting from the Section 1135 Project and Additional Water Storage project will flood approximately 5,300 feet of riparian habitat along the mainstem and 7,600 feet of riparian habitat along tributary channels (Table 4-D). Existing riparian forests will most likely be converted into non-forested habitat, although planting of inundation tree species may offset some of these losses (U.S. Army Corps of Engineers 1998). Seasonal inundation and the presence of roads or railroads will prevent development of properly functioning habitat in the affected reaches. Together, reaches affected by those activities account for approximately 19 percent of the estimated 39 miles of fish-bearing streams in the Action Area upstream of Howard Hanson Dam.

Riparian conservation measures implemented as part of Tacoma Water's proposed HCP would improve riparian habitat along the remaining 32 miles of fish-bearing streams in the Action Area, as well as along approximately 50 miles of non-fish bearing streams (DNR Type 4 and 5). The overall effect of implementing the upper watershed conservation measures under Tacoma's proposed HCP would be gradual increases in the amount of shade, LWD, and pool habitat within the Action Area.

Reservoir Habitat

The increased inundation pool could delay the downstream migration of juvenile salmonids (see U.S. Army Corps of Engineers 1998 for a complete discussion). The effect of the reservoir pool level, infill rate, and infill timing will be evaluated through studies funded as part of Tacoma Water's HCP and the Additional Water Storage Project. Over time, results of these studies would help the Green River Flow Management Committee to design a storage and release schedule that minimizes adverse effects to Covered Species.

Table 4-E. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs.

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Table 4-E. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Table 4-E. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Table 4-E. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Table 4-E. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Table 4-E. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Mitigation measures to be implemented under the Section 1135 Project and Additional Water Storage Project will improve reservoir habitat quality (Table 4-E). These measures complement improvements in riverine habitat that would occur under Tacoma Water's HCP. Retention of standing timber, planting of inundation tolerant vegetation, and construction of floating islands will all provide increased cover for juvenile fish rearing in or migrating through Howard Hanson Reservoir. While the islands may serve as convenient perches for predatory birds such as loons (Warner, pers. comm., 14 February 2000), their presence is not expected to substantially increase the number of predators or the overall rate of predation.

Mainstem Habitat

The increased reservoir pool level resulting from implementation of the Section 1135 Project and Additional Water Storage Project would inundate approximately 5,300 feet of mainstem habitat in the Action Area (Table 4-D). Based on a study of the existing inundation zone, riverine habitats would be expected to experience substantial reductions in vegetative cover, bank stability, and pool habitats and an increase in fine sediments within riffles (Wunderlich and Toal 1992).

The physical condition of habitat in the remainder of the mainstem Green River in the Action Area is expected to improve dramatically as a cumulative effect of the actions described previously. In combination, nine projects specifically designed to improve mainstem habitat have been identified as part of the proposed HCP, Section 1135 Project, Additional Water Storage Project, and Green-Duwamish Restoration Project (Table 4-E). The majority of these projects involve placement of LWD; in all, wood will be placed in up to 30 miles of the mainstem Green River. It is expected that placement of LWD under these projects will restore wood loadings to levels considered to be properly functioning (National Marine Fisheries Service 1999) in the affected reaches.

Over time, increased riparian protection provided by Tacoma Water's HCP and anticipated changes to state and county land use regulations expected in response to the Section 4(d) rules will result in improved riparian function. In turn, this will lead to a reestablishment of bank stability, shade, organic matter inputs, and LWD recruitment at levels that more closely approximate natural processes. These measures are expected to be sufficient to ensure that instream habitat conditions continue to function properly, even if habitat rehabilitation projects reach the end of their life expectancy.

Tributary Habitat

The increased reservoir pool level resulting from implementation of the Section 1135 Project and Additional Water Storage Project would inundate approximately 7,600 feet of tributary habitat in the Action Area (Table 4-D). Based on a study of the existing inundation zone, riverine habitats within these inundated areas would be expected to experience substantial reductions in vegetative cover, bank stability, and pool habitats and an increase in fine sediments within riffles (Wunderlich and Toal 1992).

Off Channel Habitat

The amount of side channel habitat in the Action Area downstream of Howard Hanson Dam decreased from approximately 103,000 linear feet in the early 20th century to approximately 37,000 linear feet in 1994, primarily as a result of flood control levees and revetments constructed by USACE and King County. Flow reductions associated with storage of additional water during the spring would dewater up to 8.4 acres of side channel habitat (Table 4-D). However, taken together, the proposed Tacoma Water HCP, Additional Water Storage Project, Section 1135 Project, and Green-Duwamish Ecosystem Restoration Project will result in the restoration of over 22,000 feet (more than 21 acres) of off-channel habitat in the Action Area (Table 4-E). Projects implemented under Tacoma Water's HCP represent about 43 percent of the off channel habitat to be restored. The cumulative effect of these actions relative to the No Action Alternative would be an increase in the amount and quality of off-channel habitat accessible to the Covered Species.

Water Quality

Overall, water quality in the Action Area is expected to improve as a result of the various programs and projects to be implemented in the foreseeable future. Restoration and stricter regulations protecting riparian habitats will eventually result in increased shade that should reduce water temperatures. The new intake tower installed at Howard Hanson Dam as part of the downstream fish passage facility will allow water to be withdrawn from deeper, cooler strata in the reservoir. Release of cooler water will reduce summer water temperatures for several miles downstream of Howard Hanson Dam.

Construction of fish passage facilities at the Headworks Dam and Howard Hanson Dam, and use of heavy equipment in or near the river during construction of habitat restoration projects conducted under the proposed HCP, Additional Water Storage Project, Second Supply Project, and Green-Duwamish Ecosystem Restoration would result in temporary, localized increases in turbidity near the construction sites. Federal, state, and county regulations all require development and implementation of erosion and sediment control plans for each project. Implementation of an approved erosion and sediment control plan during construction is expected to minimize adverse impacts to Covered fish Species.

Under the Section 7 consultation process, the USACE is developing a sediment management plan for continued operation and maintenance of Howard Hanson Dam. Development of a sediment management plan for Howard Hanson Dam is expected to restore the relationship between turbidity and high flows to a level that more closely approximates natural conditions. The sediment management plan will reduce the risk that fine sediments are remobilized as flows decline and the reservoir is emptied, then settle out in reaches utilized heavily by spawning salmonids. The Tacoma Water HCP, Plum Creek HCP, DNR HCP, and proposed changes in state regulations governing forestry activities all include provisions designed to reduce delivery of fine sediment from roads and management-related landslides. In addition, at least one project may be implemented under the Green-Duwamish Ecosystem Restoration Project that is specifically designed to stabilize and reduce sediment inputs from a large landslide near RM 42. This slide currently contributes large amounts of sediment to the river that increase turbidity and deposits on downstream spawning gravels. The cumulative effect of these actions relative to conditions under the No Action Alternative would, therefore, be an improvement of water quality in the Action Area.

<u>Fish Populations</u>

The fish hatching and rearing facility funded by the 1995 MIT/TPU Settlement would produce juvenile fish that could be released in the upper watershed, if approved by the Services. These actions would increase the number of fish rearing in the upper watershed and moving downstream past Howard Hanson Dam. Improvement of the downstream passage facility as part of Tacoma Water's proposed HCP and the Additional Water Storage Project would ensure that more of these fish safely pass downstream. Together, these projects would be expected to result in an increase in fish populations within the Action Area.

Fish Passage

As described in subsection 4.2, a major component of Tacoma Water's HCP and the Additional Water Storage Project is the development of upstream and downstream fish passage past both the Headworks and Howard Hanson Dam. These facilities would restore access to up to approximately 106 miles of habitat suitable for use by anadromous fish upstream of Howard Hanson Dam (U.S. Army Corps of Engineers 1998). Culvert replacement projects planned as part of the HCP, Additional Water Storage Project, and the Green-Duwamish Ecosystem Restoration Project will increase the amount of accessible habitat in the upper watershed by more than 3 miles.

Water Resource Inventory Area 9

The primary habitat concerns in WRIA 9 are the same as those for the Action Area, plus loss of estuarine habitat, and barriers to tributary habitat in the lower Green River basin. Watershed Resource Inventory Area 9 contains an estimated 472 miles of fish-bearing streams, including the approximately 89 miles that constitute the Action Area. Approximately 63 percent of the fish-bearing streams in WRIA 9 cross Forestland, primarily in the upper watershed, and 25 percent cross Developed Lands, primarily in the lower watershed. Agricultural Lands (8%), Wetlands (2%), and Barren Lands (2%) comprise the remainder (Figure 4-18).

Soil and geology investigations indicate that prior to development, the Green River valley downstream of RM 28 was a large wetland complex. In addition, numerous small ponds and wetlands dotted the glacial outwash plain that forms the headwaters of many tributaries in the lower basin (Galster and LaPrade 1991). Data from 1854 indicate that there were approximately 4,600 acres of estuarine wetland downstream of RM 5.3 alone (Blomberg, pers. comm., 7 October 1999). Today, only about 45 acres of estuarine wetlands remain, and less than 2 percent of the WRIA (7,900 acres) is wetland (Figure 4-17).

Flow Regime

Developed lands are associated with the greatest changes in aquatic habitat quantity and quality. Under current conditions, 25 percent of WRIA 9 is Urban or Residential Land (Figure 4-17), and that proportion

is expected to increase by up to 10 percent in the future, largely as a result of conversion of rural agricultural lands in the lower basin (King County Surface Water Management Division 1995). Aquatic habitats on urban and residential lands will be provided increased protection when city, county, and regional ordinances are revised to meet the requirements for exemption under the Section 4(d) Rule or to avoid take. Therefore, the direct effects of future development on Covered Fish Species are expected to be less than those observed historically.

Impervious surfaces associated with urban and residential development and channel simplification resulting from flood control projects altered the hydrologic regime. As described for the Action Area, data from the Soos Creek and Newaukum Creek gauges indicate that peak flows have increased and summer low flows have decreased as a result of development in those basins. In addition to potential reductions in summer low flows in the Action Area, these changes directly effect habitat conditions in tributary streams, reducing the area and quality of habitat available to fish. As noted previously, the effects of growth on stormwater runoff will be at least partially mitigated by more stringent regulations required under the ESA. Implementation of Tacoma Water's proposed HCP will not affect the flow regime of tributaries within WRIA 9.

<u>Sediment Delivery</u>

Increased sediment delivery is also a concern in many of the tributary streams in WRIA 9, particularly in areas managed for forest production. Forestlands in WRIA 9 are located primarily in the Upper Green River Watershed, and are owned by a mixture of private, tribal, and public entities (Figure 4-19). Forestry activities have been documented to result in large increases in sediment delivery from roads and in the number of landslides in portions of the upper Green River basin analyzed to date (Plum Creek Timber Company 1996a, 1997).

Requirements governing activities that may contribute sediment to channels in WRIA 9 varies according to ownership. A general comparison of aquatic protection measures to be applied under the proposed Tacoma HCP and various federal, state, and selected private management is presented in Table 4-11. Protection is generally greatest on federal lands managed according to the Northwest Forest Plan. Protection provided by the proposed Tacoma Water HCP and Plum Creek HCP are similar, as both rely

on measures developed through a cooperative watershed analysis process. Revisions to the Washington Forest Practices Code have been proposed in the Forests and Fish Report (Washington Laws First Special Session 1999) and are intended to accomplish the same aquatic conservation objectives as approved federal HCPs. These rules would govern management on private lands not covered by an HCP.

The cumulative impact of the increased level of protection on federal lands, state, and private lands covered by existing HCPs, and implementation of Tacoma Water's proposed HCP, relative to conditions under the No Action Alternative, would be a reduction in management-related sediment delivery (Table 4-E). While the conservation measures included in Tacoma Water's proposed HCP are not intended to restore sediment inputs to levels that are equivalent to unmanaged systems, the cumulative effects of the Proposed Action in combination with increased protection provided on adjacent federal lands and lands covered by approved HCPs would be to return the rate of sediment delivery to conditions that more closely approximate natural levels.

Urban and residential development, and the infrastructure needed to support these land uses have the greatest impact on sediment delivery rates downstream of Howard Hanson Dam. Any construction project that disturbs soils has the potential to increase sediment delivery. Of particular concern are construction projects in or adjacent to stream channels. Construction of the Second Supply Pipeline, for example, will require 12 stream crossings in WRIA 9, including the mainstem Green River (Table 4-C). Methods of crossing each stream have been developed on a site-by-site basis. Erosion control measures to be implemented at each site comply with local, county, and state regulations, and must be approved by various permitting agencies including the USACE (under Section 404 of the Clean Water Act) and the WDFW (through the Hydraulic Project Approval process). As described above, all permits issued by the USACE under Section 404 must undergo Section 7 consultation to ensure the action permitted is in compliance with the ESA. Hydraulic Project Approvals issued by WDFW will impose requirements currently being developed through the ESA Section 10 consultation process. Due to the increased level of protection required under the ESA, the Second Supply Project and other similar future projects are expected to result in minimal increases in sediment delivery.

Table 4-11. General comparison of aquatic protection measures to be implemented under Tacoma's HCP and various federal and state management plans (Note: footnotes and acronyms located on the third page of this table).

Table 4-11. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Table 4-11. Conservation measures to be implemented in the Green River basin (WRIA 9) within the forseeable future under the auspices of the various proposed actions/management programs. (continued)

Riparian

Like regulations governing sediment delivery, riparian management practices also vary with ownership (Table 4-11). Federal management plans and approved HCPs protect approximately 45 percent of the fish-bearing streams located on Forestland area in WRIA 9 (Figure 4-21). Almost 86 miles (approximately 25% of all fish-bearing streams in WRIA 9) are currently bordered by Old Forest. Implementation of the proposed HCP would increase the percentage of fish-bearing streams receiving protection in excess of state or county regulations by 26 percent (from 51% up to 77%). The total acreage of Old Forest on Tacoma Water lands is expected to increase by approximately 7 percent (253 acres). Assuming there would be a proportionate 7 percent increase in the length of streams bordered by Old Forest in the Action Area under Tacoma's HCP, the total length of fish-bearing streams bordered by Old Forest in WRIA 9 would increase from 86 to 89 total miles. By Plan year 50, all 39 miles of fish-bearing streams on Tacoma lands within the Action Area would be bordered by stands at least 50 years of age.

The cumulative impact of the increased level of protection on federal, state, and private lands covered by existing HCPs and implementation of the proposed Tacoma Water HCP relative to conditions under the No Action Alternative would be a gradual increases in the amount of shade, LWD, and pool habitat within WRIA 9.

Reservoir Habitat

Howard Hanson Reservoir is completely surrounded by the Action Area, thus the cumulative impacts of the proposed HCP and actions that will be undertaken by other entities in the foreseeable future will be the same as described for the Action Area.

Mainstem Habitat

The entire mainstem Green River, from RM 11 to RM 84, is within the Action Area, thus the cumulative impacts of the proposed HCP and actions that will be undertaken by other entities in the foreseeable future will be the same as described for the Action Area.

Tributary Habitat

There are currently 383 miles of tributary habitat in WRIA 9, in addition to the approximately 90 miles of mainstem and tributary habitat in the Action Area. The proposed Tacoma Water HCP would not affect tributary streams outside of the Action Area. However, habitat restoration projects implemented under other projects will benefit fish that migrate through the Action Area to utilize habitat elsewhere in WRIA 9. Candidate projects to be implemented under the Green-Duwamish Ecosystem Restoration Project include 15 projects that would directly improve over 5 miles of habitat in tributary channels (Table 4-E). Most of the projects are located downstream of RM 40 and will complement projects implemented in upper Green River basin tributaries under Tacoma Water's HCP and the Additional Water Storage Project.

Off Channel Habitat

None of the actions planned for implementation in WRIA 9 in the foreseeable future will result in adverse impacts to off-channel habitats. All off-channel habitats that will be restored or rehabilitated are associated with the mainstem Green River upstream of RM 11, thus the cumulative effects of these actions will be the same as described for the Action Area.

Water Quality

The proposed HCP will not adversely effect water quality in streams outside of the Action Area as compared to the No Action Alternative. Implementation of the proposed HCP will result in increased summer low flows relative to conditions under the No Action Alternative, which could slightly improve water quality in the estuary downstream of RM 11 (subsection 4.2). King County is also currently developing an HCP to guide operations of its Renton Wastewater Treatment Plant. It is assumed that conservation measures implemented under the Wastewater Treatment Plant HCP will also improve water quality in the Green Duwamish estuary.

Fish Populations

There are currently no plans for additional direct supplementation of fish populations in WRIA 9 outside of the Action Area as compared to the No Action Alternative. The cumulative effect of the programs described above on fish populations in WRIA 9 would, therefore, be the same as for the Action Area.

Fish Passage

Restoration of anadromy to the upper basin would allow anadromous fish to access streams upstream of Howard Hanson Dam. In addition to the 39 miles of fish-bearing stream located within the Action Area, Covered Species would benefit by gaining access to an estimated 67 additional miles of stream suitable for use by anadromous fish located on federal, state, and private lands in the Upper Green River Watershed. The increased protection provided on federal, state, and lands covered by the DNR HCP, Plum Creek HCP, and proposed Tacoma HCP will benefit fish utilizing these newly accessible habitats.

Western Washington

Western Washington contains approximately 34,000 miles of fish-bearing streams. Approximately 83 percent of the fish-bearing streams cross Forestlands, with Agricultural Lands (10%), Developed Lands (3%), and Barren Lands (4%) comprising the remainder (Figure 4-24). The proposed Tacoma Water HCP would benefit 89 miles of the total length of fish-bearing streams (about 0.26 percent) in western Washington. Implementation of the proposed HCP would improve habitat conditions in those 89 miles of stream and would restore access by anadromous fish to over 106 miles of stream.

The proposed HCP would affect the mainstem Green River downstream of Howard Hanson Dam. Approximately 46 miles of the mainstem downstream of the Green River gorge crosses Agricultural or Developed Lands. The 46 miles that would be affected by the HCP represent approximately 1 percent of the 4,301 miles of fish-bearing streams in western Washington that are located on Developed or Agricultural Lands. Habitat rehabilitation activities planned under the proposed HCP, Additional Water Storage Project, and Green-Duwamish Ecosystem Restoration Project would cumulatively benefit habitat in rural and developed areas that have historically been impacted by flood control, development, and

agricultural activities. In conjunction with general policy changes and increased protection of aquatic habitats provided by state and county regulations, the habitat improvements provided by these projects are an important part of the overall recovery of Covered Species in western Washington.

Of the fish-bearing streams located on forestlands in western Washington, 58 percent of the total are located within Federal Reserves or Management Areas, State and County Parks, or lands covered by approved HCPs. Almost 8,500 miles (approximately 30%) of the streams on forestlands in western Washington are currently bordered by Old Forest (Figures 4-27 and 4-28). Because Tacoma's ownership is small, implementation of the proposed HCP would not substantially change the length of fish-bearing streams that benefit from increased protection provided by new federal and state regulations and private HCPs, relative to the total stream network in western Washington. However, the protection provided by the proposed Tacoma upper watershed conservation measures exceeds the protection of both existing and proposed state Forest Practices Rules as well as other approved HCPs. Tacoma Water's ownership is situated in a manner to provide maximum benefits to the Covered Species, and would be instrumental in providing fish access to the improved habitat. This would represent an important contribution to salmonid conservation efforts in western Washington.

4.4.3.2 Wildlife

The following discussion analyzes three separate topics for each of the seven listed wildlife species proposed for coverage: 1) management activities that may affect the species, 2) direct and indirect effects of the Proposed Action on the species, and 3) analysis of the cumulative effects on the species and its habitat.

Bald Eagle

<u>Management Activities and Plans Affecting the Bald Eagle and Its Habitat</u>

<u>Federal Plans, Policies, and Programs</u>

Pacific Bald Eagle Recovery Plan. The Pacific Bald Eagle Recovery Plan describes the loss of breeding, wintering, and foraging habitat as the most significant threat to the long-term survival of the bald eagle (U.S.

Fish and Wildlife Service 1986). The cumulative long-term adverse effects of urban and recreational development, logging, mineral exploration and extraction, and other forms of human activity pose the most important threats to the species' recovery.

The primary objective of the Recovery Plan is to outline steps, including delisting criteria, that will provide secure habitat for bald eagles in the Pacific Recovery Area, which includes the states of California, Idaho, Montana, Nevada, Oregon, Washington, and Wyoming. To aid in the recovery process and to establish a well-distributed population, the Pacific Recovery Area is divided into management zones. Western Washington encompasses six management zones (Zone 1- Washington Coast; Zone 2 - Olympic Peninsula; Zone 3 - Southwest Washington; Zone 4 - Puget Sound; Zone 5 - Western Cascade Mountains; Zone 6 - Cascade Mountains). The Southwest Cascades Physiographic Province and the Action Area overlap Management Zones 5 and 6.

Region-wide de-listing criteria for the bald eagle include a reproductive rate of at least one fledged young per pair, with an average success rate per occupied site of not less than 65 percent over a 5-year period. Habitat management goals and recovery population goals are specified for each management zone. For the six zones covering western Washington, the total habitat recovery goal is 335 territories, and the total recovery population goal is 247 breeding pairs. Management Zones ~~4 and 5~~ 5 and 6 have a combined habitat recovery goal of 44 territories (17 and 27 per zone, respectively), and a combined recovery population goal of 33 breeding pairs (13 and 20 per zone, respectively).

Proposed Rule to De-list the Bald Eagle. The USFWS proposes to remove the bald eagle from the List of Endangered and Threatened Wildlife in the lower 48 states (U.S. Federal Register, 6 July 1999). Removal of the bald eagle would not affect the protection provided under the Bald and Golden Eagle Protection Act or the Migratory Bird Treaty Act, or under any other state laws.

In the Pacific Recovery Region, numeric recovery goals have been met since 1995 (U.S. Federal Register, 6 July 1999). A minimum of 800 pairs have been present in the Pacific Recovery Area, with an average reproductive rate of one fledged young per occupied site. The average success rate for occupied sites has not been below 65 percent in any of the last 5 years.

The Bald and Golden Eagle Protection Act (16 USCS 668-668c). The Bald and Golden Eagle Protection Act establishes prohibited acts and penalties to protect bald and golden eagles. Prohibitions under the Act are described as follows:

> *Whoever, within the United States or any place subject to the jurisdiction thereof, without being permitted to do so as hereinafter provided, shall knowingly, or with wanton disregard for the consequences of his act take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or in any manner, any bald eagle commonly known as the American eagle, or golden eagle, alive or dead, or any part, nest, or egg thereof of the forgoing eagles, or whoever violates any permit of regulation issued pursuant to this act, shall be fined...* (16 USCS 668a)
>
> In Section 668c of the Act, Take is defined as follows:
>
> ..."take" includes also pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb;...

The Migratory Bird Treaty Act (16 USCS 703-711). The Migratory Bird Treaty Act describes the following unlawful acts:

> *...it shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof...* (16 USCS 703)

Salmon and Steelhead 4(d) Rule. In June 2000 the NMFS adopted a final 4(d) Rule for 14 listed salmon and steelhead evolutionarily significant units (ESU). The 4(d) Rule is described in greater detail in subsection 4.4.3.1 of this EIS. The 4(d) Rule is intended to aid in the recovery of listed fish species, and it could have indirect benefits to bald eagles by increasing their supply of food (adult salmon).

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. The bald eagle is being addressed in that consultation. The operation of Howard Hanson Dam is not likely to have any direct effect on bald eagles, but it may have indirect benefits if planned fisheries mitigation measures increase the food supply for bald eagles in the middle and lower Green River Watersheds.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. The Additional Water Storage Project could reduce slightly the amount of potential bald eagle perching habitat along the existing reservoir, but planned fisheries mitigation measures would likely result in a substantial increase in food supply (adult salmon) in the upper watershed in the future.

Magnuson-Stevens Fishery Conservation and Management Act. This federal act was created to restore and maintain harvestable numbers of fish, including salmon. Like the Salmon and Steelhead 4(d) Rule, it may have indirect benefits to bald eagles by providing an important source of food.

Section 1135 Project. As described in subsection 4.4.3.1 of this EIS, the federal Section 1135 Project is intended to improve habitat for fish in the Green River by increasing low summer flows in dry years. It could indirectly benefit bald eagles, again by increasing the supply of food (i.e., adult salmon) in the river.

Green/Duwamish Ecosystem Restoration Project. This comprehensive program of restoring the Green River ecosystem could benefit bald eagles by: 1) increasing the food supply (i.e., adult salmon), and 2) increasing the area of potential perching, nesting, and roosting habitat in restored riparian forest along the middle and lower reaches of the river.

Northwest Forest Plan. This comprehensive plan for the management of federal forestlands in the range of the northern spotted owl has several direct and indirect benefits to bald eagles. Old-growth forest in Late Successional Reserves and other upland reserve areas will provide potential nesting and roosting habitat for bald eagles. Expansive riparian buffers will improve and maintain habitat for fish (eagle prey) and provide undisturbed perch habitat for use while foraging. Portions of the Upper Green River Watershed are on U. S. Forest Service lands managed under the Northwest Forest Plan, although most are at elevations too high to be used by bald eagles.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the U. S. Forest Service recently completed a land exchange involving more than 43,000 acres in the Washington Cascades. Approximately 11,556 acres of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including approximately 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP. Lands being transferred into federal ownership will come under the jurisdiction of the Northwest Forest Plan. The majority of lands involved are at high elevations where there are few if any bald eagles. Any bald eagles that do occur on the lands will continue to be protected under the ESA, the Bald and Golden Eagle Protection Act, and the Migratory Bird Treaty Act, regardless of ownership.

<u>State Plans, Policies, and Programs</u>

Washington Bald Eagle Protection Rules (WAC 232-12-292). The purpose of these rules is to protect the habitat of the bald eagle. The goal is to increase and maintain the population of the bald eagle so that it no longer is classified as threatened or endangered in Washington. The rules require site management plans to be developed if land use activities would adversely impact eagle habitat. Any relevant factor will be considered in developing a site management plan. As stated in the rules:

> *The purpose of the site management plan is to provide for the protection of specific bald eagle habitat in such a way as to recognize the special characteristics of the site and the landowner's property rights, goals and pertinent options. (232-12-292-5.1)*

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules designate certain forest practices as Class IV-Special if they would occur within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species. Forest Practices Applications that are designated as Class IV-Special require an Environmental Checklist in compliance with the State Environmental Policy Act. For the bald eagle, the following forest practices are designated as Class IV-Special:

> *Bald eagle - harvesting, road construction, aerial application of pesticides, or site preparation within 0.5 mile of a known active nest site, documented by the department of fish and wildlife, between the dates of January 1 and August 15 or 0.25 mile at other times of the year; and within 0.25 mile of a communal roosting site. Communal roosting sites shall not include refuse or garbage dumping areas. [WAC 222-16-080(1)(a)]*

The above forest practices will not be classified as Class IV-Special based on critical wildlife habitat (state) or critical habitat (federal) if the forest practices are consistent with one of the following proposed measures for the protection of the species: 1) an HCP and permit or an Incidental Take Statement approved by the Secretary of the Interior or Commerce pursuant to 16 U.S.C. Section 1536 (b) or Section 1539 (a); 2) a rule adopted by the USFWS for the conservation of a particular threatened species pursuant to 16 U.S.C 1533(d); 3) a special wildlife management plan approved by the DNR in consultation with the WDFW; 4) a cooperative habitat enhancement agreement developed pursuant to WAC 222-16-105; or 5) a bald eagle management plan prepared and approved under WAC 232-12-292 [WAC 222-16-080(6)(d)].

Requirements for riparian and aquatic habitat management in the current and proposed Forest Practices Rules also have the potential to benefit bald eagles. The requirements are intended to maintain and enhance fish habitat and sustain native fish populations. They may indirectly benefit bald eagles by providing food (fish) and habitat (mature riparian forest).

Water Rights. As discussed in subsection 4.4.3.1 of this EIS, no appropriations of surface water and groundwater have been approved in the Green River basin since 1980. Most activity since that time has centered around development and negotiation of minimum instream flows to be maintained in association

with existing water rights claims such as Tacoma Water's claims. The purpose of the minimum instream flows is primarily to benefit fish and other instream resources.

Wild Salmon Policy. The State of Washington's Wild Salmon Policy was adopted in 1997 in response to the proposed and final listings of several salmon stocks. It is described in subsection 4.3.3.1 of this EIS. Like comparable federal programs, it is aimed at protecting, restoring, and enhancing fisheries in Washington. If successful, it could have positive benefits to bald eagles by increasing the numbers of adult salmon available as food.

Watershed Management Act and Salmon Recovery Planning Act. These two laws were passed by the Washington State Legislature in 1998 to create a process for comprehensive resource planning. Like the Wild Salmon Policy and similar federal efforts, they are intended to lead to better protection of fish and other aquatic resources than has occurred in the past. If they result in increased protection of riparian habitat and increased numbers of salmon in the Green River, they will benefit bald eagles.

Hydraulic Project Approval. Activities that use, obstruct, divert, or change the bed or flow of state fresh and marine waters first require a Hydraulic Project Approval (HPA), a permit issued by WDFW. The Hydraulic Project Approval is issued under the authority of chapter RCW 77.55, and is required state-wide. Hydraulic Project Approvals are conditioned or denied solely for the protection of fish and shellfish based on rules promulgated under chapter WAC 220-110. Efforts are currently underway within WDFW to secure incidental take coverage for the issuance of Hydraulic Project Approvals, to ensure consistency of the Hydraulic Project Approval process with efforts to recover listed fish, and to expedite the overall permitting process for Applicants. The Hydraulic Project Approval process has been instrumental in protecting salmon habitat in the past, and should continue to do so in the future. If so, it will continue to benefit bald eagles as well.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which

oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. It is anticipated the Shoreline Management Act will continue to protect potential bald eagle nesting and perching habitat along Washington's rivers, and protect habitat for salmon as well.

Washington State Hatchery and Harvest Management. The State of Washington and the Washington Treaty Tribes have co-management responsibility for fisheries management in the state. As described in subsection 4.3.3.1 of this EIS, this co-management includes hatchery production and harvest regulation. Hatchery production of salmon and steelhead can result in localized increases in the food supply for bald eagles.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the bald eagle and other species (Washington Department of Natural Resources 1997). The term of the permit is 70 years, with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. Under its HCP, the DNR will protect bald eagles by continuing to implement current DNR policies to protect riparian areas and upland wildlife habitat and state and federal requirements for protecting threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan [Washington Department of Natural Resources 1992]), and by complying with Forest Practices Rules to protect bald eagle nest and communal roost sites (WAC 222-16-080). Increased riparian protection and large tree retention under the HCP are also expected to benefit bald eagles and their habitat.

Management Recommendations Washington's Priority Habitats and Species. The WDFW published management recommendations for the bald eagle (Rodrick and Milner 1991). The WDFW recommends that site-management plans be developed using the flexible territory zoning concept. Specific recommendations include: 1) a protected core area with a conditioned buffer area around the core; 2) timing restrictions to avoid activities that could disturb eagles during critical periods (breeding, 1 January to 1 August; wintering, 1 November to 1 April); 3) restrictions on the use of toxic biocides; 4) permanent

strips of perch trees along shorelines; and 5) buffering around major foraging areas. These recommendations are unchanged in a recent draft of updated WDFW management recommendations (Watson and Rodrick 1998).

Local Plans, Policies, and Programs

Local communities are also undertaking efforts to protect listed salmonids and their habitats. As mandated by the 1998 Watershed Management Act (Engrossed Substitute House Bill 2514) and Salmon Recovery Planning Act (Engrossed Substitute House Bill 2496), counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues. The State Conservation Commission is working with local governments and watershed stakeholders to complete an analysis of the factors within each Water Resource Inventory Area that limit salmon production. Local governments will receive grants to revise Shoreline Management Plans and Critical Area Ordinances, and are required to adopt a forest conversion ordinance. Any efforts that increase salmon numbers and protect forest habitat along salmon streams will benefit bald eagles.

King County Sensitive Areas Ordinance. Sensitive areas covered by King County's Sensitive Areas Ordinance include streams, wetlands, erosion hazard areas, landslide hazard areas, steep slopes, and flood areas. Development proposals affecting steep slopes, landslide hazard areas, streams, and wetlands must observe minimum buffer widths. Clearing and grading of erosion hazard areas may be limited, and must be conducted using an approved temporary erosion control plan. Areas protected under the Sensitive Areas Ordinance can include habitat for bald eagles and salmon, with resulting benefits to both species.

King County Stormwater Management. King County's Stormwater Management Policy provides for comprehensive management of surface and stormwaters and erosion control. Development projects regulated by this code must discharge runoff to its natural location, control flood flows, erosion and sediment delivery, contain an analysis of off-site impacts, and provide water quality treatment facilities to treat polluted surface and stormwater runoff. Improvements in fish habitat that result from stormwater management can benefit bald eagles.

King County intends to undertake a comprehensive review of regulations relating to salmon and habitat through the watershed conservation planning process (King County 1999). For example, King Counties Sensitive Areas Ordinance applies stringent standards across the entire unincorporated area, and is a fundamental element of stream protection in King County. To improve protection for salmon-bearing streams, King County is proposing to update the ordinances, increase enforcement of the regulations, and initiate an enhanced monitoring program to evaluate compliance and performance.

In the interim, King County will evaluate its use of State Environmental Policy Act authority to impose additional conditions and mitigation on development proposals to further protect salmon habitat (King County 1999). This use of State Environmental Policy Act substantive authority is consistent with existing County policies, does not require changes to the State Environmental Policy Act law, and can be accomplished within the general framework of permit review already in place.

MIT/TPU Agreement. In 1995, a written agreement was reached between the Muckleshoot Indian Tribe (MIT) and the City of Tacoma regarding the Green/Duwamish River system. The MIT/TPU Agreement is a substantial commitment by Tacoma directed toward implementation of a suite of measures that were considered by both parties to compensate for all impacts to the fishery resources associated with Tacoma's operations in the Green River, including the First Diversion Water Right claim and the Second Diversion Water Right. Although not included as part of the proposed HCP or ITP, Tacoma is committed to funding the development and construction of a fisheries restoration facility that will be owned and operated by the Muckleshoot Indian Tribe. The facility would be located next to the Green River, and would be designed to provide incubation and naturalized rearing facilities for steelhead trout, chinook salmon, and coho salmon. The juvenile fish produced at the restoration facility would be used to restore and enhance anadromous fish populations in the Green River, and could serve as the primary source for juveniles to be outplanted in the Upper Green River Watershed. Any resulting increase in adult salmon in the Green River could benefit bald eagles.

The transport and release of juvenile salmonids is contingent on a number of factors, including approval of the fish restoration facility, and its intended uses by fisheries resource agencies, and issuance of the necessary water rights and permits for the facility. If the fish restoration facility cannot be permitted or is deemed infeasible, the Muckleshoot Indian Tribe will elect to either receive a lump sum of $12,000,000 into MIT's Fisheries Trust Fund to be used for fisheries enhancement within the Green/Duwamish River system, or will accept any and all unused funds originally targeted for the fish restoration facility into the Trust Fund to be used for fisheries enhancement within the Green/Duwamish River system.

Programs on Private Lands

Plum Creek Multi-species Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The lands covered by the Plum Creek HCP include portions of the Upper Green River Watershed. The ITP does not cover the bald eagle, however, and the Covered Lands are generally outside the range of the bald eagle in Washington.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. If these enhancement projects increase salmon numbers in the Green River, they could benefit bald eagles.

Direct and Indirect Effects of the Proposed Action on the Bald Eagle

The proposed HCP would provide protection to known bald eagles, their nests, and communal roost sites similar to that which has been provided in the past under existing Forest Practices Rules. Little if any direct

or indirect effects to nesting and communal roosting bald eagles or their habitat would result from implementing the HCP. Bald eagles would benefit from increased riparian protection measures and reduced timber harvest levels under the HCP. These measures would maintain or improve bald eagle perching, roosting, and nesting habitat in the Action Area as well as improve habitat for their prey.

Analysis of Cumulative Effects on the Bald Eagle

Action Area. Management measures under the HCP would be consistent with current state and federal regulations that protect bald eagles and their habitat. In addition to this protection, riparian measures would improve habitat conditions along streams for perching, roosting, and nesting. Restrictions on timber harvest in the Natural and Conservation Zones would increase the amount of potential nesting and roosting habitat above current conditions. Similar restrictions on harvesting along streams on the Covered Lands (under the HCP) and as other lands in the upper watershed (under Forest Practices, the Northwest Forest Plan, and other HCPs) would result in an overall increase in potential perching, roosting, and nesting habitat.

Southwest Cascades Physiographic Province. Bald eagles are highly associated with fish-bearing streams and lakes in western Washington. Habitat conditions along these waters can have an influence on prey availability and on nesting, roosting, and perching habitat quality. Within the Southwest Cascades Physiographic Province, 96 percent of the fish-bearing streams are classified as a Forestland land type. An estimated 40 percent of the fish-bearing streams in the Forestland land type are within the Federal Reserve Areas management strategy, while 29 percent collectively are in management strategies classified as Federally Managed Areas (20%) and Completed HCPs (9%). The Tacoma Water HCP management strategy accounts for only 2 percent of the fish-bearing streams in the Forestland type. In the broad context of the Southwest Cascades Physiographic Province, the Tacoma Water HCP would have little influence on fish-bearing stream habitat.

The Southwest Cascades Physiographic Province overlaps bald eagle management Zones 5 and 6. In 1998, 117 territories were checked for occupancy in these two zones (Stofel, pers. comm., 15 January 1999). A total of 105 of the territories were classified as occupied (77 in zone 5, and 28 in zone 6). Within Management Zone 5, 92 percent of the occupied sites were classified as breeding, 88 percent were

classified as breeding in Zone 6. The reproductive rate in 1998 was 1.11 young per occupied territory in Zone 5 and 1.26 in Zone 6. The average success rate for the past 5 years was 82 percent in Zone 5 and 68 percent in Zone 6. The current population exceeds the recovery goals for management Zones 5 and 6.

Implementing the HCP would continue recent management protection that has been provided under the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and Forest Practices Rules. In addition, management measures that would improve riparian habitat conditions would complement those provided under current state laws, the DNR HCP, and the Northwest Forest Plan, providing a network of high quality perching, roosting, and nesting habitat along rivers, streams, and lakes in the Southwest Cascades Physiographic Province. The riparian management measures in these three plans (i.e., the Tacoma Water HCP, the DNR HCP, and the Northwest Forest Plan) would also improve habitat conditions for anadromous fish species, which are an important food source for wintering bald eagles. Similar increases in food supply and riparian habitat would be expected from salmon recovery efforts under the ESA, the Magnuson-Stevens Salmon Conservation and Management Act, the State Salmon Recovery Act and other programs. The combined effect of implementing all local, state and federal salmon recovery initiatives would be a benefit to resident and wintering bald eagles in the Southwest Cascades Physiographic Province.

Western Washington. Within western Washington, approximately 83 percent of the fish-bearing streams occur on Forestland. An estimated 36 percent of the fish-bearing streams in the Forestland land type are within the Federal Reserve Areas management strategy, while 21 percent are in management strategies classified as Federal Management Areas (9.3%), Completed HCPs (9.8%), and Other In-Progress HCPs (1.9%). The Tacoma Water HCP management strategy accounts for 0.3 percent of the fish-bearing streams in the Forestland type in western Washington. These numbers suggest that the Tacoma Water HCP would have little influence on fish-bearing stream habitat that supports resident and wintering bald eagles in western Washington. Overall, fish numbers are expected to increase throughout western Washington due to numerous local, state, and federal initiatives already underway.

The bald eagle has been proposed for delisting throughout the lower 48 states (U.S. Federal Register 6 July 1999). Recovery goals have been met or exceeded in all five recovery regions. The Tacoma Water HCP would implement management measures that provide continued protection to bald eagles consistent with protection provided by the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, and the Forest Practices Rules.

Peregrine Falcon

<u>Management Activities and Plans Affecting the Peregrine Falcon and Its Habitat</u>

<u>Federal Plans, Policies, and Programs</u>

Pacific Coast Recovery Plan for the American Peregrine Falcon. The Pacific Coast Recovery Plan (including the states of California, Nevada, Oregon, and Washington) for the American Peregrine Falcon identifies the proliferation of organochlorine pesticides, especially DDT and its principal metabolite DDE, as the most significant factor contributing to the decline of the peregrine falcon (U.S. Fish and Wildlife Service 1973).

Recovery goals for the peregrine falcon include 30 pairs in Washington and a total of 185 pairs for the Pacific Coast population. Productivity for the entire population should average 1.5 fledged young per active territory. The recovery plan further outlines breeding management units within the recovery zone. The breeding management unit that includes the Cascade Mountains in Washington has a goal of five active pairs. The breeding management area goals are intermediate recovery goals. Once all of the breeding management area goals have been met, the species can be considered for reclassification to threatened.

Final Rule to Remove the American Peregrine Falcon from the Federal List of Endangered and Threatened Wildlife, and to Remove the Similarity of Appearance Provisions for Free-Flying Peregrines in the Conterminous United States. The USFWS has removed the peregrine falcon *(Falco peregrinus anatum)* throughout its range from the List of Threatened and Endangered Wildlife (U.S. Federal Register, 25 August 1999). The determination to remove the peregrine falcon from the list was

based on available data indicating that this subspecies has recovered following restrictions on organochlorine pesticides in the United States and Canada, and following the implementation of successful management activities. Removing the peregrine from the list will not affect protection provided to the species by the Migratory Bird Treaty Act, or state laws and regulations.

The Migratory Bird Treaty Act (16 USCS 703-711). The Migratory Bird Treaty Act describes the following unlawful acts:

> *...it shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof...* (16 USCS 703)

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. Because the peregrine falcon has been removed from the List of Threatened and Endangered Wildlife, it is not being addressed in that consultation. The operation of Howard Hanson Dam is not likely to have any direct or indirect effect on the peregrine falcon.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. Because the peregrine falcon has been de-listed, it is not being addressed in that consultation. The Additional Water Storage Project is not likely to effect the peregrine falcon, however, because the species does not use the types of habitat that will be altered by the project.

Green/Duwamish Ecosystem Restoration Project. This comprehensive program of restoring the Green River ecosystem could benefit peregrine falcons by increasing the area of potential perching and hunting habitat in restored riparian forest along the middle and lower reaches of the river.

Northwest Forest Plan. This comprehensive plan for the management of federal forestlands in the range of the northern spotted owl has potential direct and indirect benefits to peregrine falcons. Late Successional Reserves and other upland reserve areas will reduce human activity and habitat alteration around potential nesting sites (cliffs) and hunting areas (large wetlands). Expansive riparian buffers will also improve and maintain potential hunting and perching habitat. Portions of the Upper Green River Watershed are on USFS lands managed under the Northwest Forest Plan, and some include cliffs that could serve as nesting habitat in the future.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the USFS recently completed a land exchange involving more than 43,000 acres in the Washington Cascades. Approximately 11,556 acres of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including approximately 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP. Lands being transferred into federal ownership will come under the jurisdiction of the Northwest Forest Plan. Most of the lands involved in the exchange are at high elevations, and some contain potential nesting habitat for peregrine falcons. Any peregrine falcons on the exchanged lands would continue to be protected under the Migratory Bird Treaty Act, regardless of ownership.

<u>State Plans, Policies, and Programs</u>

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules specify forest practices that are designated Class IV-Special within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species. Forest practice applications that are designated as Class IV-Special require an environmental checklist in compliance with the State Environmental Policy Act. For the peregrine falcon, the following forest practice are designated as Class IV-Special:

> *Peregrine falcon - harvesting, road construction, aerial application of pesticides, or site preparation within 0.5 mile of a known active nest site, documented by the department of fish and wildlife, between the dates of March 1 and July 30 or harvesting, road construction, or aerial application of pesticides within 0.25 mile of the nest site at other times of the year.*[WAC 222-16-080(1)(f)]

The above forest practices will not be classified as Class IV-Special based on critical wildlife habitat (state) or critical habitat (federal) if the forest practices are consistent with one of the following proposed measures for the protection of the species: an HCP and permit or an Incidental Take Statement approved by the Secretary of the Interior or Commerce pursuant to 16 U.S.C. Section 1536 (b) or Section 1539 (a); a rule adopted by the USFWS for the conservation of a particular threatened species pursuant to 16 U.S.C 1533(d); a special wildlife management plan approved by the DNR in consultation with the WDFW; or a cooperative habitat enhancement agreement developed pursuant to WAC 222-16-105.

Watershed Management Act and Salmon Recovery Planning Act. These two laws were passed by the Washington State Legislature in 1998 to create a process for comprehensive resource planning. Like the Wild Salmon Policy and similar federal efforts described in subsection 4.4.3.1, they are intended to lead to better protection of fish and other aquatic resources than has occurred in the past. These laws could result in the protection of wetland and riparian habitats used by peregrine falcons for hunting.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. They could result in increased protection of wetlands and riparian areas used by peregrine falcons for hunting.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the peregrine falcon and other species (Washington Department of Natural Resources 1997). The term of the permit is 70 years, with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. Under its HCP, the DNR will protect peregrine falcons by continuing to implement current DNR policies to protect riparian areas and upland wildlife habitat and state and federal requirements for protecting threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan [Washington Department of Natural Resources 1992]), and by complying with Forest Practices Rules to protect peregrine falcon nest sites (WAC 222-16-080). Increased cliff protection under the HCP is also expected to benefit peregrine falcons and their habitat.

Management Recommendations for Washington's Priority Habitats and Species. The WDFW has published management recommendations for the peregrine falcon (Hays and Milner 1999). Management recommendations include restricting access to cliff rims where nests are built within 0.5 mile and cliff faces within 0.25 mile from March through June; avoiding forest practices within 0.5 mile during the breeding season; preserving all snags and large trees around nests; avoiding aircraft approaches closer than 1,500 feet above a nest; and maintaining large trees and snags as perches in winter peregrine feeding areas.

<u>Local Plans, Policies, and Programs</u>

Local communities are also undertaking efforts to protect listed salmonids and their habitats that could have indirect effects on peregrine falcons. As mandated by the 1998 Watershed Management Act (Engrossed Substitute House Bill 2514) and Salmon Recovery Planning Act (Engrossed Substitute House Bill 2496), counties are conducting watershed planning to address water quality, water quantity, and salmon habitat issues. The State Conservation Commission is working with local governments and watershed stakeholders to complete an analysis of the factors within each Water Resource Inventory Area that limit salmon production. Local governments will receive grants to revise Shoreline Management Plans and Critical Area Ordinances, and are required to adopt a forest conversion ordinance.

King County Sensitive Areas Ordinance. Sensitive areas covered by King County's Sensitive Areas Ordinance include streams, wetlands, erosion hazard areas, landslide hazard areas, steep slopes, and flood

areas. Development proposals affecting steep slopes, landslide hazard areas, streams, and wetlands must observe minimum buffer widths. Clearing and grading of erosion hazard areas may be limited, and must be conducted using an approved temporary erosion control plan. The Sensitive Areas Ordinance has little effect on the peregrine falcon because there are very few areas under county jurisdiction that support falcons.

Programs on Private Lands

Plum Creek Multispecies Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species, including the peregrine falcon, on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The amount of potential nesting habitat for the peregrine falcon would not change under the HCP, and measures in the HCP would result in the protection of the habitat from disturbance if occupied by falcons. The lands covered by the Plum Creek HCP include portions of the Upper Green River Watershed.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. Re-opening and use of the rail line are not likely to have any effect on peregrine falcons, as they will not directly alter falcon habitat or disrupt falcon behavior.

Direct and Indirect Effects of the Proposed Action on the Peregrine Falcon

Seasonal and long-term protection of peregrine falcon nests sites under the HCP would be comparable to existing regulations. Long-term protection of hunting habitat under the HCP would exceed that provided by existing regulations, and could result in more viable nesting habitat in the Upper Green River Watershed in the future. The HCP would result in no direct negative effects on peregrine falcons.

Analysis of Cumulative Effects on the Peregrine Falcon

Action Area. Management measures under the HCP would be consistent with current Forest Practices Rules that are used to protect peregrine falcons and their habitat. In addition to this protection, riparian measures would improve habitat conditions along streams for peregrine falcon hunting habitat in the vicinity of the Action Area.

Southwest Cascades Physiographic Province. The Southwest Cascades Physiographic Province constitutes approximately one-quarter of Breeding Management Unit 5 delineated in the Pacific Coast Recovery Plan (U.S. Fish and Wildlife Service 1962). Currently, the Cascades of Washington support five known peregrine territories, four of which were occupied and produced young in 1997 (Stofel, pers. comm., 18 February 1998).

Implementing the HCP would continue the management protection that is provided under current Forest Practices Rules. This management has allowed the peregrine population to increase in Washington so that the peregrine population has been removed from the federal List of Endangered and Threatened Species. In addition, the HCP would improve riparian habitat conditions. This management would complement the management provided under the Northwest Forest Plan, DNR HCP, the Plum Creek HCP, and other local, state and federal plans to improve habitat for salmon. Although the peregrine falcon is not known to nest in the vicinity of the Tacoma Water HCP Area, improved riparian protection for peregrine prey and protecting potential nesting habitat could provide the opportunities for future expansion of its range. The Tacoma Water HCP is consistent with and complementary to all of the management efforts for peregrine falcons in the Southwest Cascades Physiographic Province.

Western Washington. The Action Area (14,888 acres) is less than 1 percent of the western Washington analysis area (21.3 million acres). While this is a relatively small portion of the analysis area, if suitable habitat were present in the Action Area, the area could have a relatively higher importance to the peregrine falcon population.

The peregrine falcon has been de-listed in North America. Populations in Washington and throughout the peregrine's range wide have reached levels that are considered capable of supporting a self-sustaining wild population. Implementing the Tacoma Water HCP would provide continued management consistent with recent management efforts on private timberlands that have contributed to the population increase. In addition, the Tacoma Water HCP and the numerous other efforts to protect habitat for salmon in the region would improve riparian conditions important to peregrine prey species.

Marbled Murrelet

Management Activities and Plans Affecting the Marbled Murrelet and its Habitat

Federal Plans, Policies, and Programs

Designation of Critical Habitat for the Marbled Murrelet, Final Rule. The final designation of critical habitat for the marbled murrelet does not include all suitable habitat (U.S. Federal Register 24 May 1996). Emphasis was placed on those areas considered most essential to the species' conservation in terms of habitat, distribution, and ownership. A designation of critical habitat begins with identifying areas essential to the conservation of the species. In Washington, the allocation of critical habitat by ownership is as follows:

Federal Lands	Acres
Congressionally withdrawn lands	1,800
Late Successional Reserves	1,200,200
Non-Federal Lands	
State lands	426,800
Private lands	2,500
TOTAL	1,631,300

Within the boundaries of the designated critical habitat, only those areas that contain one or more primary constituent elements are, by definition, critical habitat. Primary constituent elements include individual trees with potential nesting platforms and forested areas within 0.5 mile of these trees with a canopy height of at least one-half the site-potential tree height, regardless of contiguity.

Recovery Plan for the Marbled Murrelet. The Recovery Plan for the marbled murrelet lists the loss of nesting habitat and poor reproductive success as the two major factors leading to the decline of the population (U.S. Fish and Wildlife Service 1997). Factors contributing to the poor reproductive success are habitat fragmentation and edge effect, nest predation, low productivity, adult mortality, and nest mortality.

For purposes of recovery, the plan divides the range of the marbled murrelet in Washington, Oregon, and California into six Conservation Zones. The Action Area is within Zone 1. The objectives of the Recovery Plan are to stabilize and then increase population size throughout the listed range, provide future conditions with a reasonable likelihood of continued existence of viable populations, and gather necessary information to develop specific de-listing criteria. Interim de-listing criteria are provided until information on population and life history requirements is available to develop recovery criteria. The interim de-listing criteria include: 1) a trend in estimated population size and productivity that is stable or increasing in four of the six zones over a 10-year period, and 2) management commitments (marine and terrestrial) and monitoring that is implemented to provide adequate protection of marbled murrelets in the six Conservation Zones for at least the near future (50 years). The recovery strategy includes protecting habitat, reducing or eliminating threats, and conducting research and monitoring.

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. The marbled murrelet is being addressed in that consultation. The operation of Howard Hanson Dam is not likely to have any direct effect on the marbled murrelet because it would not modify or disturb habitat used by the species.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. The Additional Water Storage Project would cause a slight reduction in the amount of coniferous

forest along the existing reservoir, but the forest is presently too young to support marbled murrelet nesting. Mitigation measures associated with the Additional Water Storage Project could increase the amount of potential nesting habitat (late-seral coniferous forest) along the reservoir in the future.

Section 1135 Project. As described in subsection 4.4.3.1 of this EIS, the federal Section 1135 Project is intended to improve habitat for fish in the Green River by increasing low summer flows in dry years. It would have no direct or indirect effect on marbled murrelets.

Green/Duwamish Ecosystem Restoration Project. This comprehensive program of restoring the Green River ecosystem could have indirect benefit to the marbled murrelet in the very long term by increasing the amount of potential nesting habitat in restored riparian forest along the middle and lower reaches of the river.

Northwest Forest Plan. The Northwest Forest Plan resulted in the designation of over 7 million acres of Late Successional Reserves (LSR) where no active forest management will occur. Many of these LSRs support occupied, suitable, and/or potential marbled murrelet nesting habitat that will be protected indefinitely. Outside the LSRs, the plan also requires special measures to protect occupied ~~The Northwest Forest Plan is designed to protect occupied~~ marbled murrelet habitat within 40 miles of marine water and recruitment marbled murrelet habitat that is within 0.5 mile of occupied habitat (U.S. Forest Service and Bureau of Land Management 1994). Pre-project surveys for marbled murrelets are required in marbled murrelet habitat within 40 miles of marine waters. If habitat is found to be occupied by marbled murrelets, all contiguous existing and recruitment habitat on USFS lands will be protected within a 0.5-mile radius. USFS lands in the Upper Green River Watershed are managed according to the Northwest Forest Plan, and some have been found to be occupied by nesting marbled murrelets. These occupied lands will be protected under the federal plan.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the USFS recently completed a land exchange involving more than 43,000 acres in the Washington Cascades. Approximately 11,556 acres of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including approximately 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP. Lands

being transferred into federal ownership will come under the jurisdiction of the Northwest Forest Plan. Some of the lands originally considered for transfer from the USFS to Plum Creek were found to support marbled murrelet nesting, and were retained in federal ownership as a result.

State Plans, Policies, and Programs

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules designate certain forest practices as Class IV-Special if they occur within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species (WAC 222-16-080). Forest practice applications that are designated as Class IV-Special require the preparation of an Environmental Checklist in compliance with the State Environmental Policy Act. For the marbled murrelet, the following is a summary of the forest practices designated as Class IV-Special [WAC 222-16-080(1)(j)]:

- Harvest, other than removal of down trees outside of the critical nesting season, or road construction within: 1) occupied marbled murrelet sites, 2) suitable marbled murrelet habitat within a marbled murrelet detection area, or 3) marbled murrelet habitat containing seven platforms per acre outside a marbled murrelet detection area. An exception to this is where a protocol survey for nesting marbled murrelets has been conducted and no marbled murrelets have been detected.

- Harvest within a 300-foot managed buffer zone adjacent to an occupied marbled murrelet site that results in less than a residual stem density of 75 trees per acre greater than 6 inches in dbh, provided that 25 of the trees are greater than 12 inches dbh and five of the trees are greater than 25 inches dbh, where they exist prior to harvest.

The above forest practices will not be classified as Class IV-Special based on critical wildlife habitat (state) or critical habitat (federal) if the forest practices are consistent with one of the following proposed measures for the protection of the species: 1) an HCP and permit or an Incidental Take Statement approved by the Secretary of the Interior or Commerce pursuant to 16 U.S.C. Section 1536 (b) or Section 1539 (a); 2) a rule adopted by the USFWS for the conservation of a particular threatened species pursuant to 16 U.S.C 1533(d); 3) a special wildlife management plan approved by the DNR in consultation with the WDFW; or 4) a cooperative habitat enhancement agreement developed pursuant to WAC 222-16-105.

Watershed Management Act and Salmon Recovery Planning Act. These two laws were passed by the Washington State Legislature in 1998 to create a process for comprehensive resource planning. Like the Wild Salmon Policy and similar federal efforts, they are intended to lead to better protection of fish and other aquatic resources than has occurred in the past. They may also lead to the protection of coniferous forest that could be used by marbled murrelets in the future.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. Additional protection of coniferous riparian forest under the Act could increase the amount of suitable marbled murrelet nesting habitat in the future.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the marbled murrelet (Washington Department of Natural Resources 1997). The term of the permit is 70 years with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. The DNR, in its HCP, has an objective of developing a long-term conservation strategy for the habitat of the marbled murrelet. At the time the DNR HCP was prepared, information was not available to develop such a strategy. An interim management approach was developed and is being implemented until a long-term management strategy is developed. The following is a summary of the interim management approach:

- The DNR will identify and defer harvest of any part of a suitable habitat block while a 2-year habitat relationship study is conducted to determine the relative importance (based on murrelet occupancy) of various habitat types in each planning unit.

- Following the completion of the habitat relationship study, marginal habitat types that would

be expected to contain a maximum of 5 percent of the occupied sites on DNR land in each planning unit will be available for harvest. However, no known occupied sites will be released for harvest.

- The remaining habitat will be surveyed using a survey protocol approved by the USFWS to locate occupied sites. Outside southwest Washington, surveyed habitat that is not occupied will be available for harvest if it is not within 0.5 mile of known occupied habitat, and if at least 50 percent of the suitable marbled murrelet habitat on DNR-managed lands within a WAU would remain after harvest. Within southwest Washington, surveyed, unoccupied habitat will not be released for harvest until a long-term management strategy is completed (see below) or until at least 12 months have passed since the initiation of the negotiations for a long-term plan without completion of those negotiations.

- After the other interim measures are completed for each planning unit, the information obtained during these and other research efforts shall be used to develop a long-term conservation strategy for marbled murrelet habitat on DNR-managed HCP lands within the planning unit.

Management Recommendations Washington's Priority Habitats and Species. The Washington Department of Fish and Wildlife Priority Habitats and Species Program currently does not address the marbled murrelet.

<u>Local Plans, Policies, and Programs</u>

King County Sensitive Areas Ordinance. Sensitive areas covered by King County's Sensitive Areas Ordinance include streams, wetlands, erosion hazard areas, landslide hazard areas, steep slopes, and flood areas. Development proposals affecting steep slopes, landslide hazard areas, streams, and wetlands must observe minimum buffer widths. Clearing and grading of erosion hazard areas may be limited, and must be conducted using an approved temporary erosion control plan. The Sensitive Areas Ordinance is not

likely to have any effect on marbled murrelets since little or no marbled murrelet habitat falls under county jurisdiction.

King County Stormwater Management. King County's Stormwater Management Policy provides for comprehensive management of surface water, stormwater, and erosion control. Development projects regulated by this code must discharge runoff to its natural location, control flood flows, erosion and sediment delivery, contain an analysis of off-site impacts, and provide water quality treatment facilities to treat polluted surface and stormwater runoff.

King County intends to undertake a comprehensive review of regulations relating to salmon and habitat through the watershed conservation planning process (King County 1999). For example, King Counties Sensitive Areas Ordinance applies stringent standards across the entire unincorporated area, and is a fundamental element of stream protection in King County. To improve protection for salmon-bearing streams, King County is proposing to update the ordinances, increase enforcement of the regulations, and initiate an enhanced monitoring program to evaluate compliance and performance. Increased protection of salmon habitat could indirectly lead to increased habitat for nesting marbled murrelets in the future.

In the interim, King County will evaluate its use of State Environmental Policy Act authority to impose additional conditions and mitigation on development proposals to further protect salmon habitat (King County 1999). This use of State Environmental Policy Act substantive authority is consistent with existing County policies, does not require changes to the state law, and can be accomplished within the general framework of permit review already in place.

MIT/TPU Agreement. In 1995, a written agreement was reached between the Muckleshoot Indian Tribe (MIT) and the City of Tacoma regarding the Green/Duwamish River system. The MIT/TPU Agreement is a substantial commitment by Tacoma directed toward implementation of a suite of measures that were considered by both parties to compensate for all impacts to the fishery resources associated with Tacoma's operations in the Green River, including the First Diversion Water Right claim and the Second Diversion Water Right. Riparian protection measures that Tacoma Water has committed to under the agreement could lead to the development of potential marbled murrelet nesting habit in the upper watershed in the future.

Programs on Private Lands

Plum Creek Multispecies Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The HCP covers the marbled murrelet, although the species is rare on the high-elevation lands covered by the plan. In general, incidental take of marbled murrelets will be avoided under the Plum Creek HCP.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. Re-opening and use of the line will not alter marbled murrelet habitat or disrupt murrelet behaviors.

Direct and Indirect Effects of the Proposed Action on the Marbled Murrelet

Implementing the Tacoma Water HCP would have no negative effect on marbled murrelet nesting habitat. No suitable or occupied habitat would be harvested or otherwise modified under the HCP. Over the term of the proposed ITP, potential marbled murrelet habitat could develop in the Natural and Conservation zones, and in riparian management areas within the Commercial Zone. The amount of forest stands that exceed 100 years old would increase over the term of the ITP to approximately 5,000 acres, and some of this could support marbled murrelet nesting at some time in the future.

Analysis of Cumulative Effects on the Marbled Murrelet

Action Area. Implementing the proposed HCP would minimize disturbance around occupied marbled murrelet habitat on adjacent federal lands during the nesting season, and increase the amount of potential nesting habitat on Tacoma lands in the future. Both of these effects are consistent with the objectives of the Recovery Plan for the Marbled Murrelet.

Southwest Cascades Physiographic Province. Within the Southwest Cascades Physiographic Province, 90 percent of the area is classified as Forestland land type. The Federal Reserve Areas management strategy encompasses 37.3 percent of the Forestland land type, while Federally Managed Areas (18.1%) and Completed HCP (11.2%) management strategies make up 29.3 percent of the area. Roughly 0.5 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy.

An estimated 28 percent of the Forestland land type is classified as old forest, with 51 percent of the old forest under the Federal Reserve Area management strategy. The old forest classification is expected to include all the currently suitable and potential marbled murrelet habitat (potentially suitable within 25 years) in the Southwest Cascades Physiographic Province, although it does not account for elevation, tree species, or proximity to marine water. The Federally Managed Areas account for 25 percent of the old forest. The Tacoma Water HCP management strategy accounts for approximately 0.5 percent of the old forest in the Southwest Cascades Physiographic Province. Management on the Action Area would not substantially affect the amount of old forest in the Southwest Cascades Physiographic Province.

The Northwest Forest Plan, the DNR HCP, and the Plum Creek HCP are all designed to protect occupied habitat in the Southwest Cascades Physiographic Province and potential habitat within 0.5 mile of occupied habitat. In addition, the Northwest Forest Plan has established LSRs that will be developing habitat suitable for marbled murrelets. Both the Northwest Forest Plan and the DNR HCP will be developing habitat in riparian areas that could provide suitable marbled murrelet habitat in the future. The Plum Creek HCP may have similar benefits. The proposed Tacoma Water HCP would provide management consistent with all three plans, as habitat would be developed that could become suitable in the future.

Western Washington. Within the western Washington analysis area, 78 percent of the area is classified as the Forestland land type. The Federal Reserve Areas management strategy encompasses 35.0 percent of the Forestland land type, while Federally Managed Areas (8.8%) and Completed HCP (10.8%) management strategies make up 19.6 percent of the area. Less than 0.1 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy.

An estimated 23 percent of the Forestland land type is classified as old forest, with 51.1 percent of the old forest under the Federal Reserve Area management strategy. The old forest classification is expected to include all the currently suitable and potential habitat in the western Washington analysis area, although it does not account for elevation, tree species, or proximity to marine waters. The Federally Managed Areas (11.3%) and Completed HCPs (13.9%) account for 25.2 percent of the old forest. The Tacoma Water HCP management strategy accounts for less than 0.1 percent of the old forest. Management on the Action Area would not substantially affect the amount of old forest in the western Washington analysis area, as there would be no removal of suitable habitat.

The Northwest Forest Plan, the DNR HCP, and the Plum Creek HCP are all designed to protect occupied habitat in the western Washington analysis area and potential habitat within 0.5 mile of occupied habitat. All will develop habitat that could become suitable for murrelet nesting in the future. Suitable unoccupied marbled murrelet habitat could be harvested under these plans, as it could on any other lands within the range of the species. The amount harvested under these plans, however, would be small compared to the amount of occupied, suitable, and potential habitat protected. The proposed Tacoma Water HCP would provide management consistent with these three plans, as habitat would be developed that could become suitable in the future.

The numerous ongoing local and regional efforts to protect and improve habitat for salmon could indirectly benefit the marbled murrelet by increasing the amount of late-seral forest in the future that could serve as nesting habitat. These salmon protection and enhancement plans would have no individual or cumulative negative effects on the marbled murrelet because they would result in no direct loss or adverse modification of occupied, suitable, or potential marbled murrelet habitat.

Northern Spotted Owl

<u>Management Activities and Plans Affecting the Northern Spotted Owl and Its Habitat</u>

<u>Federal Plans, Policies, and Programs</u>

The Recovery Plan for the Northern Spotted Owl, Final Draft. The final draft of the Recovery Plan for the Northern Spotted Owl divides the range of the northern spotted owl into provinces (U.S. Fish and Wildlife Service 1992). There are three provinces that cover western Washington: the Western Washington Cascades Province, which includes the Action Area; the Western Washington Lowlands Province; and the Olympic Peninsula Province. For identifying significant threats to the northern spotted owl, the recovery plan splits the Western Washington Cascades Province into two segments (north and south). Interstate 90 is the dividing line between the two segments; the Tacoma Water HCP Area is south of Interstate 90. Declining habitat was listed as the only severe threat that could cause province-wide population instability and decline in the southern segment of the Western Washington Cascades Province. Limited habitat, low population, declining population, poor distribution of populations and habitats, and isolation were all listed as moderate threats.

De-listing criteria provided in the final draft Recovery Plan include: 1) owl populations and owl habitat in the area have been monitored with scientifically credible monitoring plans for the preceding 8 or more consecutive years; 2) the population has been stable or increasing during at least the last 8 years, as indicated by density estimates and demographic analyses, in parts of the area that would be considered significant under the Endangered Species Act; 3) regulatory mechanisms or land management commitments have been implemented that provide for adequate long-term protection of breeding, foraging, and dispersal habitat; and 4) the population is unlikely to need protection under the Endangered Species Act during the foreseeable future.

The biological goals on nonfederal land in the southern segment of the Western Washington Cascades Province are: 1) to provide nesting, roosting and foraging habitat within or directly adjacent to DCAs with checkerboard ownership, 2) to provide nesting, roosting and foraging habitat to help support the reserve

pair area that will be established on federal lands in the checkerboard ownership, and 3) to provide dispersal habitat on nonfederal lands between DCAs.

Determination of Critical Habitat for the Northern Spotted Owl, Final Rule. Designating critical habitat for the northern spotted owl provides additional protection requirements under Section 7 of the Endangered Species Act with regard to activities that are funded, authorized, or carried out by a federal agency. The final designation of critical habitat did not include any private or Tacoma-owned timberlands (U.S. Federal Register, 15 January 1992).

The Migratory Bird Treaty Act (16 USCS 703-711). The Migratory Bird Treaty Act describes the following unlawful acts:

> *...it shall be unlawful at any time, by any means or in any manner, to pursue, hunt, take, capture, kill, attempt to take, capture, or kill, possess, offer for sale, sell, offer to barter, barter, offer to purchase, purchase, deliver for shipment, ship, export, import, cause to be shipped, exported, or imported, deliver for transportation, transport or cause to be transported, carry or cause to be carried, or receive for shipment, transportation, carriage, or export, any migratory bird, any part, nest, or eggs of any such bird, or any product, whether or not manufactured, which consists, or is composed in whole or part, of any such bird or any part, nest, or egg thereof...* (16 USCS 703)

Northwest Forest Plan. The Northwest Forest Plan outlines a management strategy for managing federal old-growth and late-successional forest (U.S. Forest Service and the Bureau of Land Management 1994). The plan designates Late Successional Reserves (LSR) representing 30 percent of the federal land within the range of the northern spotted owl. These reserves, in combination with Congressionally Reserved Areas, Adaptive Management Areas, Managed Late Successional Areas, Administratively Withdrawn Areas, Riparian Reserves, and Matrix Lands, were designed to maintain a functional, interactive, late-successional and old-growth forest ecosystem.

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. The northern spotted owl is being addressed in that consultation. The operation of Howard Hanson Dam will have no effect on the northern spotted owl, as it will result in no alteration or disturbance of suitable spotted owl habitat.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. The Additional Water Storage Project would reduce the amount of currently suitable spotted owl habitat in the upper watershed by 17.6 acres, and the amount of future potential habitat by approximately 228 acres. As mitigation, an estimated 143 acres of young forest in the vicinity of the reservoir would be managed to accelerate the development of late-seral forest conditions capable of supporting spotted owls. The overall effects of the Additional Water Storage Project on the northern spotted owl will be minor.

Section 1135 Project. As described in subsection 4.4.3.1 of this EIS, the federal Section 1135 Project is intended to improve habitat for fish in the Green River by increasing low summer flows in dry years. It would have no effect on the northern spotted owl.

Green/Duwamish Ecosystem Restoration Project. This comprehensive program of restoring the Green River ecosystem could benefit the northern spotted owl by increasing the area of potential roosting and foraging habitat in restored riparian forest along the middle and lower reaches of the river. Any such benefits would be minor, however, because spotted owls are generally absent from that portion of their historic range.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the USFS recently completed a land exchange involving more than 43,000 acres in the Washington Cascades. Approximately 11,556 acres of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including approximately 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP, which includes several provisions specifically for the management of spotted owl habitat. Lands being transferred

into federal ownership will come under the jurisdiction of the Northwest Forest Plan.

State Plans, Policies, and Programs

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules designate certain forest practices as Class IV-Special if they occur within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species. Forest practice applications that are designated as Class IV-Special require the completion of an Environmental Checklist in compliance with the State Environmental Policy Act. The following is a summary of forest practices designated as Class IV-Special for the northern spotted owl:

- Within a Spotted Owl Special Emphasis Area (SOSEA) boundary (see maps in WAC 222-16-086), harvesting, road construction, or aerial application of pesticides on suitable spotted owl habitat located within a median home range circle that is centered within the SOSEA or on adjacent lands will be designated a Class IV-Special. The Upper Green River Watershed is within the I-90 West SOSEA. [WAC 222-16-080(1)(h)(i)]

- Outside of a SOSEA, harvesting, road construction, or aerial application of pesticides, between 1 March and 31 August on the 70 acres of the highest quality suitable habitat surrounding a northern spotted owl site center located outside a SOSEA will be designated a Class IV-Special. The highest quality suitable habitat shall be determined by the USFWS in cooperation with the WDFW. Consideration shall be given to habitat quality, proximity to the activity center and contiguity. [WAC 222-16-080(h)(iii)]

- To avoid disturbance within a SOSEA boundary road construction, felling and bucking, operation of heavy equipment, helicopter yarding, and burning is not allowed within 0.25 mile of a northern spotted owl site center between 1 March and 31 August. [WAC 222-16-24 through 30]

The above forest practices will not be classified as Class IV-Special based on critical wildlife habitat (state) or critical habitat (federal) if the forest practices are consistent with one of the following measures proposed

for the protection of the species: 1) an HCP and permit or an Incidental Take Statement approved by the Secretary of the Interior or Commerce pursuant to 16 U.S.C. Section 1536 (b) or Section 1539 (a); 2) a rule adopted by the USFWS for the conservation of a particular threatened species pursuant to 16 U.S.C 1533(d); 3) a special wildlife management plan approved by the DNR in consultation with the WDFW; or 4) a cooperative habitat enhancement agreement developed pursuant to WAC 222-16-105.

Watershed Management Act and Salmon Recovery Planning Act. These two laws were passed by the Washington State Legislature in 1998 to create a process for comprehensive resource planning. Like the Wild Salmon Policy and similar federal efforts, they are intended to lead to better protection of fish and other aquatic resources than has occurred in the past. The protection of habitat for salmon could potentially involve forestland that is also suitable for spotted owls, but it is unlikely that salmon recovery efforts will increase the overall amount of habitat beyond that being protected and created under plans and policies directed specifically at spotted owls.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. Restrictions on shoreline development and habitat alteration could eventually increase the total amount of spotted owl habitat in the state, but the overall increase would be very small.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the northern spotted owl (Washington Department of Natural Resources 1997). The term of the permit is 70 years with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. The Action Area is within the South Puget planning unit in the DNR HCP. Under its HCP, the DNR has designated areas to be managed for spotted owl NRF

habitat and other areas to be managed for dispersal habitat. Management within NRF areas will maintain at least 50 percent of the area in NRF habitat. Depending on the amount of NRF habitat within the combined area of federal reserves and the DNR NRF area within a WAU, more than 50 percent of the NRF area may be maintained in NRF habitat. Nesting habitat also will be provided in one 300-acre patch in the Upper Green River Watershed. The DNR land designated for spotted owl dispersal habitat will be managed to maintain 50 percent of the designated area within a WAU as dispersal habitat.

Management Recommendations Washington's Priority Habitats and Species. The Washington Department of Fish and Wildlife Priority Habitats and Species Program currently does not address the northern spotted owl.

Local Plans, Policies, and Programs

King County Sensitive Areas Ordinance. Sensitive areas covered by King County's Sensitive Areas Ordinance include streams, wetlands, erosion hazard areas, landslide hazard areas, steep slopes, and flood areas. Development proposals affecting steep slopes, landslide hazard areas, streams, and wetlands must observe minimum buffer widths. Clearing and grading of erosion hazard areas may be limited, and must be conducted using an approved temporary erosion control plan. Some identified sensitive areas in the county may support suitable spotted owl habitat, although most are within areas of human development where spotted owls are rare.

MIT/TPU Agreement. In 1995, a written agreement was reached between the Muckleshoot Indian Tribe (MIT) and the City of Tacoma regarding the Green/Duwamish River system. The MIT/TPU Agreement is a substantial commitment by Tacoma directed toward implementation of a suite of measures that were considered by both parties to compensate for all impacts to the fishery resources associated with Tacoma's operations in the Green River, including the First Diversion Water Right claim and the Second Diversion Water Right. The riparian protection commitments in the MIT/TPU Agreement, which have been incorporated into the Tacoma Water HCP, could result in increased amounts of suitable spotted owl habitat in the upper watershed in the future.

Programs on Private Lands

Plum Creek Multispecies Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The lands covered by the Plum Creek HCP include portions of the Upper Green River Watershed. The northern spotted owl is a primary species of focus in the HCP. The numerous measures in the HCP to maintain habitat for the northern spotted owl are expected to result in overall benefits to the species.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. Re-opening and use of the line will not alter spotted owl habitat or disrupt spotted owl behaviors.

Direct and Indirect Effects of the Proposed Action on the Northern Spotted Owl

The Tacoma Water HCP would result in an increase in the amount of suitable spotted owl habitat in the Upper Green River Watershed (from approximately 3,500 acres to 5,000 acres on Tacoma lands), and seasonal protection of active spotted owl nests from potentially disturbing activities. No timber felling, yarding, road construction or use of low-flying aircraft would be conducted within 0.25 mile of any known spotted owl activity center between 1 March and 30 June, unless the resident spotted owls have been found to be non-nesting, and no blasting would occur within 1 mile under similar conditions.

Analysis of Cumulative Effects on the Northern Spotted Owl

Action Area. Implementing the proposed HCP would be consistent with recommendations in the Forest Practices Rules for management within the I-90 West SOSEA and biological goals for the recovery of the spotted owl for nonfederal lands from the Draft Federal Recovery Plan. The proposed Tacoma Water HCP would increase connectivity between federal LSRs and increase the amount of foraging and roosting habitat within 1.8 miles of known spotted owl site centers. Implementing the proposed HCP would not affect any federally designated spotted owl critical habitat. The Action Area is intermingled with federal lands managed under the Northwest Forest Plan, state lands managed under the DNR HCP, and private lands managed under the Plum Creek HCP. The cumulative effect of all plans in the Action Area will be increases in the amount and quality of spotted owl habitat.

Southwest Cascades Physiographic Province. Within the Southwest Cascades Physiographic Province, 90 percent of the area is classified as the Forestland land type. The Federal Reserve Areas management strategy encompasses 37.3 percent of the Forestland land type, while Federally Managed Areas (18.1%) and Completed HCP (11.2%) management strategies make up approximately 29.3 percent of the area. Less than 0.5 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy.

An estimated 28 percent of the Forestland land type is classified as old forest, with approximately 51 percent of the old forest under the Federal Reserve Area management strategy. Old forest habitat is assumed to provide spotted owl NRF habitat. The Federally Managed Areas account for 25 percent of the old forest. The Tacoma Water HCP management strategy accounts for 0.5 percent of the old forest in the Southwest Cascades Physiographic Province. Management on the Action Area would not substantially affect the amount of old forest in the Southwest Cascades Physiographic Province. However, the current known spotted owl population within the Southwest Cascades Physiographic Province is low, and old forest in the Action Area could provide important habitat to some spotted owl site centers.

The Action Area is also within an area identified in the Draft Recovery Plan for the Northern Spotted Owl as needing dispersal and demographic support from nonfederal lands. Implementing the proposed HCP would increase the amount of dispersal, foraging, and roosting habitat in the Southwest Cascades Physiographic Province.

The Northwest Forest Plan, the DNR HCP and the Plum Creek HCP are all designed to protect known spotted owl site centers and to develop habitat to support future site centers in the vicinity of the Action Area. In addition, the DNR and Plum Creek HCPs will be developing habitat for spotted owl dispersal within the I-90 West SOSEA. The proposed HCP would provide management consistent with these plans. Implementing the proposed HCP would complement these other management efforts.

Western Washington. Within the western Washington analysis area, 78 percent of the area is classified as the Forestland land type. The Federal Reserve Areas management strategy encompasses 35.0 percent of the Forestland land type, while Federally Managed Areas (8.8%) and Completed HCPs (10.8%) management strategies make up 19.6 percent of the area. Less than 0.1 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy.

An estimated 23 percent of the Forestland land type is classified as old forest, with 51.1 percent of the old forest under the Federal Reserve Area management strategy. Older forest is assumed to provide northern spotted owl NRF habitat. The Federally Managed Areas (11.3%) and Completed HCPs (13.9%) account for another 25.2 percent of the old forest. The Tacoma Water HCP management strategy accounts for less than 0.1 percent of the old forest. Management on the Action Area would not substantially affect the amount of old forest in the western Washington analysis area, but would increase the amount of dispersal, foraging, and roosting habitat locally.

Grizzly Bear

<u>Management Activities and Plans Affecting the Grizzly Bear and Its Habitat</u>

<u>Federal Plans, Policies, and Programs</u>

Grizzly Bear Recovery Plan. The grizzly bear was listed as threatened on 28 July 1975 (U.S. Fish and Wildlife Service 1993). Habitat loss and human-caused mortality (both direct and indirect) were responsible for the grizzly bears' decline in numbers. Seven recovery zones are identified for possible grizzly bear recovery. The Action Area lies to the south of the North Cascade Recovery Zone. The chapter for the recovery plan for the North Cascades Grizzly Bear Recovery Zone was not completed

when the recovery plan was published. The final draft North Cascades Grizzly Bear Recovery Chapter was distributed in 1994. Information on the ecosystem required to make final recovery goals was still not available at the time the draft chapter was distributed. However, the North Cascades Grizzly Bear Recovery Chapter states the population would be considered recovered when it is large enough to offset some level of human-induced mortality and be self-sustaining, and reproducing grizzly bears are distributed across the recovery area. The only management recommendation in the list of priority recovery actions to be recommended for the first 5 years is the implementation of the Interagency Grizzly Bear Guidelines (Interagency Grizzly Bear Committee 1986).

Interagency Grizzly Bear Guidelines. The Interagency Grizzly Bear Guidelines describe five management situations relevant to management on public lands by the National Park Service, the USFS, and the U.S. Bureau of Land Management. Management direction and guidelines are provided for each management situation. None of the management situations clearly fit the management of municipal watersheds. However, the management situation that may best describe the proposed Tacoma Water HCP is Management Situation 2:

> *Current information indicates that the area lacks distinct population centers; highly suitable habitat does not generally occur, although some grizzly bear habitat components exist and grizzlies may be present occasionally. Habitat resources in Management Situation 2 either are unnecessary for survival and recovery of the species, or the need has not yet been determined but habitat resources may be necessary. Certain management actions are necessary. The status of such areas is subject to review and change according to demonstrated grizzly population and habitat needs. Major federal activities may affect the conservation of the grizzly bear primarily in that they may contribute toward (a) human-caused bear mortalities or (b) long-term displacement where the zone of influence could affect habitat use in Management Situation 1.*

The recommended management direction for Management Situation 2 that may apply to non-federal lands is as follows:

> *The grizzly bear is an important, but not the primary, use of the area. In some cases, habitat maintenance and improvement may be important management considerations. Minimization of grizzly-human conflict potential that could lead to human-caused mortalities is a high management priority. In this management situation, managers would accommodate demonstrated grizzly populations and/or grizzly habitat use in other land use activities if feasible, but not to the extent of exclusion of other uses. A feasible accommodation is one which is compatible with (does not make unobtainable) the major goals and/or objectives of other uses...*

The following is a summary of the management guidelines for timber harvest under Management Situation 2 that apply to western Washington:

- All proposed logging activities will be evaluated for their effects upon grizzlies and/or their habitat.

- Where grizzly populations and habitat use is likely, timber sales will specify grizzly management goals and objectives and measures to meet them.

- Logging management activities that will adversely affect grizzly bear populations and/or their habitat will, if feasible, be avoided.

- Grizzly bear habitat improvement will generally not be a consideration. If it is, habitat will be improved, if feasible.

Salmon and Steelhead 4(d) Rule. In June 2000 the NMFS adopted a final 4(d) Rule for 14 listed salmon and steelhead evolutionarily significant units (ESU). The 4(d) Rule is described in greater detail in subsection 4.4.3.1 of this EIS. The 4(d) Rule is intended to aid in the recovery of listed fish species, and it could have indirect benefits to the grizzly bear by increasing their supply of food (adult salmon).

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. The grizzly bear is being addressed in that consultation. The operation of Howard Hanson Dam is not likely to have any direct effect on the grizzly bear because it will not involve any areas known to be inhabited by the species.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. The Additional Water Storage Project would not affect the grizzly bear, but planned fisheries mitigation measures could result in a substantial increase in food supply (i.e., adult salmon) in the upper watershed in the future.

Magnuson-Stevens Fishery Conservation and Management Act. This federal act was created to restore and maintain harvestable numbers of fish, including salmon. Like the Salmon and Steelhead 4(d) Rule, it may have indirect benefits to grizzly bears by providing an important source of food.

Section 1135 Project. As described in subsection 4.4.3.1 of this EIS, the federal Section 1135 Project is intended to improve habitat for fish in the Green River by increasing low summer flows in dry years. It could indirectly benefit grizzly bears, again by increasing the supply of food (i.e., adult salmon) in the river.

Green/Duwamish Ecosystem Restoration Project. This comprehensive program of restoring the Green River ecosystem could benefit grizzly bears by increasing the food supply (i.e., adult salmon) in the upper Green River.

Northwest Forest Plan. This comprehensive plan for the management of federal forestlands in the range of the northern spotted owl has several direct and indirect benefits to grizzly bears. Restrictions on human activity in Late Successional Reserves and other special management areas reduces the potential for adverse encounters between humans and bears. Expansive riparian buffers will also improve and maintain habitat for fish, which can be an important part of the diet of the grizzly bear. Portions of the Upper Green River Watershed are on USFS lands managed under the Northwest Forest Plan.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the USFS recently completed a land exchange involving more than 43,000 acres in the Washington Cascades. Approximately 11,556 acres of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including approximately 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP. Lands being transferred into federal ownership will come under the jurisdiction of the Northwest Forest Plan. Most of the lands involved in the exchange lie just south of the North Cascades Grizzly Bear Recovery Zone.

State Plans, Policies, and Programs

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules designate certain forest practices as Class IV-Special if conducted within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species. Forest practice applications that are designated as Class IV-Special require the preparation of an Environmental Checklist in compliance with the State Environmental Policy Act. For the grizzly bear, the following forest practices are designated as Class IV-Special:

> *Grizzly bear - harvesting, road construction, aerial application of pesticides, or site preparation within 1 mile of a known active den site, documented by the department of fish and wildlife, between the dates of October 1 and May 30 or 0.25 mile from the den site at other times of the year.*

The above forest practices will not be classified as Class IV-Special based on critical wildlife habitat (state) or critical habitat (federal) if the forest practices are consistent with one of the following proposed measures for the protection of the species: 1) an HCP and permit or an Incidental Take Statement approved by the Secretary of the Interior or Commerce pursuant to 16 U.S.C. Section 1536 (b) or Section 1539 (a); 2) a rule adopted by the USFWS for the conservation of a particular threatened species pursuant to 16 U.S.C 1533(d); 3) a special wildlife management plan approved by the DNR in consultation with the WDFW; or 4) a cooperative habitat enhancement agreement developed pursuant to WAC 222-16-105.

Wild Salmon Policy. The State of Washington's Wild Salmon Policy was adopted in 1997 in response to the proposed and final listings of several salmon stocks. It is described in subsection 4.3.3.1 of this EIS. Like comparable federal programs, it is aimed at protecting, restoring, and enhancing fisheries in Washington. If successful, it could have positive benefits to grizzly bears by increasing the numbers of adult salmon available as food.

Watershed Management Act and Salmon Recovery Planning Act. These two laws were passed by the Washington State Legislature in 1998 to create a process for comprehensive resource planning. Like the Wild Salmon Policy and similar federal efforts, they are intended to lead to better protection of fish and other aquatic resources than has occurred in the past. Also like the Wild Salmon Policy, they could have benefits to grizzly bears if they increase the available supply of salmon.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. The Act covers only the management of non-federal lands in Washington. Since the current range of the grizzly bear in western Washington is restricted almost entirely to high-elevation federal lands, the Shoreline Management Act is not likely to affect grizzly bears.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the grizzly bear (Washington Department of Natural Resources 1997). The term of the permit is 70 years with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. Under its HCP, the DNR will protect grizzly bears by continuing to implement current DNR policies to protect riparian areas and upland wildlife habitat and state and federal requirements for protecting threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan, DNR 1992), and by complying with Forest Practices Rules to protect grizzly bear den sites

(WAC 222-16-080). The combination of the riparian, marbled murrelet, and northern spotted owl strategies and improved road management plans are expected to provide support to grizzly bears.

In addition, within 10 miles of a Class 1 grizzly bear observation (observations confirmed by a biologist and/or photograph, carcass, track, hair, dig, or food cache), the DNR will establish a grizzly bear habitat management area on DNR-managed lands within the North Cascades Grizzly Bear Recovery Area. The DNR will meet with the USFWS and develop and implement practicable site-specific plans to limit human disturbance in the grizzly bear habitat management area, which will remain in effect for 5 years after the last Class 1 grizzly bear observation in the grizzly bear habitat management area.

Management Recommendations Washington's Priority Habitats and Species. The Washington Department of Fish and Wildlife Priority Habitats and Species Program currently does not address the grizzly bear.

Local Plans, Policies, and Programs

The grizzly bear is rare in western Washington, and its range is restricted to high-elevation federal lands. There are currently no local plans or policies likely to influence the grizzly bear in any way, other than those directed at increasing salmon numbers, as discussed in subsection 4.4.3.1.

Programs on Private Lands

Plum Creek Multispecies Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species (including the grizzly bear) on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The lands covered by the Plum Creek HCP include portions of the Upper Green River Watershed. The Plum Creek HCP includes several measures similar to those in the Tacoma Water HCP for the protection of grizzly bears and their habitat in the upper watershed.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the

Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. Re-opening and use of the rail line could disrupt grizzly bear activity in the upper watershed, but the potential for such disruption is very low because the grizzly bear is currently absent from the area.

Direct and Indirect Effects of the Proposed Action on the Grizzly Bear

Implementing the HCP would avoid direct effects from road construction to important grizzly bear habitat, such as meadows, berry fields, and avalanche chutes. Riparian function measures would also protect important grizzly bear foraging habitat. Direct effects to individual grizzly bears would be minimized by restricting management activities and public access within one mile of a known active grizzly bear den during the denning season.

Indirect effects would be reduced by requiring operators and public users to remove trash generated at work sites and areas of recreational activities. Management activity would also be restricted during periods of potential seasonal high-use in the Action Area within the same geographic area of consistent grizzly bear use. Vegetation to provide visual screening would be left between preferred habitats and roads that would otherwise be within 1 mile and the direct line of sight of the preferred habitat. Firearms would not be permitted in vehicles in the Action Area outside hunting seasons regulated by the state.

Indirect benefits to grizzly bears would also result from the general closure of Tacoma-owned lands in the watershed to public access, elimination of commercial timber harvest in the Natural Zone, and reduced harvest levels in the Conservation and Commercial Zones. These measures would result in low levels of human activity in much of the Action Area, thereby improving conditions for grizzly bears.

Analysis of Cumulative Effects on the Grizzly Bear

Action Area. The HCP was developed to provide habitat protection and to avoid disturbance in areas most likely to be used by grizzly bears and, where it may be desirable, to manage for grizzly bears. Rather than review individual harvest plans, measures were developed to provide habitat and disturbance protection on a programmatic basis. The protection provided in the proposed Tacoma Water HCP is consistent with management guidelines in the Interagency Grizzly Bear Guidelines and protection provided under the Forest Practices Rules. It is also consistent with management taking place on intermingled lands administered by the USFS, DNR and Plum Creek.

Southwest Cascades Physiographic Province. Within the Southwest Cascades Physiographic Province, 90 percent of the area is classified as the Forestland land type. Other land types that may provide grizzly bear habitat are Wetlands (3%) and Barren (3%), however, the portion of the Action Area in these land types is very small, and forest management activities would have little effect on the total amount of these land types in the Southwest Cascades Physiographic Province. The Federal Reserve Areas management strategy encompasses 37.3 percent of the Forestland land type, while Federally Managed Areas (18.1%) and Completed HCPs (11.2%) management strategies make up another 29.3 percent of the area. Management strategies on this 66.6 percent of the Forestland land type currently consider grizzly bears and their habitat. Approximately 0.5 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy. Management activities on the Action Area would have little effect on the Southwest Cascades Physiographic Province capacity to support a grizzly bear population. However, the Action Area is generally located between federal land and more developed areas. The Action Area location can serve to provide habitat that could be used by grizzly bears, but also as a buffer between grizzly bears and human populations.

The Northwest Forest Plan, the DNR HCP, and the Plum Creek HCP include measures to manage for grizzly bear in the Southwest Cascades Physiographic Province by improving habitat conditions and by minimizing disturbance. The proposed Tacoma Water HCP would provide management consistent with these plans. Important habitats would be protected from modification, disturbance from management activities and public users would be minimized in the same geographic area as confirmed grizzly bear use,

and the potential for human-caused grizzly bear mortality would be minimized by garbage removal and restrictions on firearms in vehicles.

Western Washington. Within the western Washington analysis area, 78 percent of the area is classified as the Forestland land type. The Federal Reserve Areas management strategy encompasses approximately 35.0 percent of the Forestland land type, while Federally Managed Areas (8.8%) and Completed HCP (10.8%) management strategies make up another 19.6 percent of the area. Less than 0.1 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy. Management activities on the Action Area would be consistent with management on federal lands and lands under similar HCPs in the region, but would have little effect on the ability of the western Washington analysis area to support grizzly bears because of the small overall size of the Action Area.

Gray Wolf

Management Activities and Plans Affecting the Gray Wolf and Its Habitat

Federal Plans, Policies, and Programs

Feasibility Study on the Reintroduction of Gray Wolves to the Olympic Peninsula. The Feasibility Study on the Reintroduction of Gray Wolves to the Olympic Peninsula concluded that the reintroduction of wolves was biologically feasible (U.S. Fish and Wildlife Service 1998b). The analysis indicated that sufficient habitat and prey base exists to support a marginally viable wolf population over the long term. However, concerns by sportsmen over a possible decline in elk and deer hunting success should be considered before any introduction is initiated. Livestock and pet losses are not expected to be substantial, but would likely occur and would be a concern for the public.

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. The gray wolf is being addressed in that consultation. The operation of Howard Hanson Dam is not likely to have any direct effect on the gray wolf because it will not involve any areas known to be inhabited by the species.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. The Additional Water Storage Project would reduce the total area of potential hunting habitat for gray wolves in the upper watershed by approximately 300 acres.

Northwest Forest Plan. This comprehensive plan for the management of federal forestlands in the range of the northern spotted owl has several direct and indirect benefits to gray wolves. Restrictions on human activity in Late Successional Reserves and other special management areas reduces the potential for adverse encounters between humans and wolves and increases the suitability of these areas for denning and hunting. Portions of the Upper Green River Watershed are on USFS lands managed under the Northwest Forest Plan.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the USFS recently completed a land exchange involving more than 43,000 acres in the Washington Cascades. Approximately 11,556 of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP. Lands being transferred into federal ownership will come under the jurisdiction of the Northwest Forest Plan. Management for the gray wolf will not change appreciably as a result of the exchange, as habitat for the species is protected under both the Northwest Forest Plan and the Plum Creek HCP.

State Plans, Policies, and Programs

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules designate certain forest practices as Class IV-Special if conducted within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species. Forest practice applications that are designated as Class IV-Special require completion of an Environmental Checklist in compliance with the State Environmental Policy Act. For the gray wolf, the following forest practices are designated as Class IV-Special:

Gray wolf - harvesting, road construction, or site preparation within 1 mile of a known active den site, documented by the department of fish and wildlife, between the dates of March 15 and July 30 or 0.25 mile from the den site at other times of the year.

The above forest practices will not be classified as Class IV-Special based on critical wildlife habitat (state) or critical habitat (federal) if the forest practices are consistent with one of the following proposed measures for the protection of the species: 1) an HCP and permit or an Incidental Take Statement approved by the Secretary of the Interior or Commerce pursuant to 16 U.S.C. Section 1536 (b) or Section 1539 (a); 2) a rule adopted by the USFWS for the conservation of a particular threatened species pursuant to 16 U.S.C 1533(d); 3) a special wildlife management plan approved by the DNR in consultation with the WDFW; or 4) a cooperative habitat enhancement agreement developed pursuant to WAC 222-16-105.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. The Act covers only the management of non-federal lands in Washington. Since the current range of the gray wolf in western Washington is restricted almost entirely to federal lands, the Shoreline Management Act is not likely to affect gray wolves.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the gray wolf (Washington Department of Natural Resources 1997). The term of the permit is 70 years with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. Under its HCP, the DNR will protect gray wolves by continuing to implement current DNR policies to protect riparian areas and upland wildlife habitat and state and federal

requirements for protecting threatened and endangered species (Policy Nos. 20, 22, and 23 of the Forest Resource Plan, DNR 1992), and by complying with state Forest Practices Rules to protect gray wolf den sites (WAC 222-16-080). The combination of the riparian, marbled murrelet, and northern spotted owl strategies and improved road management plans are expected to provide support to gray wolves.

In addition, within 8 miles of a Class 1 gray wolf observation (observations confirmed by a biologist and/or photograph, carcass, track, hair, or food cache), the DNR will establish a gray wolf habitat management area on DNR-managed lands. The DNR will meet with the USFWS and develop and implement practicable site-specific plans to limit human disturbance in the gray wolf habitat management area, which will remain in effect for 5 years after the last Class 1 gray wolf observation in the gray wolf habitat management area. The DNR will also attempt to provide more secure areas for gray wolves and their prey by continuing to implement road closures to increase big game security and to reduce hunting pressure, and to the extent practicable will schedule management activities to occur at times of the year when wolves are least likely to be present.

Management Recommendations Washington's Priority Habitats and Species. The Washington Department of Fish and Wildlife Priority Habitats and Species Program currently does not address the gray wolf.

Local Plans, Policies, and Programs

The gray wolf is rare in western Washington, and its range is largely restricted to federal lands. There are currently no local plans or policies likely to influence the gray wolf.

Programs on Private Lands

Plum Creek Multispecies Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species (including the gray wolf) on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The lands covered by the Plum Creek HCP include portions of the Upper Green River Watershed. The Plum Creek

HCP includes several measures similar to those in the Tacoma Water HCP for the protection of gray wolves and their habitat in the upper watershed.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. Re-opening and use of the line could disrupt wolf activity in the area, but the potential for such disruption is very low because the gray wolf has been absent from the watershed for several decades.

Direct and Indirect Effects of the Proposed Action on the Gray Wolf

Implementing the proposed Tacoma Water HCP would minimize direct effects to denning gray wolves and their habitat by restricting selected activities within 1 mile of gray wolf den sites from 15 March through 15 July. Prohibiting firearms in vehicles outside regular hunting seasons would also reduce the potential for direct effects to individual wolves. Implementing the proposed Tacoma Water HCP would also require Tacoma Water to consult with the USFWS prior to conducting selected management activities within 0.25 mile of a known den site outside the denning season. The intent of this consultation would be to minimize the effects management activities may have on future use of the den site.

Analysis of Cumulative Effects on the Gray Wolf

Action Area. Implementing the proposed Tacoma Water HCP would increase protection of gray wolves and their habitat. Protection for denning wolves and den sites would be similar to measures under the current Forest Practices Rules. In addition, public access would be seasonally restricted on roads leading into areas with known active wolf dens.

Southwest Cascades Physiographic Province. Within the Southwest Cascades Physiographic Province, 90 percent of the area is classified as the Forestland land type. Other land types that may provide gray wolf habitat are Wetlands (3%) and Barren (3%); however, the proportion of the Action Area in these land types is very small, and forest management activities would have little effect on the total amount of these land types in the Southwest Cascades Physiographic Province. The Federal Reserve Areas management strategy encompasses 37.3 percent of the Forestland land type, while Federally Managed Areas (18.1%) and Completed HCP (11.2%) management strategies make up another 29.3 percent of the area combined. Management strategies on this 66.6 percent of the Forestland land type currently consider gray wolves and their habitat. Approximately 0.5 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy. Management activities in the Action Area would have little effect on the province's capacity to support a gray wolf population. However, the Action Area is generally located between federal land and more developed areas. The Action Area's location can serve to provide areas that could be used by gray wolves, but also as a buffer between gray wolves and human populations.

The Northwest Forest Plan, the DNR HCP, and the Plum Creek HCP include measures to manage for gray wolves in the Southwest Cascades Physiographic Province by improving habitat conditions and by minimizing disturbance. The proposed Tacoma Water HCP would provide management consistent with these plans. Disturbance from management activities and public users would be minimized around gray wolf denning sites, disturbance to gray wolf prey would be minimized, and the potential for human-caused gray wolf mortality would be minimized by restricting firearms in vehicles.

Western Washington. Within the western Washington analysis area, 78 percent of the area is classified as the Forestland land type. The Federal Reserve Areas management strategy encompasses approximately 35.0 percent of the Forestland land type, while Federally Managed Areas (8.8%) and Completed HCP (10.8%) management strategies make up another 19.6 percent of the area. Less than 0.1 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy. Management activities in the Action Area would have little effect on the ability of the western Washington analysis area to support gray wolves.

Canada Lynx

Management Activities and Plans Affecting the Canada Lynx and Its Habitat

Federal Plans, Policies, and Programs

The Canada lynx was federally listed as a Threatened species on 24 March 2000 (U.S. Federal Register, 24 March 2000). The USFWS has not yet designated critical habitat for the species, or prepared a recovery plan.

Section 7 Consultation for the Continued Operation and Maintenance of Howard Hanson Dam. The USACE is currently conducting formal consultation with the Services on the continued operation and maintenance of Howard Hanson Dam. The Canada lynx is being addressed in that consultation. The operation of Howard Hanson Dam is not likely to have any direct effect on the lynx because it lies below the elevations considered within the range of the species.

Section 7 Consultation for the Additional Water Storage Project. The USACE is also conducting formal consultation with the Services on the Additional Water Storage Project being sponsored by Tacoma Water. The Additional Water Supply Project would not affect the Canada lynx because the project area lies below the elevations considered within the range of the species.

Northwest Forest Plan. This comprehensive plan for the management of federal forestlands in the range of the northern spotted owl has potential direct and indirect effects to the Canada lynx. Restrictions on human activity in Late Successional Reserves and other special management areas reduces the potential for human disturbance of den sites. Late-seral forest created and maintained under the federal plan could become suitable denning habitat for the lynx, but reductions in timber harvesting on federal lands under the plan could reduce habitat for the primary prey of the lynx (snowshoe hare). Portions of the Upper Green River Watershed are on USFS lands managed under the Northwest Forest Plan.

Plum Creek – U. S. Forest Service Land Exchange. Plum Creek Timber Company and the USFS recently completed a land exchange involving more than 43,000 acres in the Washington Cascades.

Approximately 11,556 acres of former USFS lands were transferred to Plum Creek ownership, and 31,713 acres of Plum Creek lands were added to the National Forest system. The lands being transferred into Plum Creek ownership in the I-90 corridor (including 2,000 acres in the Upper Green River Watershed) will be managed for timber production in compliance with Plum Creek's HCP. Lands being transferred into federal ownership will come under the jurisdiction of the Northwest Forest Plan. Land management will change as a result of the land exchange, but it is difficult to determine whether the change will have a positive effect, negative effect, or no effect on the Canada lynx. The overall amount of timber harvest (and associated human activity) will be less on lands in federal ownership, but the lack of timber harvest could also result in a reduction of early-successional habitat for primary prey of the lynx (snowshoe hare).

State Plans, Policies, and Programs

Washington Forest Practices Rules (WAC 222). Washington Forest Practices Rules designate certain forest practices as Class IV-Special if conducted within critical wildlife habitat (state) and critical habitat (federal) of threatened and endangered species. Forest practice applications that are designated as Class IV-Special require completion of an Environmental Checklist in compliance with the State Environmental Policy Act. Critical habitat for the Canada lynx has not yet been designated under the federal ESA or Washington Forest Practices Rules.

Shoreline Management Act. The Washington State Shoreline Management Act was adopted in 1972 in response to the federal Coastal Zone Management Act. It regulates activities within 200 feet of Waters of the State (marine shorelines, lakes of 20 acres or more, and streams with a mean annual flow of 20 cfs or greater) and their associated wetlands. In June 2000 the Washington Department of Ecology, which oversees administration of the act by counties and cities, released proposed new shoreline master program guidelines for public review and comment. The new guidelines, if adopted, would take effect no earlier than 2002. The changes being considered are largely in response to recent listings of salmon and steelhead, and are intended to increase fish and aquatic resource protection under the Shoreline Management Act. The Act covers only the management of non-federal lands in Washington. Since the current range of the Canada lynx in western Washington is restricted almost entirely to federal lands, the Shoreline Management Act is not likely to affect the species.

Washington Department of Natural Resources Habitat Conservation Plan. The DNR developed an HCP and was issued an ITP that covers the a number of species within the range of the northern spotted owl (Washington Department of Natural Resources 1997). The term of the permit is 70 years with an option for the DNR to renew the permit up to three times for a period of 10 years per renewal. The HCP includes no specific management measures for the Canada lynx, but the combination of the riparian, marbled murrelet, and northern spotted owl strategies and improved road management plans are expected to improve habitat conditions for the lynx in the limited number of areas where it occurs.

Management Recommendations Washington's Priority Habitats and Species. The Washington Department of Fish and Wildlife Priority Habitats and Species Program recommends that habitat for the Canada lynx and its primary prey (snowshoe hare) can be maintained by managing for a mosaic of early- and late-seral stage forest with interconnecting travel corridors. The Program notes that the lynx is restricted almost entirely to high-elevation forest of lodgepole pine, subalpine fir, and Englemann spruce east of the Cascade crest in Washington.

Local Plans, Policies, and Programs

The Canada lynx is rare in western Washington, and its range is largely restricted to federal lands. There are currently no local plans or policies likely to influence the lynx in any way.

Programs on Private Lands

Plum Creek Multispecies Habitat Conservation Plan. Plum Creek Timber Company has an approved HCP and ITP for multiple species on approximately 170,000 acres of company land intermingled with USFS land along the Interstate 90 corridor in western Washington. The lands covered by the Plum Creek HCP include portions of the Upper Green River Watershed. The Plum Creek HCP does not cover the Canada lynx.

Re-opening of Burlington Northern Santa Fe Rail Line. In 1887, a railroad line was constructed through the Green River Watershed and across Stampede Pass. The railroad runs roughly parallel to the

Green River throughout much of the upper watershed, and constrains the channel with riprap banks in a number of areas. The line was abandoned and became inactive in 1983. In 1996, in response to increased local container traffic at the ports of Seattle and Tacoma, the Burlington Northern Santa Fe Railroad reactivated and upgraded the line. The railbed was expanded and additional rock was placed in the Green River. At the same time, a number of habitat enhancement projects were implemented, such as placement of LWD into the affected reaches. Re-opening and use of the line are unlikely to have any effect on the Canada lynx. They will result in little or no alteration of lynx habitat and little or no disruption of lynx activity.

Direct and Indirect Effects of the Proposed Action on the Canada Lynx

Implementing the proposed Tacoma Water HCP would minimize direct effects to denning lynx and their habitat by restricting selected activities within 0.25 mile of lynx den sites from 1 May through 31 July. Prohibiting firearms in vehicles outside regular hunting seasons would also reduce the potential for direct effects to individual lynx. Indirectly, the HCP could benefit the lynx by providing a desirable interspersion of mature forest and early successional habitat, particularly in the Commercial Zone.

Analysis of Cumulative Effects on the Canada Lynx

Action Area. Implementing the proposed Tacoma Water HCP would increase protection of Canada lynx and their habitat. Current Forest Practices Rules place no restrictions on activities near lynx dens, but such restrictions will presumably be added in the future.

Southwest Cascades Physiographic Province. Within the Southwest Cascades Physiographic Province, 90 percent of the area is classified as the Forestland land type. Other land types that may provide lynx habitat are Wetlands (3%) and Barren (3%); however, the proportion of the Action Area in these land types is very small, and forest management activities would have little effect on the total amount of these land types in the Southwest Cascades Physiographic Province. The Federal Reserve Areas management strategy encompasses 37.3 percent of the Forestland land type, while Federally Managed Areas (18.1%) and Completed HCP (11.2%) management strategies make up another 29.3 percent of the area combined. Management strategies on this 66.6 percent of the Forestland land type currently give only minimal consideration to the Canada lynx because the federal listing is very recent. Approximately 0.5 percent of

the Forestland land type is classified as the Tacoma Water HCP management strategy. Lynx protection in the Action Area would exceed that on surrounding non-federal lands, but it would have little effect on the province's capacity to support a lynx population.

The Northwest Forest Plan, the DNR HCP and the Plum Creek HCP include measures that may indirectly improve habitat for the Canada lynx. The proposed Tacoma Water HCP would provide management consistent with these plans. Disturbance from management activities and public users would be minimized around lynx denning sites, and the potential for human-caused lynx mortality would be minimized by restricting firearms in vehicles.

Western Washington. Within the western Washington analysis area, 78 percent of the area is classified as the Forestland land type. The Federal Reserve Areas management strategy encompasses approximately 35.0 percent of the Forestland land type, while Federally Managed Areas (8.8%) and Completed HCP (10.8%) management strategies make up another 19.6 percent of the area. Less than 0.1 percent of the Forestland land type is classified as the Tacoma Water HCP management strategy. Management activities in the Action Area would have little effect on the ability of the western Washington analysis area to support the Canada lynx.

Table 4-1. Covered activities anticipated to result in effects to the human environment under an ITP for either of the two action water withdrawal or upper watershed management alternatives (Alternatives B and C).

Covered Activity in ITP*	Ownership & Land Use		Geology & Soils		Air Quality		Surface Water Quality & Quantity		Vegetation		Fish & Aquatic Habitat		Wildlife		Recreation		Visual Resources		Social & Economic Conditions		Cultural Resources	
	Alternative		Alternative		Alternative		Alternative		Alternative		Alternative		Alternative		Alternative		Alternative		Alternative		Alternative	
	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C	B	C
Timber harvesting, inventory, & monitoring			X[1]	X[1]			X[1]	X1	X[1]	X[1]	X[1]	X[1]	X[1]	X[1]				/[1]	X[1]	X[1]		/[1]
Silvicultural treatments								X[1]		X[1]		X[1]		X[1]								
Site preparation				/[1]		X[1]		X[1]		X[1]		X[1]		X[1]				/[1]				/[1]
Tree planting								X[1]		X[1]		X[1]		X[1]								
Road construction, maintenance, & use			X[1]	X[1]	X[1]	X[1]	X[1]	X[1]	/[1]	X[1]	X[1]	X[1]	/[1]	X[1]								/[1]
Quarrying stone & gravel													/[1]	/[1]								
Fish & wildlife habitat enhancement			X[2]	X[2]			X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	X[2]								
Tribal access																						
Water withdrawal		X[2]		X[2]			X[2]	X[2]	/[2]	X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	/[2]	X[2]	X[2]	X[2]		
Monitoring, surveying, & maintenance											X[1,2]	X[1,2]	/[1,2]	/[1,2]								
Fish passage							/[2]	/[2]			X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	/[2]	/[2]	X[2]	X[2]	/[2]	/[2]
Headworks Construction		X[2]	X[2]	X[2]			X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	X[2]	X[2]			/[2]	X[2]	X[2]	X[2]	/[2]	/[2]

/ = activity is expected to occur in a different quantity, or a different manner than the No Action alternative.
X = there will be a discernable difference in the way this covered activity affects the human environment when compared to the No Action alternative (i.e., impact).
[1] applies to upper watershed management alternatives
[2] applies to water withdrawal alternatives

Table 4-2. Comparison of average mainstem and side channel habitat area values for chinook salmon spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

Alternative	Change in Fry Outmigration Survival Index from Alt. A (%)		Mainstem Spawning Habitat (acres)		Side Channel Area During Spawning Period (acres)	Mainstem Spawnable Width (ft)	Mainstem Dewatered Spawnable Width During Incubation (ft)	Continuously Wetted Side Channel Area During Incubation (acres)	Mainstem Juvenile Rearing Habitat (acres)		Side Channel Area During Juvenile Rearing Period (acres)
	Lower River	Middle River	Lower River	Middle River					Lower River	Middle River	
No Action (A)	-	-	46.8	80.5	8.5	134.5	4.1	6.3	28.2	27.6	6.8
Proposed Action (B)	0.01	0.06	52.2	88.6	8.4	134.5	4.1	6.3	30.9	29.5	6.4
New Diversion (C)	0.01	4.50	52.2	104.7	10.3	136.1	3.9	7.6	30.9	27.2	7.8
Difference, B-A	0.01	0.06	11.5%	10.1%	-1.2%	0.0%	0.0%	0.0%	9.6%	6.9%	-5.9%
Difference, C-A	0.01	4.50	11.5%	30.1%	21.2%	1.2%	-4.9%	20.6%	9.6%	-1.4%	14.7%

Table 4-3. Comparison of average mainstem and side channel habitat area values for coho salmon spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

Alternative	Change in Fry Outmigration Survival Index from Alt. A (%)		Mainstem Spawning Habitat (acres)		Side Channel Area During Spawning Period (acres)	Mainstem Spawnable Width (ft)	Mainstem Dewatered Spawnable Width During Incubation (ft)	Continuously Wetted Side Channel Area During Incubation (acres)	Mainstem Juvenile Rearing Habitat (acres)		Side Channel Area During Juvenile Rearing Period (acres)
	Lower River	Middle River	Lower River	Middle River					Lower River	Middle River	
No Action (A)	-	-	49.4	68.1	12.2	137.2	5.4	7.4	40.7	33.1	11.9
Proposed Action (B)	0.94	2.22	52.2	72.9	11.8	137.0	5.6	7.1	42.6	34.4	11.5
New Diversion (C)	0.94	6.62	52.2	64.9	13.6	138.4	5.4	8.4	42.6	30.6	13.0
Difference, B-A	0.94	2.22	5.7%	7.0%	-3.3%	-0.1%	3.7%	-4.1%	4.7%	3.9%	-3.4%
Difference, C-A	0.94	6.62	5.7%	-4.7%	11.5%	0.9%	0.0%	13.5%	4.7%	-7.6%	9.2%

Table 4-4. Comparison of average mainstem and side channel habitat area values for chum salmon spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

Alternative	Change in Fry Outmigration Survival Index from Alt. A (%)		Mainstem Spawning Habitat (acres)		Side Channel Area During Spawning Period (acres)	Mainstem Spawnable Width (ft)	Mainstem Dewatered Spawnable Width During Incubation (ft)	Continuously Wetted Side Channel Area During Incubation (acres)	Mainstem Juvenile Rearing Habitat (acres)		Side Channel Area During Juvenile Rearing Period (acres)
	Lower River	Middle River	Lower River	Middle River					Lower River	Middle River	
No Action (A)	-	-	39.4	63.9	16.0	140.0	5.6	7.4	28.2	27.6	6.8
Proposed Action (B)	-2.65	-3.71	41.8	69.3	15.3	139.5	5.8	7.1	30.9	29.5	6.4
New Diversion (C)	-2.65	0.12	41.8	59.0	16.8	140.7	5.6	8.4	30.9	27.2	7.8
Difference, B-A	-	-	6.1%	8.5%	-4.4%	-0.4%	3.6%	-4.1%	9.6%	6.9%	-5.9%
Difference, C-A	-	-	6.1%	-7.7%	5.0%	0.5%	0.0%	13.5%	9.6%	-1.4%	14.7%

Table 4-5. Comparison of average mainstem and side channel habitat area values for steelhead trout spawning, incubation, and rearing in the lower and middle Green River, Washington; 1964-1995.

Alternative	Change in Fry Outmigration Survival Index from Alt. A (%)		Mainstem Spawning Habitat (acres)		Side Channel Area During Spawning Period (acres)	Mainstem Spawnable Width (ft)	Mainstem Dewatered Spawnable Width During Incubation (ft)	Continuously Wetted Side Channel Area During Incubation (acres)	Mainstem Juvenile Rearing Habitat (acres)		Side Channel Area During Juvenile Rearing Period (acres)
	Lower River	Middle River	Lower River	Middle River					Lower River	Middle River	
No Action (A)	-	-	76.5	103.9	13.7	144.4	1.8	4.2	65.4	67.8	11.9
Proposed Action (B)	0.94	1.31	76.2	104.4	13.0	144.4	1.9	4.5	67.8	71.5	11.5
New Diversion (C)	0.94	5.71	76.2	100.2	14.1	145.1	1.4	6.6	67.8	67.3	13.0
Difference, B-A	0.94	1.31	-0.4%	0.5%	-5.1%	0.0%	5.6%	7.1%	3.7%	5.5%	-3.4%
Difference, C-A	0.94	5.71	-0.4%	-3.6%	2.9%	0.5%	-22.2%	57.1%	3.7%	-0.7%	9.2%

Table 4-6. Percentage of days under the No Action Alternative with average daily flows within the preferred range for rafting and kayaking (Water Withdrawal Alternative A) (1964-1995).

Month	Rafting: 1,300 – 4,000 cfs (percentage of days)	Kayaking: 1,000 – 3,000 cfs (percentage of days)
January (31 days)	26	31
February (28 days)	26	37
March (31 days)	21	40
April (30 days)	31	46
May (31 days)	29	38
June (30 days)	13	22
July (31 days)	3	4
August (31 days)	0	0
September (30 days)	4	4
October (31 days)	4	6
November (30 days)	25	34
December (31 days)	29	36

Table 4-7. Percentage of days under the Proposed Action Alternative with average flows within the preferred range for rafting and kayaking (Water Withdrawal Alternative B).

Month	Rafting: 1,300–4,000 cfs (percentage of days)			Kayaking: 1,000–3,000 cfs (percentage of days)		
	Alternative A	Alternative B	Difference	Alternative A	Alternative B	Difference
January (31 days)	26	24	-2	31	28	-3
February (28 days)	26	23	-3	45	31	-6
March (31 days)	21	9	-12	40	30	-10
April (30 days)	31	29	-2	46	42	-4
May (31 days)	29	37	+8	38	51	+13
June (30 days)	13	10	-3	22	17	-5
July (31 days)	3	2	-1	4	3	-1
August (31 days)	0	0	0	0	0	0
September (30 days)	4	3	-1	4	4	0
October (31 days)	4	4	0	6	5	-1
November (30 days)	25	22	-3	34	30	-4
December (31 days)	29	26	-3	36	32	-4

Table 4-8. Percentage of days under the New Diversion Alternative with average flows within the preferred range for rafting and kayaking (Water Withdrawal Alternative C).

Month	Rafting: 1,300–4,000 cfs (percentage of days)			Kayaking: 1,000–3,000 cfs (percentage of days)		
	Alternative A	Alternative C	Difference	Alternative A	Alternative C	Difference
January (31 days)	26	29	+3	31	35	+4
February (28 days)	26	28	+2	37	39	+2
March (31 days)	21	11	-10	40	20	-20
April (30 days)	31	33	+2	46	50	+4
May (31 days)	29	43	+14	38	59	+21
June (30 days)	13	15	+2	22	24	+2
July (31 days)	3	3	0	4	5	+1
August (31 days)	0	0	0	0	1	+1
September (30 days)	4	4	0	4	4	0
October (31 days)	4	6	+2	6	9	+3
November (30 days)	25	29	+4	34	38	+4
December (31 days)	29	32	+3	36	41	+5

Table 4-9. Management plans/programs affecting salmonids and salmonid habitat in the Tacoma HCP cumulative effects analysis area.

Federal	State	Local/Private
Plan/Program	Plan/Program	Plan/Program
ESA # 4(d) rules # HHD Section 7 Consultation *Continued Howard Hanson Dam operation and maintenance* *Additional Water Storage Project* Magnuson-Stevens Act Sustainable Fisheries Act USACE Activities # Green/Duwamish Ecosystem Restoration Project # Additional Water Storage Project # Section 1135 Project Northwest Forest Plan	Wild Salmonid Policy WDFW Priority Habitats and Species Program Salmon Recovery Planning Act Water Rights # Instream Flows # Surface water # Groundwater Watershed Management Act # WRIA 9 Conservation Plan Washington DNR HCP Forest Practices Rules Hydraulic Project Approval Shorelines Management Act Hatchery/Harvest Other State Sponsored Programs # Conservation Reserve Enhancement Program # Jobs for the Environment Program	Other Tacoma Water Actions # Tacoma Second Supply Project # 1995 MIT/TPU Agreement King County Plans and Policies # Levee maintenance and flood control # Critical Area Ordinances # Stormwater Management # Early Action Programs # Water Treatment Plant HCP Local Subbasin Plans Plum Creek HCP and Land Exchange Burlington Northern Santa Fe Railroad Line Reopening

Table *4-B.* Instream flow requirements at the USGS gauge at Auburn (USGS # 12113000) and Palmer (USGS # 12106700) under Ecology's Instream Resource Protection Program. These requirements may be modified during critical drought years (<1 in 10 low-flow frequency) as specified in WAC 173-509.

Season	Auburn	Palmer
1 July to 14 July	550 cfs	150 cfs
15 July to 15 September	300 cfs	150 cfs
16 September to 30 September	300 cfs	150 cfs
1 October to 14 October	300 cfs	190 cfs
15 October to 31 October	350 cfs	240 cfs
1 November to 30 November	550 cfs	300 cfs
1 December to 30 June	650 cfs	300 cfs

Table *4-C*. Green River basin watercourses that will be crossed during construction of Pipeline No. 5.

Watercourse	Pipeline Marker (mi.)	Average flow during August/September (cfs)	Construction Method	Fish Species Affected
Green River (RM 58)	1.8	199	Bridge	CK,CO,CH,SH,CTT.RES
Ginder Creek	8.0	2 (est.)	Trench under existing culvert	RES
Rock Creek	9.0	2 (est.)	Divert creek through 100-foot flume	CO, RES
Covington Creek	10.8	4 (est.)	Divert creek through 100-foot flume	CO, SH, CTT, RES, NC
N.F. Covington Creek	13.0	<1 (est.)	Dry trench	CO, RES
Unnamed	14.4	dry	Bore	RES
Big Soos Creek	14.9	34	Microtunnel	CK,CO,CH,SH,CTT,RES
Soosette Creek	16.0	6 (est.)	Divert creek through 100-foot flume	RES
Unnamed	17.2	<1 (est.)	Open trench, dry	RES
Green River (RM 29)	18.4	345	Microtunnel	CK,CO,CH,SH,CTT,RES
Mill Creek	19.9	2	Divert creek through 100-foot flume	CO,CTT,RES
Mill Creek	22.1	<1 (est.)	Divert creek through 100-foot flume	RES

CK = chinook
CO = coho
CH = chum
SH = steelhead
CTT = cutthroat trout
RES = resident
< = less than

Table *4-D*. Potential unavoidable adverse effects of actions implemented within the foreseeable future under the auspices of the various proposed actions/management programs.

Impact	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Flow Regime			
Reduction in spring flows (mid-February through March)	RM 0 to RM 64.5	TW-HCP; AWSP; 1135	Action Area
Groundwater			
Continued reductions in groundwater contributions to tributary streams from development of wells for individual residences	unknown	WAC	WRIA 9
Development of additional wells for municipal water supply	Lower Puyallup or Chambers/Clover basin	SSP	WRIA 9, Southwest Cascades Physiographic Province
Sediment Delivery			
Temporary increases in sediment delivery during construction of fish passage facilities RM 64.5	localized	TW-HCP; AWSP; USACE Section 7	Action Area
Temporary increases in sediment delivery during modification of headworks and construction of fish passage facilities RM 61	localized	TW-HCP; SSP	Action Area
Temporary increases in sediment delivery at 18 stream crossings during construction of pipeline	localized	SSP	WRIA 9, Southwest Cascades Physiographic Province
Riparian			
Continued prevention of riparian recovery due to presence of streamside roads, railroads	Approximately 5 miles	TW-HCP; PC-HCP; DNR-HCP; WFPA; BNSF	Action Area, WRIA 9
Mainstem Habitat			
Seasonal inundation of mainstem between elevation 1,141 and 1,147	1,105 feet	1135	Action Area
Seasonal inundation of mainstem between elevation 1,147 and 1,167	4,232 feet	AWSP	Action Area

NOTE: Legend on page 4-231

Table *4-D.* Continued.

Impact	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Tributary Habitat			
Seasonal inundation of tributary habitat between elevation 1,141 and 1,147	1,679 feet	1135	Action Area
Seasonal inundation of tributary habitat between elevation 1,147 and 1,167	5,882 feet	AWSP	Action Area
Continued suppression of riparian recovery due to presence of streamside roads	unknown	TW-HCP; PC-HCP; DNR-HCP; WFPA	Action Area, WRIA 9
Off-Channel Habitat			
Dewatering of up to 8.4 acres of side channel habitat in the spring	RM 32 to RM 45	TW-HCP; AWSP	Action Area
Water Quality			
Temporary increases turbidity during construction of fish passage facilities RM 64.5	localized	TW-HCP; AWSP; USACE Section 7	Action Area
Temporary increases in turbidity during modification of headworks and construction of fish passage facilities RM 61	localized	TW-HCP; SSP	Action Area
Temporary increases turbidity at 18 stream crossings during construction of pipeline	localized	SSP	WRIA 9
Fish Populations			
Potential delay and increased mortality of juvenile outmigrants due to storage during the spring	RM 0 to RM 64.5	AWSP; 1135	Action Area
Potential dewatering of early spawning steelhead redds	RM 0 to RM 64.5	AWSP; 1135	Action Area
Competition and incidental harvest with hatchery fish	RM 31 to RM 0	Co-managers	Action Area, WRIA 9

NOTE: Legend on page 4-231

Table *4-D*. Legend

TW-HCP	Tacoma Water Habitat Conservation Plan
AWSP	Additional Water Storage Project
USACE Section 7	USACE's Section 7 consultation with NMFS and USFWS
WAC	Washington Administrative Code
DNR-HCP	Washington Department of Natural Resources Habitat Conservation Plan
WFPA	Washington Forest Practices Act
PC-HCP	Plum Creek Timber Companies Habitat Conservation Plan
1135	Section 1135 Project
SSP	Second Supply Project

Table *4-E*. Conservation measures to be implemented within the foreseeable future under the auspices of the various proposed actions/ management programs.

Project Name	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Flow Regime			
Minimum instream flows under First Diversion Water Right claim	RM 0 to RM 61	TW-HCP; MIT/TPU	Action Area
Seasonal restrictions on Second Diversion Water Right	RM 0 to RM 61	TW-HCP	Action Area
Snowpack and precipitation monitoring	RM 0 to RM 64.5	TW-HCP; AWSP	Action Area
Adaptive management of volume and frequency of storage and pattern of refill and release	RM 0-RM 64.5	TW-HCP; AWSP; USACE Section 7; 1135	Action Area
Closure to new surface water rights		WAC	Action Area, WRIA 9
Groundwater			
Closure to new groundwater rights		WAC	WRIA 9
Sediment Delivery			
Harvest on unstable slopes	upper watershed	TW-HCP; AWSP; DNR-HCP; PC-HCP; WFPR	Action Area, WRIA 9, Southwest Cascades Physiographic Province
Road construction and maintenance measures	upper watershed	TW-HCP; AWSP; DNR-HCP; PC-HCP; WFPR	Action Area, WRIA 9, Southwest Cascades Physiographic Province
Burns Creek	unknown	GI	WRIA 9
Howard Hanson Dam Sediment management plan	RM 0-RM 64.5	Section 7 consultation	Action Area, WRIA 9
Flaming Geyser Landslide	RM 0 to RM 43	GI	Action Area
Gravel Replacement	RM 32 to RM 45; 4,000 cubic yards	GI	Action Area
Upper Green River gravel placement[1]	RM 57 to RM 61; 8,000 cubic yards	GI,TW-HCP, AWSP, USACE Section 7	Action Area

NOTE: Legend on page 4-240

Table *4-E*. Continued.

Project Name	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Riparian			
Riparian management measures	upper watershed	TW-HCP; AWSP; DNR-HCP; PC-HCP; WFPR	Action Area, WRIA 9
Riparian reserves	55 miles^2	NWFP	WRIA 9
Auburn Narrows floodplain wetland restoration	31 acres	SSP	Action Area
Sunday Creek riparian plantings	unknown	GI	Action Area
Volunteer revegetation	unknown	GI	WRIA 9
Reservoir Habitat			
Revegetation of the reservoir inundation zone	RM 64.5 to RM 69 (approx. 69 acres)	TW-HCP; AWSP; 1135	Action Area
Standing timber retention	RM 64.5 to RM 69 (approx. 69 acres)	TW-HCP; AWSP; 1135	Action Area
Installation of 15 floating islands in reservoir	RM 64.5 to RM 69	1135	WRIA 9
Excavation of subimpoundments	RM 64.5 to RM 69	TW-HCP; AWSP; 1135	Action Area
Reservoir tributary restoration	2,500 to 3,000 feet	TW-HCP; AWSP; 1135	Action Area
Mainstem Habitat			
Tacoma Headworks large woody debris/rootwad placement	RM 61 to RM 64	TW-HCP; SSP	Action Area
Standing timber retention	RM 69.5 to RM 71	TW-HCP; AWSP	Action Area
Bar Apex jams in mainstem Green River	RM 58 to RM 60	TW-HCP; AWSP	Action Area
AWSP mainstem channel maintenance	RM 69.5 to RM 71	TW-HCP; AWSP	Action Area
Habitat restoration	RM 71 to RM 73	TW-HCP; AWSP	Action Area
Tacoma Wildlands setasides in Conservation and Natural Forest Zones	RM 73 to RM 82	TW-HCP; AWSP	Action Area
Relocate and fix mainstem into historical channel	RM 83	TW-HCP; AWSP	Action Area

NOTE: Legend on page 4-240

Table *4-E*. Continued.

Project Name	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Mainstem maintenance	unknown	GI	Action Area
Mainstem LWD	RM 32 to RM 45	GI	Action Area
Tributary Habitat			
North Fork channel maintenance within new inundation	2,148 feet (RM 0.9 to RM 1.4)	TW-HCP; AWSP	Action Area
North Fork stream restoration	3,696 feet (RM 1.4 to RM 2.1)	TW-HCP; AWSP	Action Area
North Fork stream improvements	5,280 feet (RM 2.1 to RM 3.1)	TW-HCP; AWSP	Action Area
Gale Creek stream improvements within new inundation	2,083 feet (RM 0.3 to RM 0.8)	TW-HCP; AWSP	Action Area
Gale Creek stream restoration	1,584 feet (RM 0.8 to RM 1.1)	TW-HCP; AWSP	Action Area
Gale Creek stream improvements	1,056 feet (RM 1.1 to RM 1.3)	TW-HCP; AWSP	Action Area
Tributary improvements within new inundation	3,003 feet total	TW-HCP; AWSP	Action Area
Gilliam Creek	2,000 feet	GI	WRIA 9
Lower Springbrook	4,500 feet	GI	WRIA 9
Upper Springbrook	900 feet	GI	WRIA 9
Mill Creek East	unknown	GI	WRIA 9
Garrison Creek	unknown	GI	WRIA 9
Mullen Slough Reach	unknown	GI	WRIA 9
Mill Creek – Schuler Bridge	unknown	GI	WRIA 9
Mill Creek - Merlino	unknown	GI	WRIA 9
Mill Creek Wetland 5K	unknown	GI	WRIA 9
NE Auburn Creek	unknown	GI	WRIA 9
Meridian Valley Creek	unknown	GI	WRIA 9
Olson Creek	1,500 feet	GI	WRIA 9
Ray Creek Tributary	12,150 feet	GI	WRIA 9

NOTE: Legend on page 4-240

Table *4-E*. Continued.

Project Name	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Newaukum Creek LWD	unknown	GI	WRIA 9
Big Spring Creek	3,700 feet	GI	WRIA 9
Estuarine Habitat			
Elliot Bay Nearshore	unknown	GI	WRIA 9
Duwamish Site 1	1,000 feet	GI	WRIA 9
Codiga Farms	unknown	GI	WRIA 9
Black River Marsh	1,200 feet	GI	WRIA 9
Off-Channel Habitat			
Signani Slough	4,500 feet (5+ acres)	TW-HCP; AWSP	Action Area
Page Mill Pond and Page Creek channel maintenance	4,900 feet (2 acres)	TW-HCP; AWSP	Action Area
Mullen Slough Nursery	500 feet	GI	WRIA 9
Mill Creek - Goedke	2,100 feet	GI	WRIA 9
Green River Park	unknown	GI	Action Area
Horsehead Bend side channel	950 feet	GI	Action Area
Riverside Estates side channel	unknown	GI	WRIA 9
Porter Levee	1,300 feet (8 acres)	GI	Action Area
Kaech Levee	unknown	GI	Action Area
Hamikami Levee	525 feet (3 acres)	GI	Action Area
Turley Levee	unknown	GI	Action Area
Loans Levee	1,500 feet (2.8 acres)	GI	Action Area
Flaming Geyser side channel	2,100 feet	GI	Action Area
Brunner Slough	4,500 feet	GI	Action Area
Upper Green River side channel	unknown	GI	Action Area
Water Quality			
Sediment management plan	RM 0- RM 64.5	USACE Section 7; AWSP	Action Area
Variable elevation withdrawal	RM 61 – RM 64.5	USACE Section 7; AWSP	Action Area

NOTE: Legend on page 4-240

Table *4-E*. Continued.

Project Name	Amount of Habitat Affected	Project	Cumulative Effects Analysis Area
Wasterwater Treatment Plant Section 10	RM 0-RM 11	KC-HCP	WRIA 9
Fish Populations			
Juvenile salmonid transport and release	Upper Green River subbasin	TW-HCP	Action Area, WRIA 9
Fisheries restoration facility	Upper Green River subbasin	MIT/TPU	Action Area, WRIA 9
Fish Passage			
Tacoma Headworks upstream passage facility	Entire upper watershed	TW-HCP; SSP	Action Area, WRIA 9
Tacoma Headworks downstream fish bypass facility	Entire upper watershed	TW-HCP; SSP	Action Area, WRIA 9
Howard Hanson Dam Downstream fish passage facility	Entire upper watershed	TW-HCP; USACE Section 7; AWSP	Action Area, WRIA 9
Boundary Creek culvert replacement	5,280 feet	TW-HCP; AWSP; GI	Action Area
Maywood Creek culvert replacement	5,280 feet	TW-HCP; AWSP; GI	Action Area
Green Canyon Creek culvert replacement	5,280 feet	TW-HCP; AWSP	Action Area
Restore fish passage at McDonald Creek	2,500 feet	1135	Action Area
Restore fish access at Page Mill Creek	2,640 feet	1135	Action Area
Lake Meridian outlet relocation	unknown	GI	WRIA 9
Gale Creek culvert	unknown	GI	Action Area
Sweeney Creek culvert	unknown	GI	Action Area
Olsen Creek culvert	unknown	GI	Action Area
May Creek culvert	unknown	GI	Action Area
Gold Creek culvert retrofit	unknown	GI	Action Area
North East Creek culvert	unknown	GI	Action Area

NOTE: Legend on page 4-240

Table *4-E*. Legend

TW-HCP	Tacoma Water Habitat Conservation Plan
MIT/TPU	1995 Settlement Agreement between Tacoma Public Utilities and the Muckleshoot Indian Tribe
AWSP	Additional Water Storage Project
USACE Section 7	USACE's Section 7 consultation with NMFS and USFWS
GI	Green-Duwamish Ecosystem Restoration Project
WAC	Washington Administrative Code
DNR-HCP	Washington Department of Natural Resources Habitat Conservation Plan
WFPA	Washington Forest Practices Act
PC-HCP	Plum Creek Timber Companies Habitat Conservation Plan
1135	Section 1135 Project
KC-HCP	King County's Wastewater Treatment Plant Habitat Conservation Plan
SSP	Second Supply Project

Table 4-11. General comparison of aquatic protection measures to be implemented under Tacoma's HCP and various federal and state management plans (Note: footnotes and acronyms located on the third page of this table).

	FEMAT		**DNR HCP**				**Tacoma Water HCP**			
Riparian										
Stream Type	Total Width (ft)	No-cut width (ft)	Total Width (ft)	No-cut width (ft)	Partial-cut width (ft)[1]	Leave Requirement[2]	Total Width (ft)	No-cut width (ft)	Partial-cut width (ft)[1]	Leave Requirement trees per acre
1	300	300	100-200[3]	25	25 to 100	≥90% of stand volume	200	200	NA	NA
					100 to SPTH	≥75% of stand volume:				
2	300	300	100-200[3]	25	25 to 100	≥90% of stand volume	200	200	NA	NA
					100 to SPTH	≥75% of stand volume:				
3 (lrg) $10 ft	300	300	100-200[3]	25	25 to 100	≥90% of stand volume	200	150	50	70 largest conifers
					100 to SPTH	≥75% of stand volume:				
3 (sm) <10 ft	300	300	100-200[3]	25	25 to 100	≥90% of stand volume	200	150	50	70 largest conifers
					100 to SPTH	≥75% of stand volume:				
4[4]	150	150	100	25	25 to 100	≥90% of stand volume	50-100[9]	50-100[9]	NA	
5[5]	50-100	50-100	Variable[6]	NA	NA	NA	50	25	25	50 largest conifers
Mass Wasting										
Watershed Analysis required in key watersheds No harvest on inner gorge and other landslide prone areas			No harvest of unstable hillslopes with a high risk of mass wasting as identified by field reconnaissance or slope geomorphology modeling				Addressed through Watershed Analysis			
Roads										
No new roads in roadless areas within key watersheds Reduction in overall road mileage in key watersheds Development of road management plan through watershed analysis			Minimize active road density Completion of baseline road inventory (no timeline) Identification and treatment prioritization of road-related migration barriers Development of road maintenance, treatment and abandonment plan				Addressed through Watershed Analysis			

Table 4-11. Continued.

	Plum Creek HCP				Existing State Rules[7]				WA Forest and Fish Report[8]			
Riparian												
Stream Type	Total Width (ft)	No-cut Width (ft)	Partial-cut (ft)	Leave Requirement (volume)	Total Width (ft)	No-cut width (ft)	Partial-cut Width (ft)	Leave Req. (trees/ 1000 ft)	Total Width (ft)	No-cut (ft)	Partial-cut (ft)	Leave Req. (per acre)
1	200	30	170	≥50%	75-100	0	75-100	25-50	90-200	50	50 to ¾ SPTH	BA=190-285
											to outer edge	20 trees
2	200	30	170	≥50%	75-100	0	75-100	50-100	90-200	50	50 to ¾ SPTH	BA=190-285
											to outer edge	20 trees
3 (lrg) $10 ft	200	30	170	≥50%	50	0	50	25-75	90-200	50	50 to ¾ SPTH	BA=190-285
											to outer edge	20 trees
3 (sm) <10 ft	200	30	170	≥50%	25	0	25	25	90-200	50	50 to $^{2}/_{3}$ SPTH	BA=190-285
											to outer edge	20 trees
4[4]	25-100	0	25-100	25 12"dbh trees/ 100 ft or ≥50%	0	NA	NA	NA	0-50[10]	0-50[10]	NA	NA
5[5]	0	NA	NA		0	NA	NA	NA	0	NA	NA	NA
Mass Wasting												
	Addressed through Watershed Analysis				Class IV special permit Application for slide-prone lands (requires completion of SEPA checklist and potentially additional information or preparation of a detailed SEIS prior to approval				Regional inventory to identify unique unstable slopes (within 6 months) Screening to determine whether activities are located on unstable slopes on FPA by FPA basis; Proposed activities on unstable slopes require Class IV Special Permit (see existing rules)			
Roads												
	Addressed through Watershed Analysis				Submittal of annual road maintenance plan in WAUs where harvest is occurring or planned within 2 years (Emergency Rule) Restrictions on design, location and drainage of new roads				Mandatory road maintenance and abandonment plans from each landowner within 5 years Complete implementation of road maintenance and abandonment plan within 15 years Restrictions on the design and location of new roads			

Table 4-11. Continued.

Acronyms and Footnotes:

SPTH=Site Potential Tree Height

[1]Areas prone to windthrow receive an additional 100 feet of buffer on windward side, with removal of up to 50% of volume allowed

[2]Leave requirements for DNR HCP are interim defaults that will soon be replaced by a descriptive process to design site-specific timber harvest prescriptions

[3]100 feet or one site potential tree height (SPTH), whichever is greater

[4]Type 4 streams assumed to be equivalent to perennial non-fish bearing streams for purposes of this comparison

[5]Type 5 streams assumed to be equivalent to intermittent or seasonal non-fish bearing streams for the purpose of this comparison

[6] Applied to Type 5 waters "when necessary for water quality, fisheries habitat stream banks, wildlife and other important elements of the aquatic system".

[7]Emergency rules currently in force require determination of fish use for type 4 and 5 streams, classifies activities within 200 feet of Type 1, 2 and 3 waters as Class IV special, requiring additional review under SEPA prior to approval of FPA, requires determination of shade requirements using TFW temperature prediction model and may require additional leave trees along Type 4 and 5 waters.

[8]Specific to forests west of the Cascades Crest

[9]All Type 4 streams receive continuous 50-foot no-harvest buffers. Buffer width is increased to100 feet around special habitats (junctions with fish-bearing, low gradient plateaus, Type 4 junctions, seeps/springs, and source areas).

[10]Buffer width is 50 feet around special habitats (junctions with fish-bearing streams, headwall seeps, side-slope seeps and springs, permanent initiation points, alluvial fans, and confluences with other perennial non-fish streams). Buffers must cover at least 50 percent of the length of each individual stream.

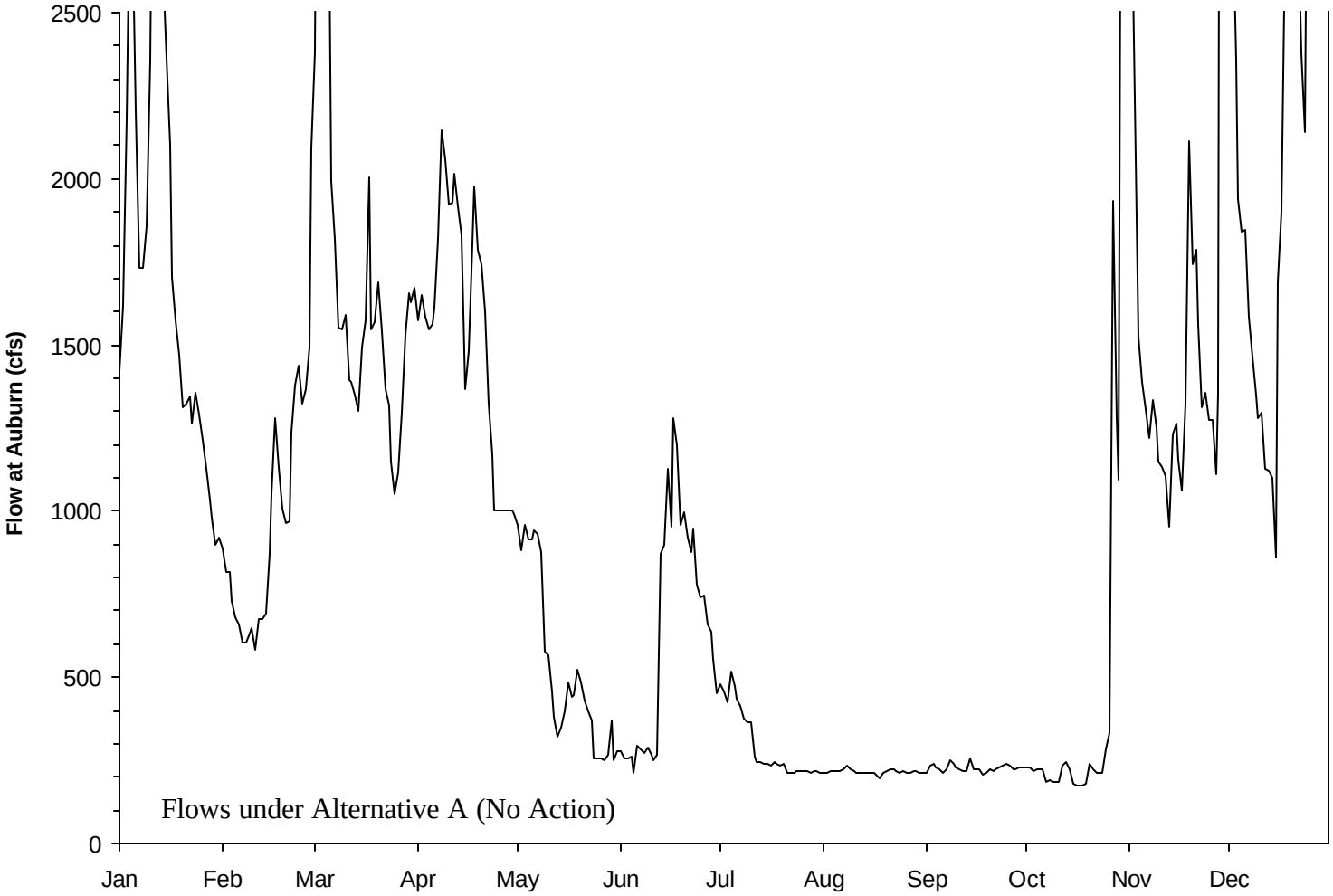

Figure 4-1a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative A; average year conditions (1994).

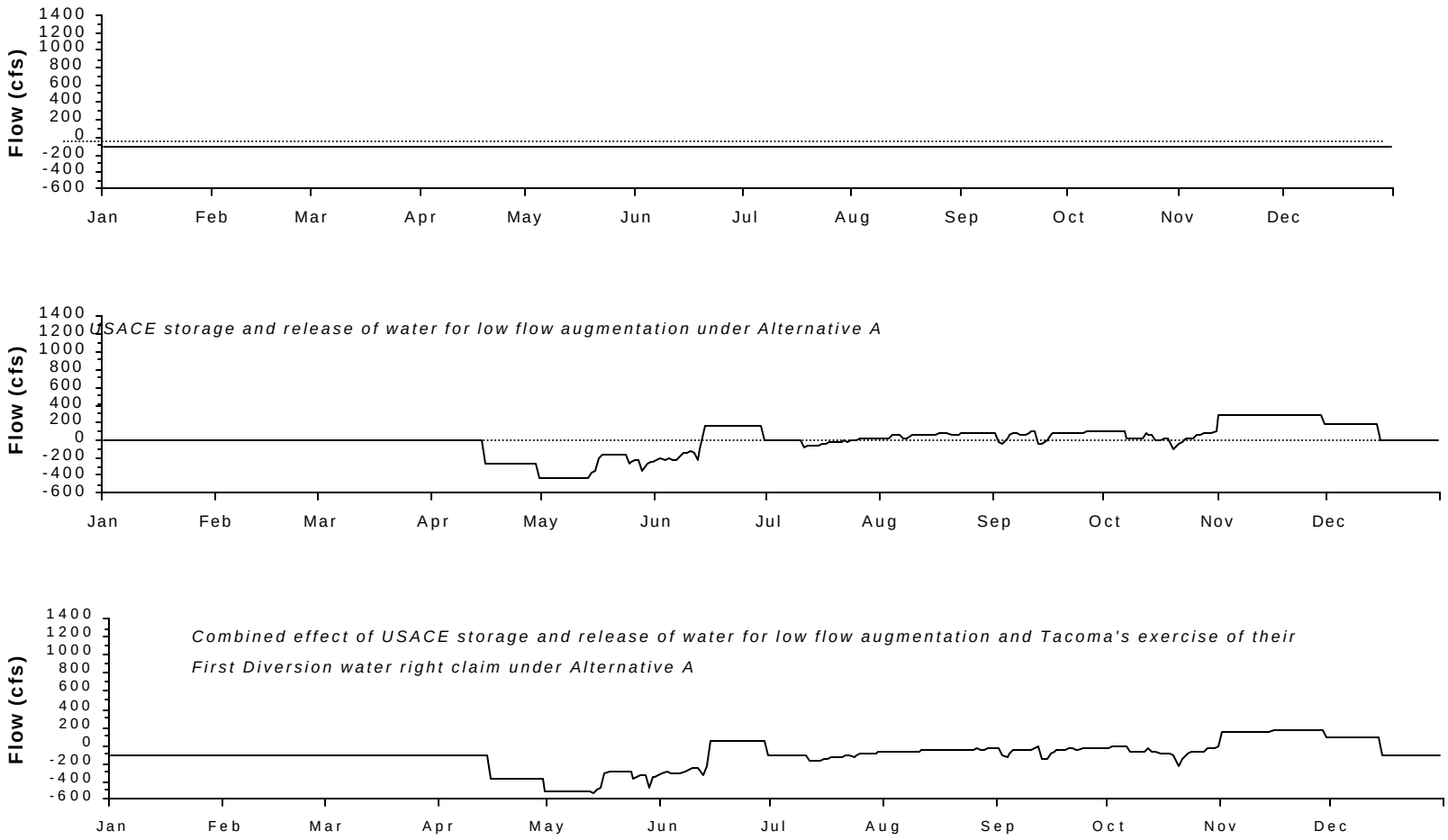

Figure 4-1b. Green River flow changes under Water Withdrawal Alternative A at the USGS gauge at Auburn; average year conditions (1994).

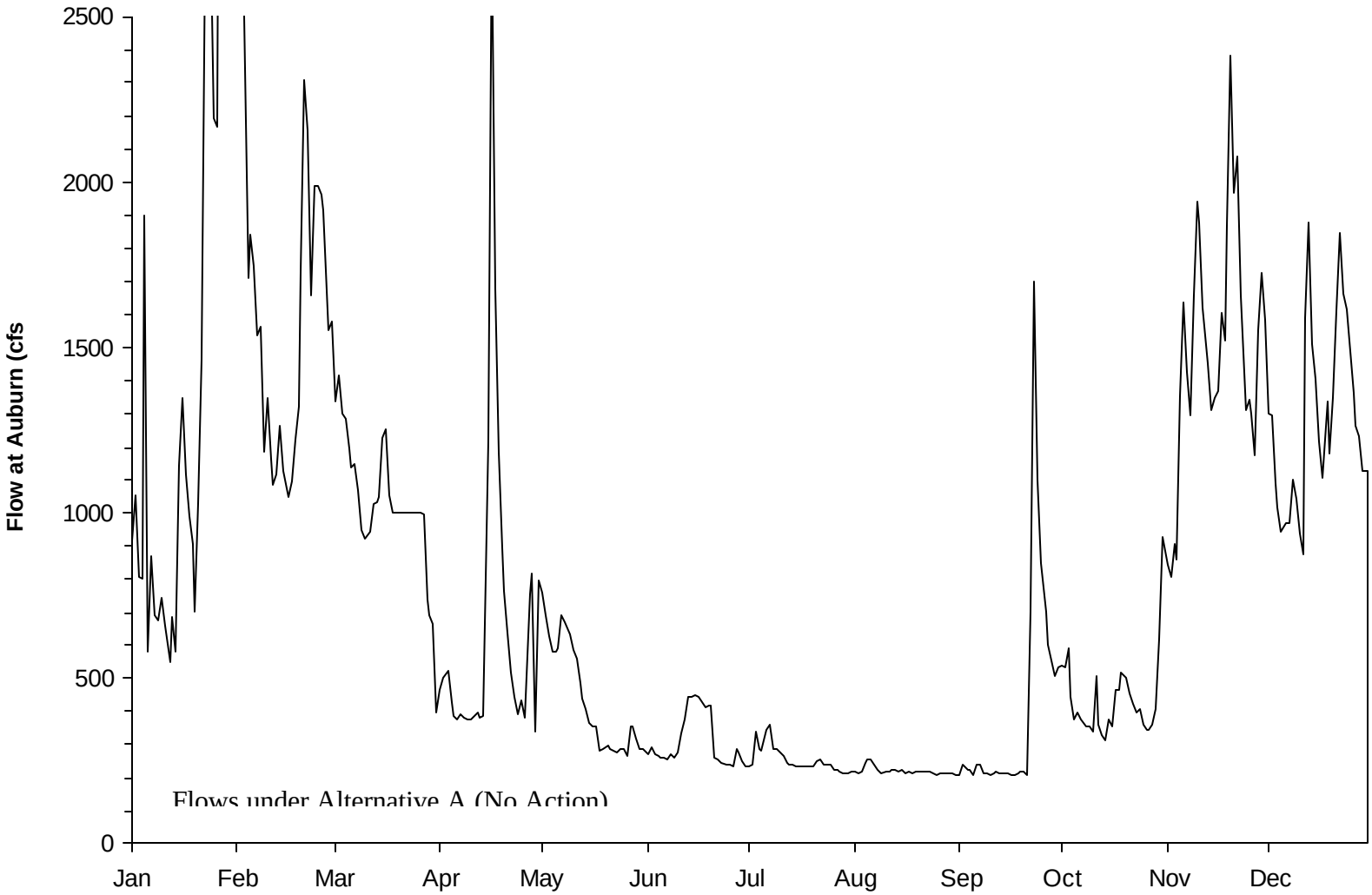

Figure 4-2a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative A; dry year conditions (1992).

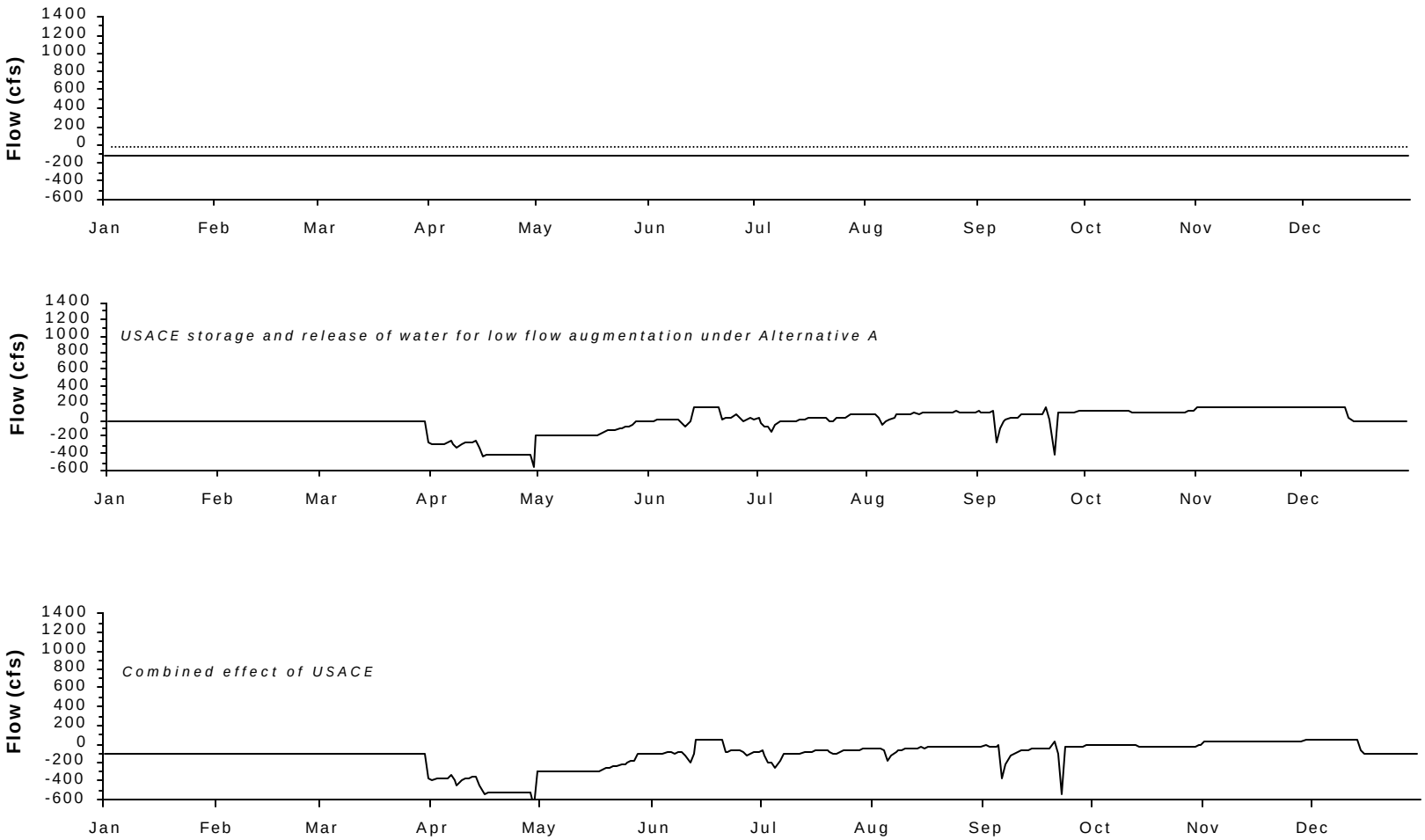

Figure 4-2b. Green River flow changes under Water Withdrawal Alternative A at the USGS gauge at Auburn; dry year conditions (1992).

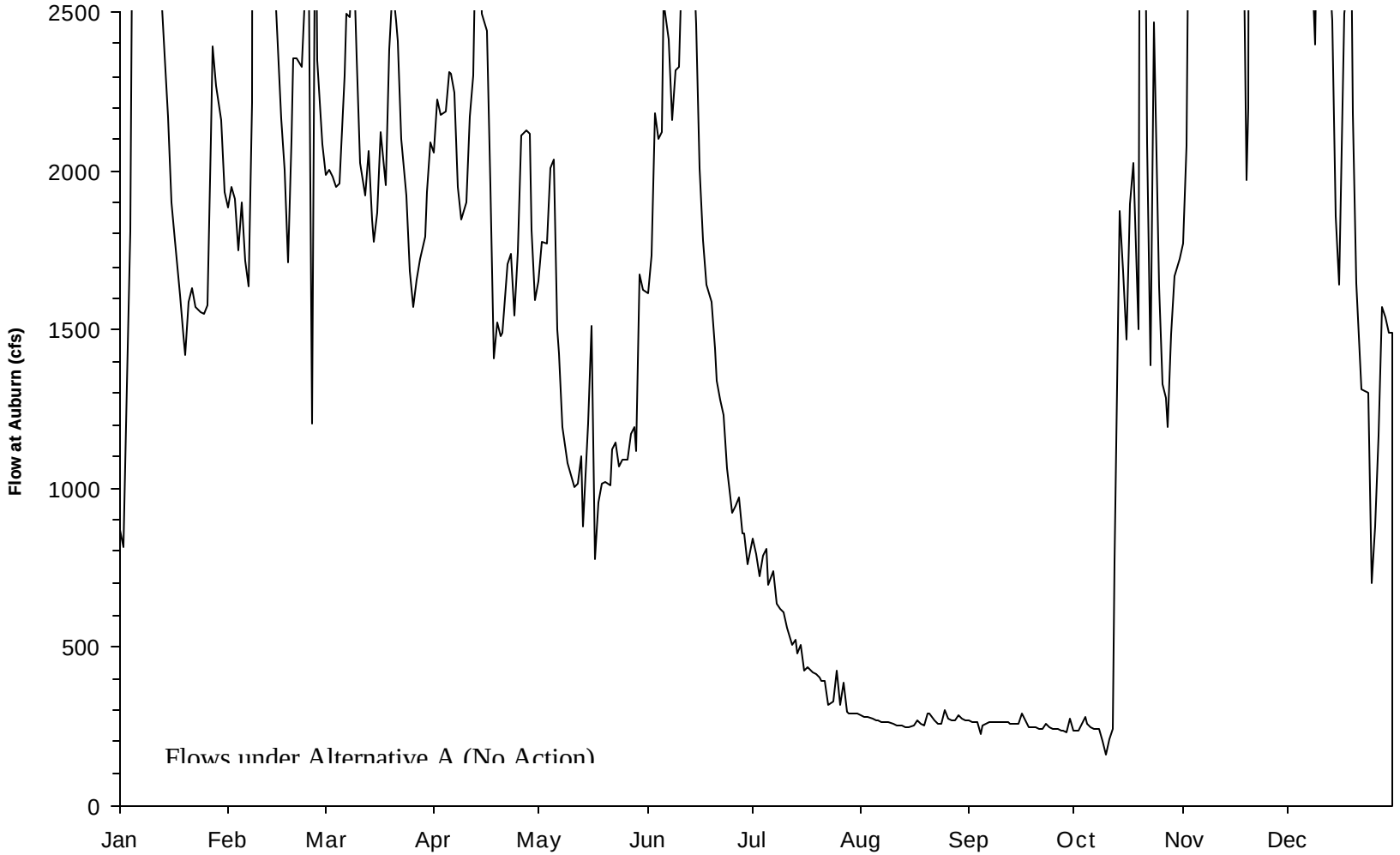

Figure 4-3a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative A; wet year conditions (1990).

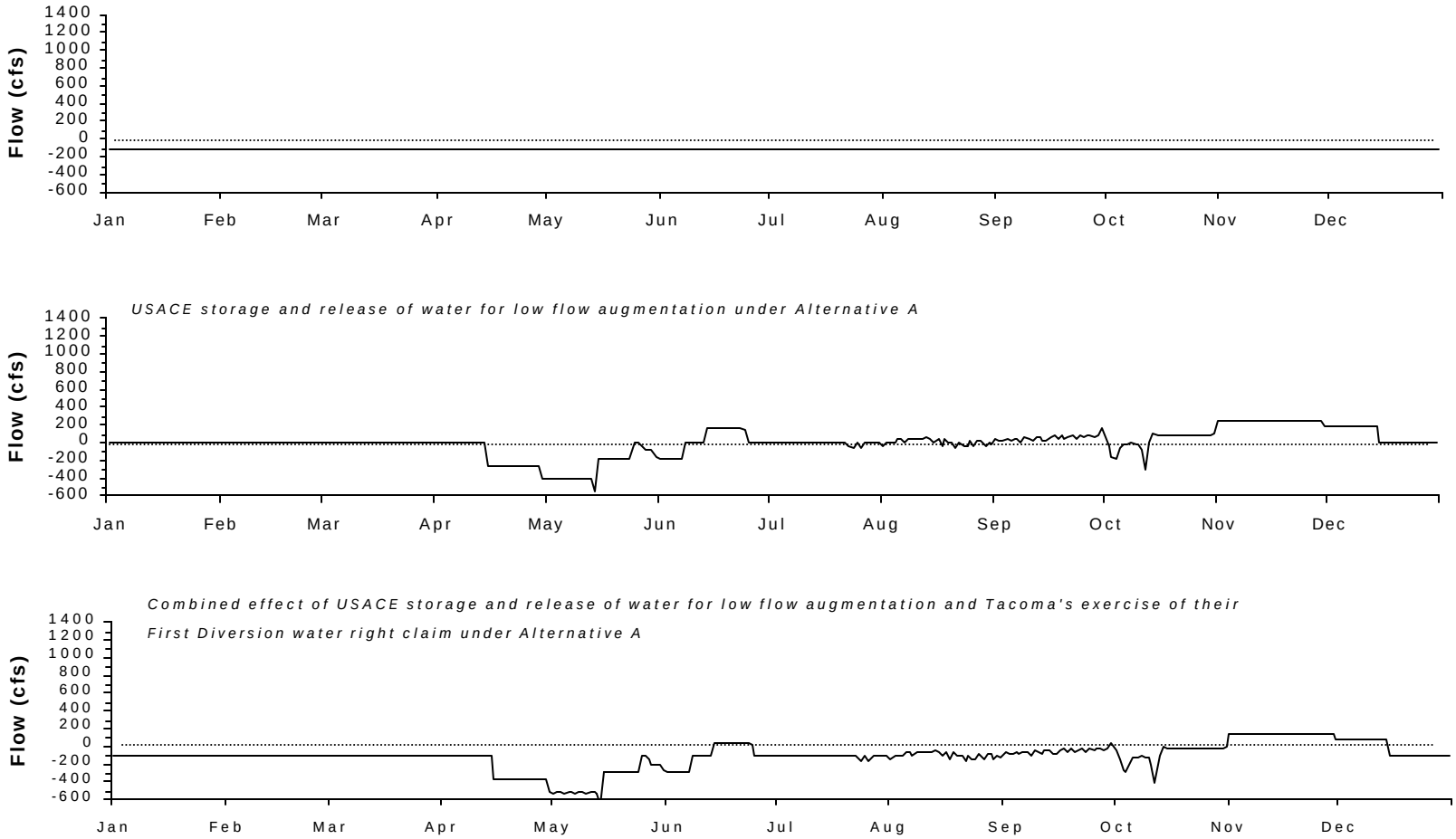

Figure 4-3b. Green River flow changes under Water Withdrawal Alternative A at the USGS gauge at Auburn; wet year conditions (1990).

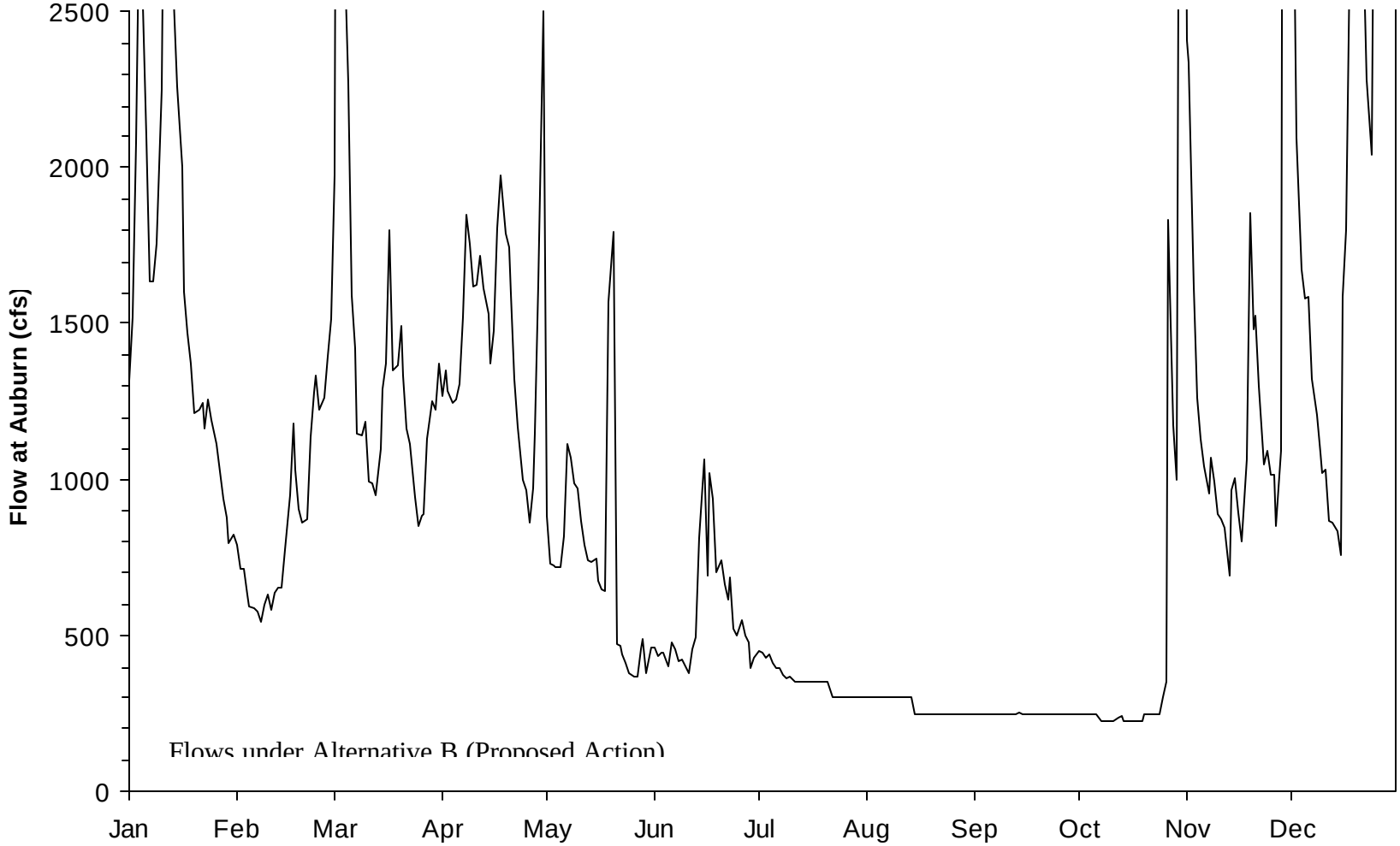

Figure 4-4a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative B; average year conditions (1994).

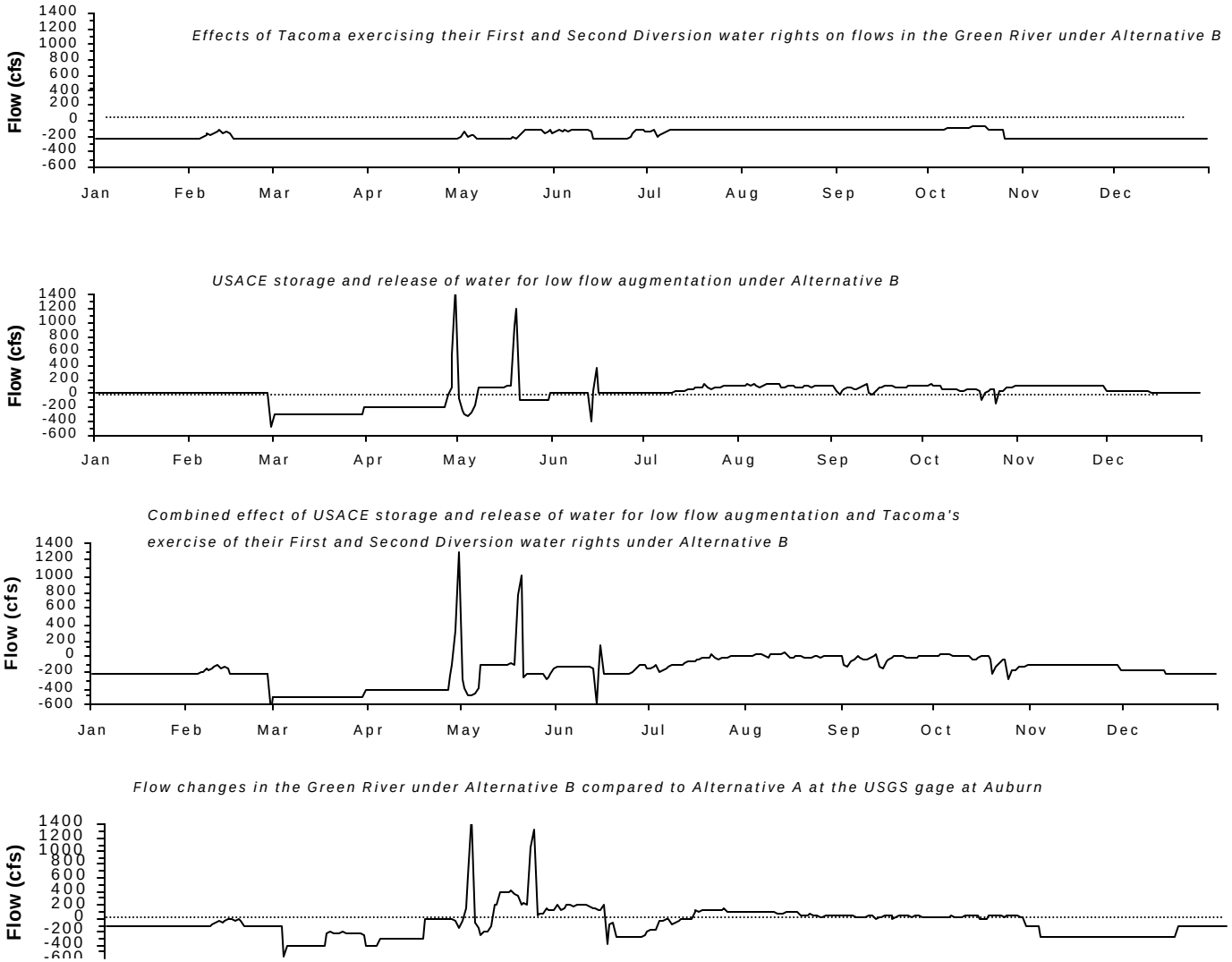

Figure 4-4b. Green River flow changes under Water Withdrawal Alternative B at the USGS gauge at Auburn; average year conditions (1994).

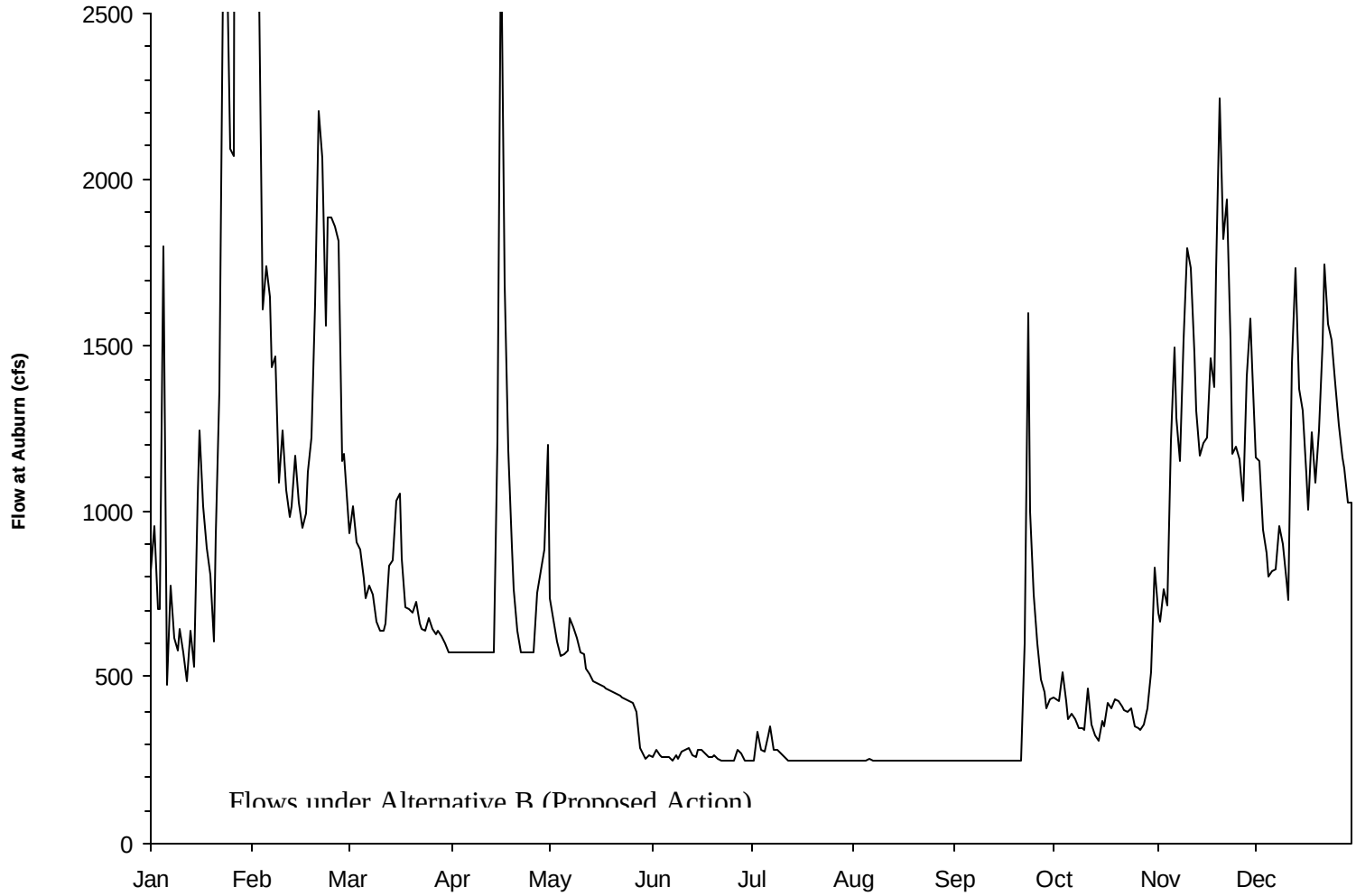

Figure 4-5a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative B; dry year conditions (1992).

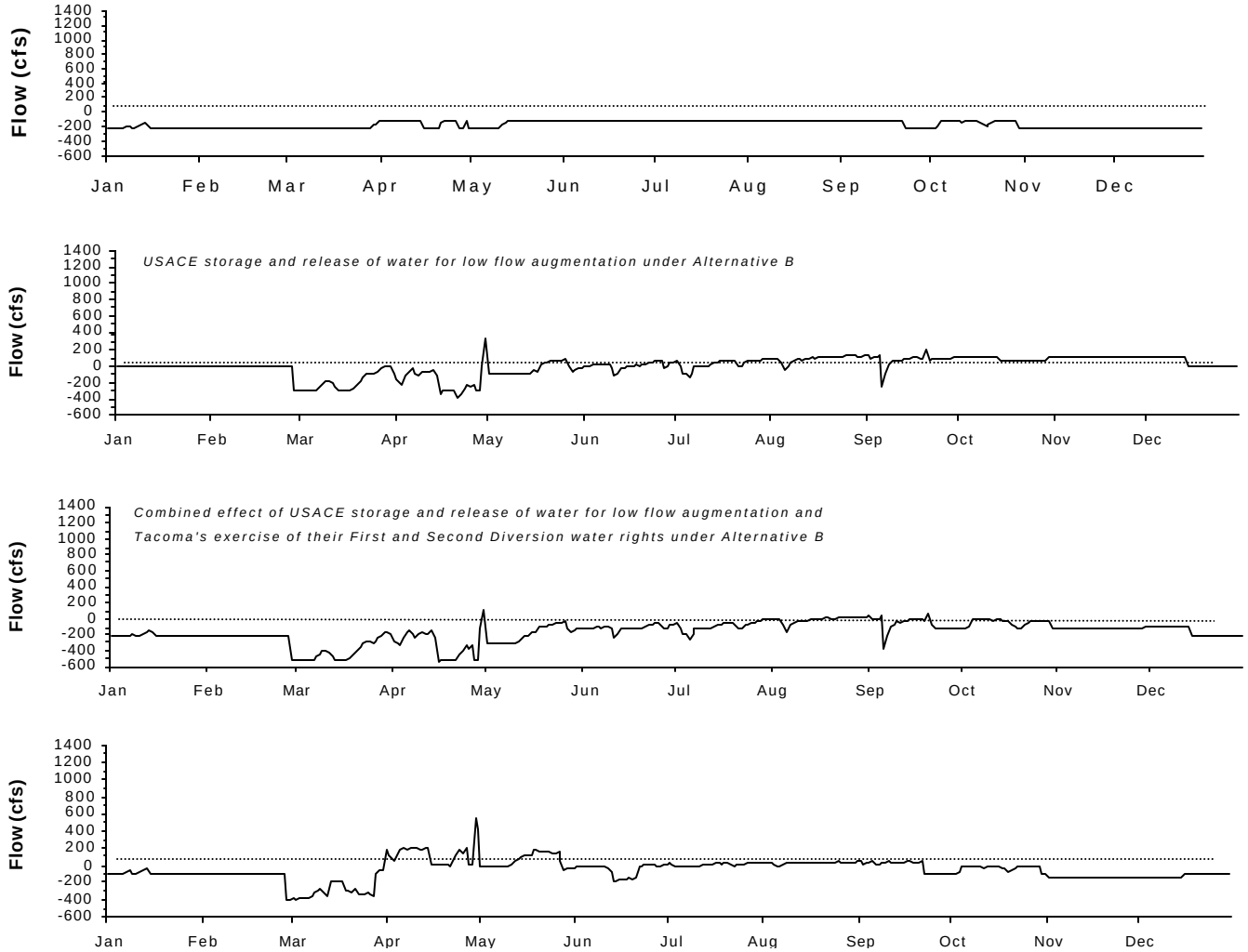

Figure 4-5b. Green River flow changes under Water Withdrawal Alternative B at the USGS gauge at Auburn; dry year conditions (1992).

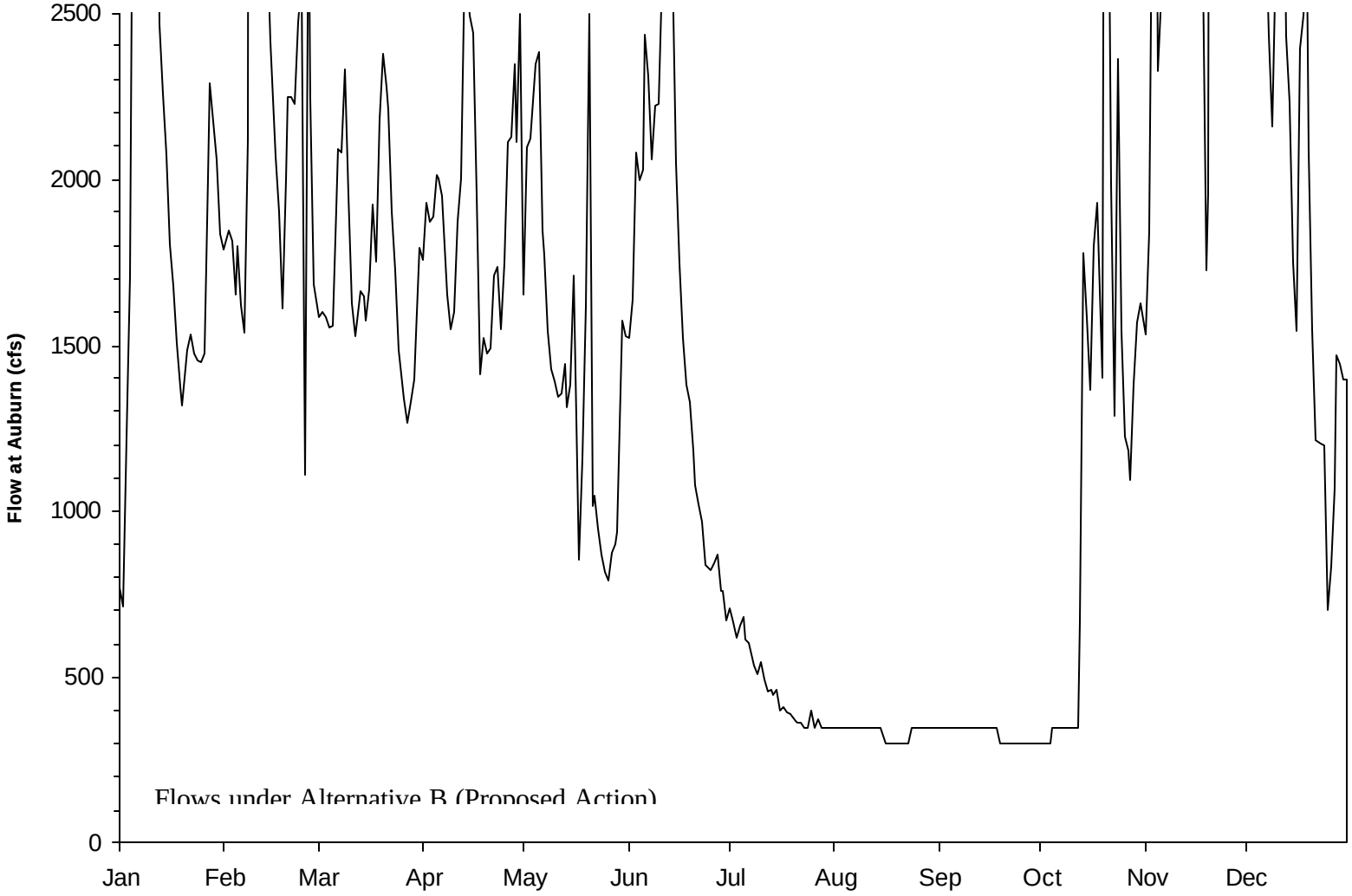

Figure 4-6a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative B; wet year conditions (1990).

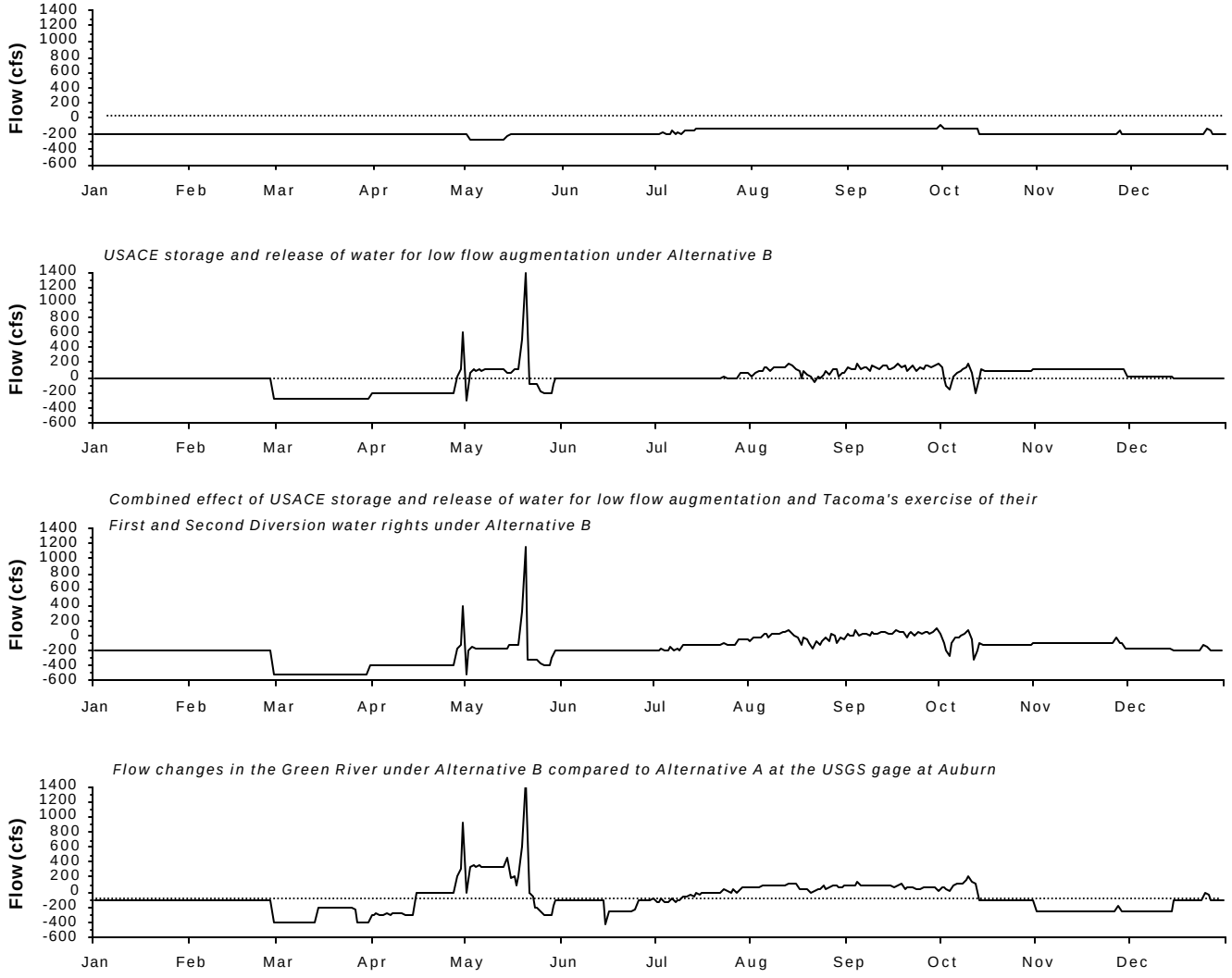

Figure 4-6b. Green River flow changes under Water Withdrawal Alternative B at the USGS gauge at Auburn; wet year conditions (1990).

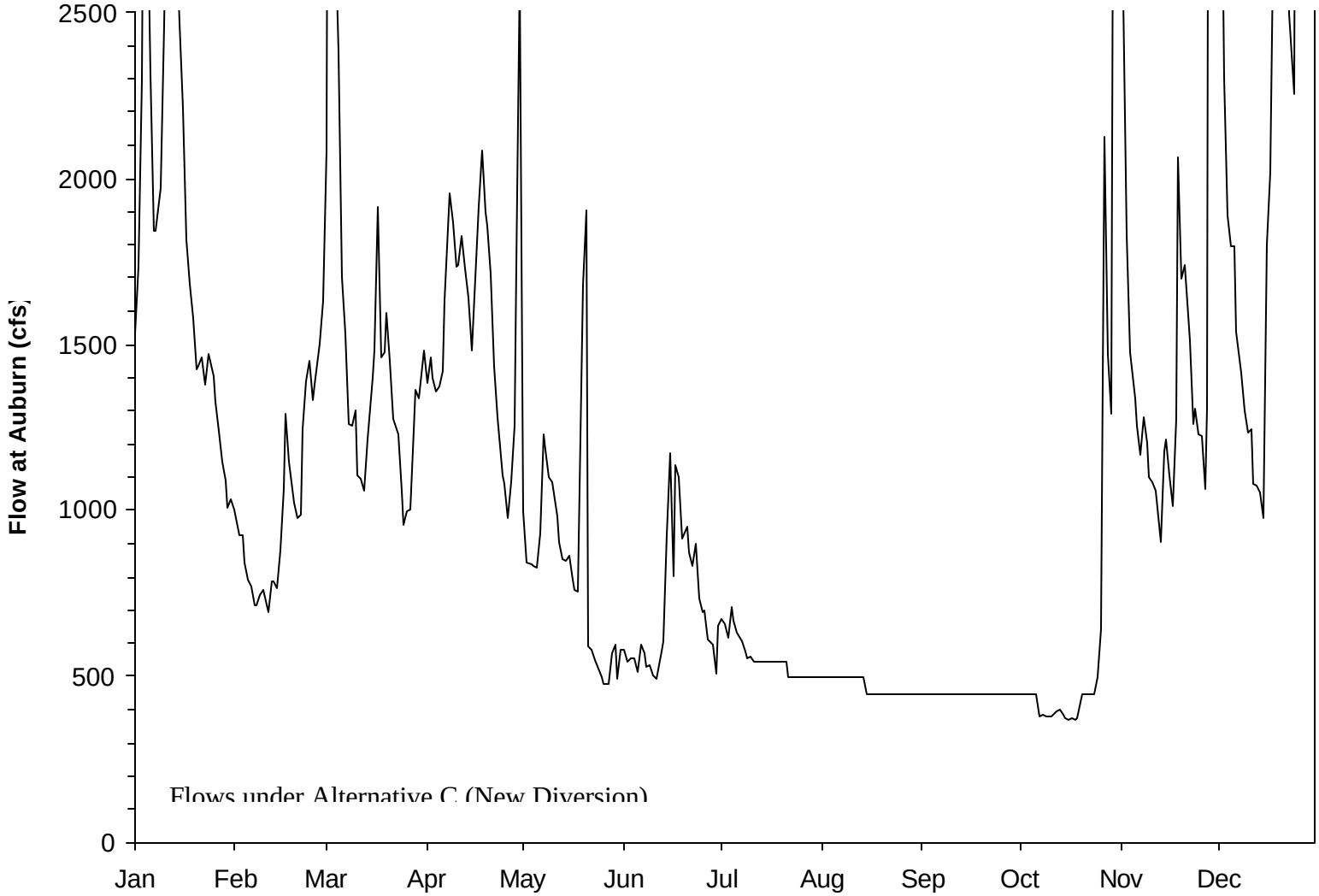

Figure 4-7a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative C; average year conditions (1994).

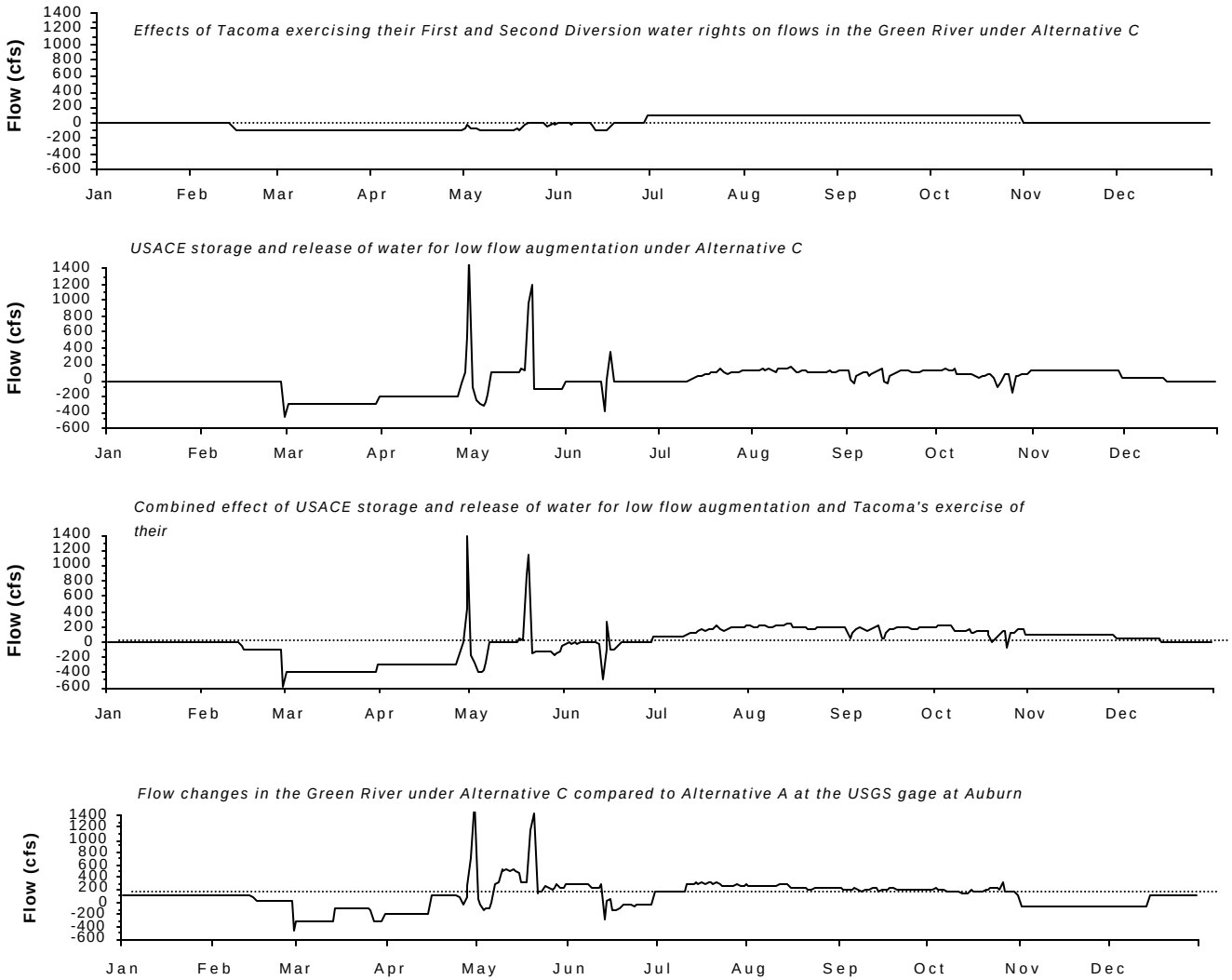

Figure 4-7b. Green River flow changes under Water Withdrawal Alternative C at the USGS gauge at Auburn; average year conditions (1994).

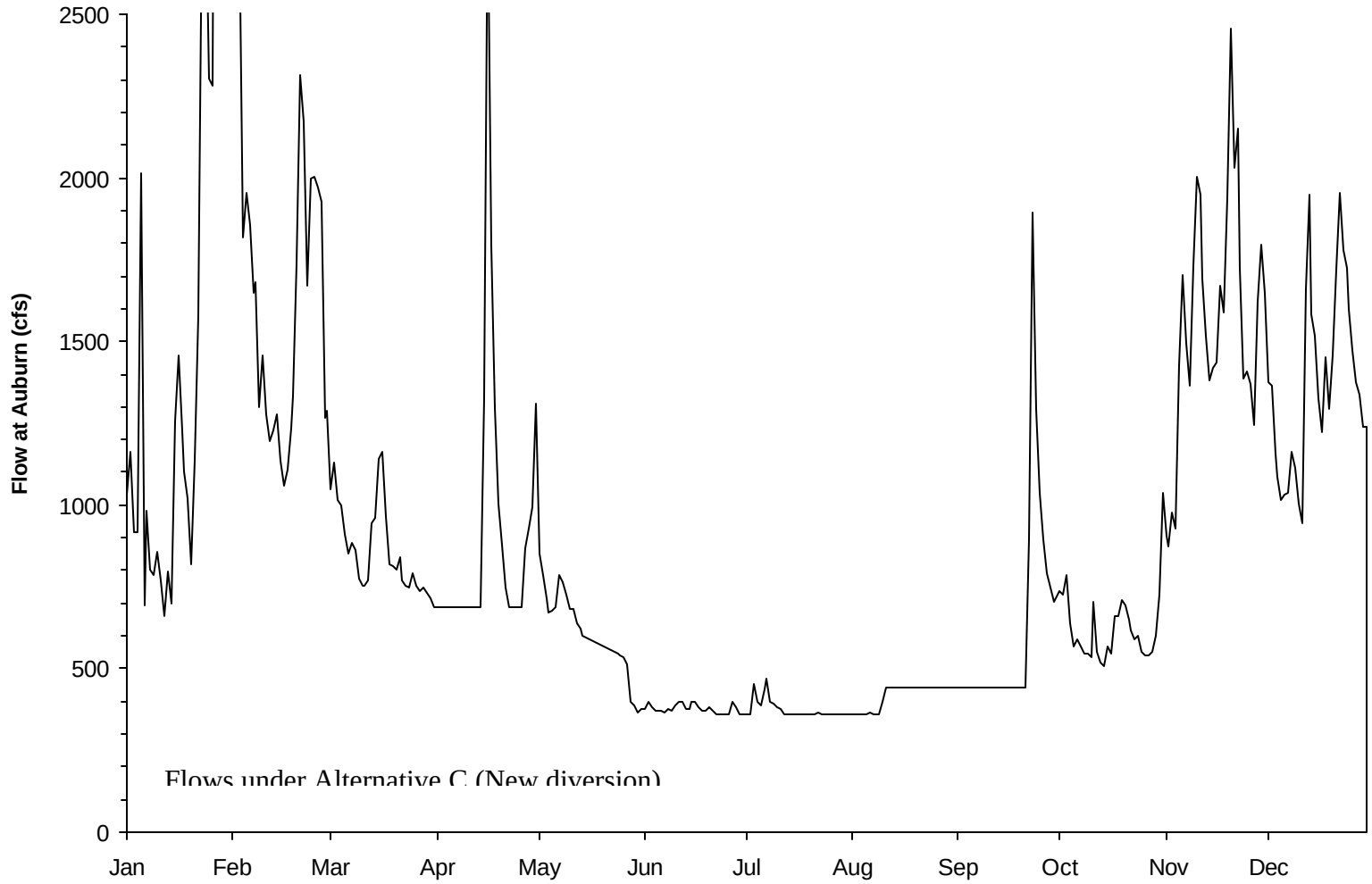

Figure 4-8a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative C; dry year conditions (1992).

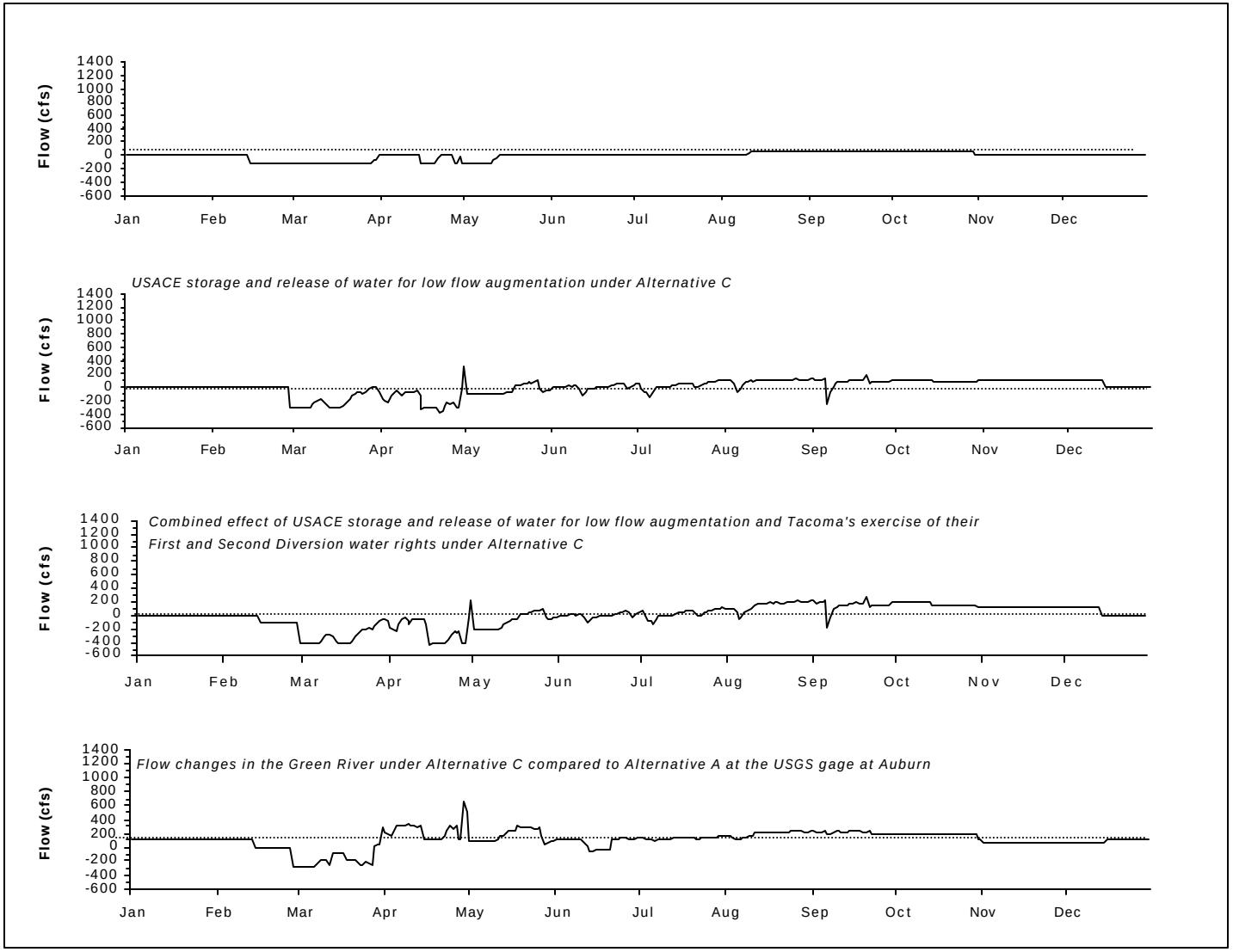

Figure 4-8b. Green River flow changes under Water Withdrawal Alternative C at the USGS gauge at Auburn; dry year conditions (1992).

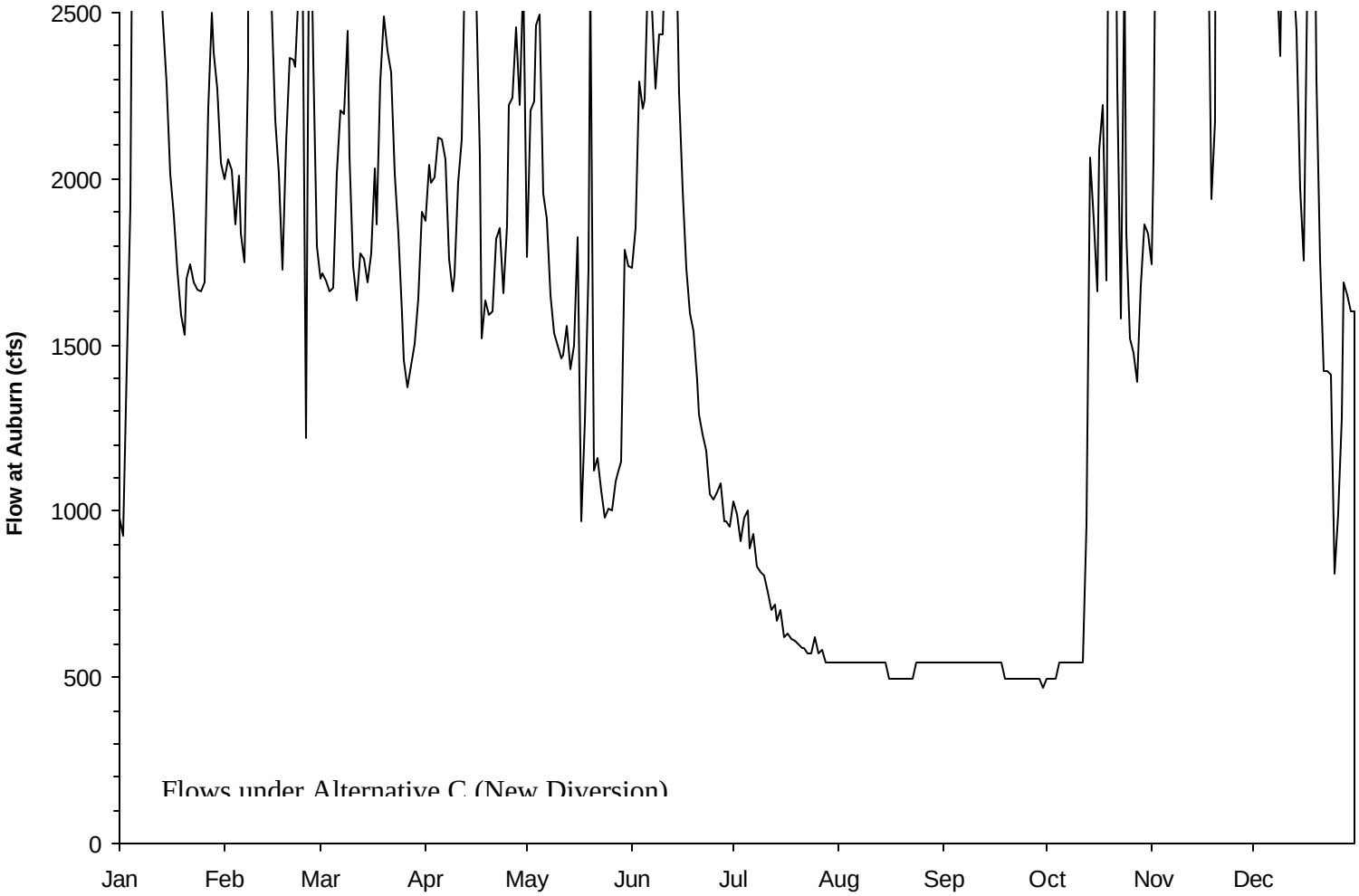

Figure 4-9a. Flows in Green River, Washington at Auburn under Water Withdrawal Alternative C; wet year conditions (1990).

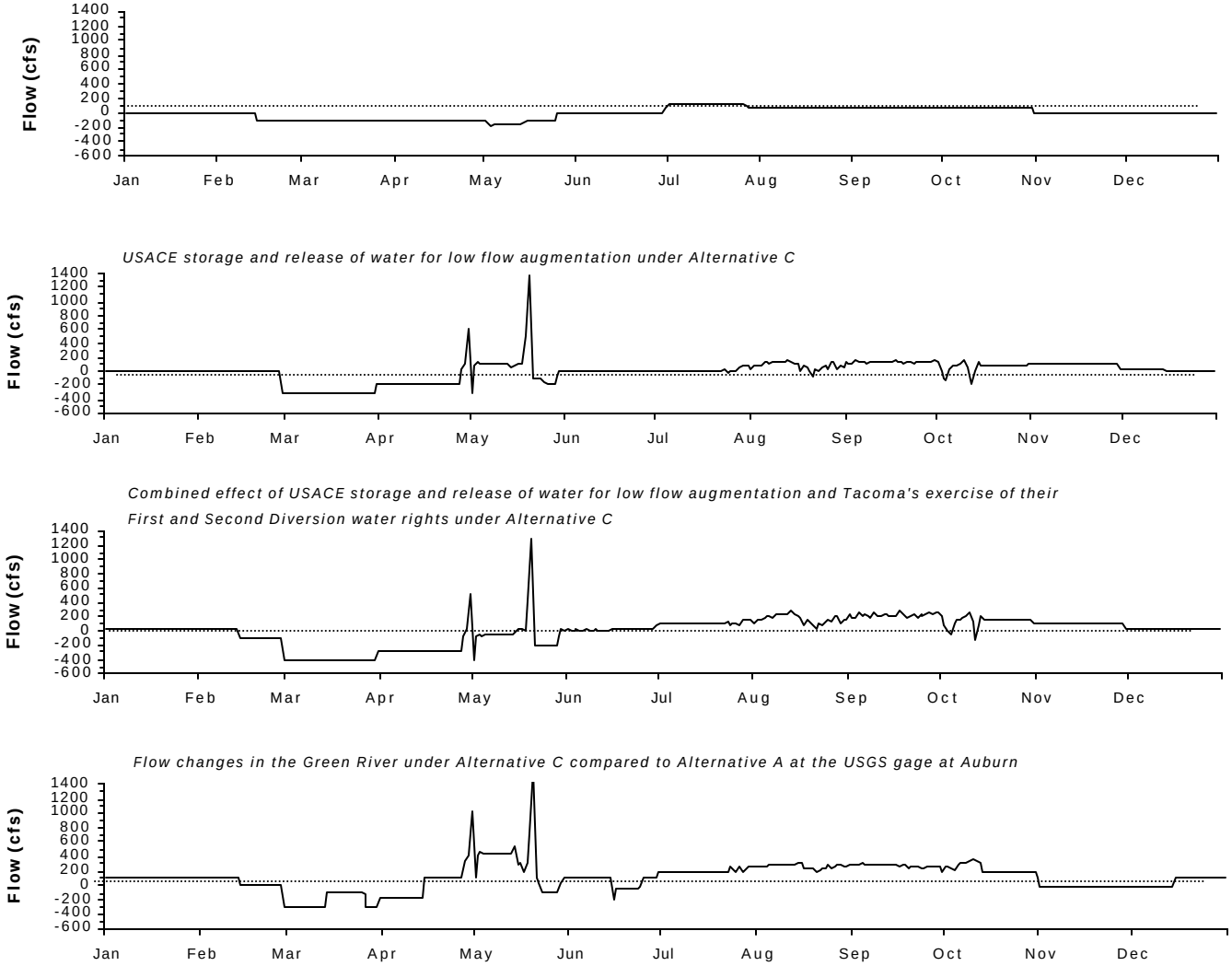

Figure 4-9b. Green River flow changes under Water Withdrawal Alternative C at the USGS gauge at Auburn; wet year conditions (1990).

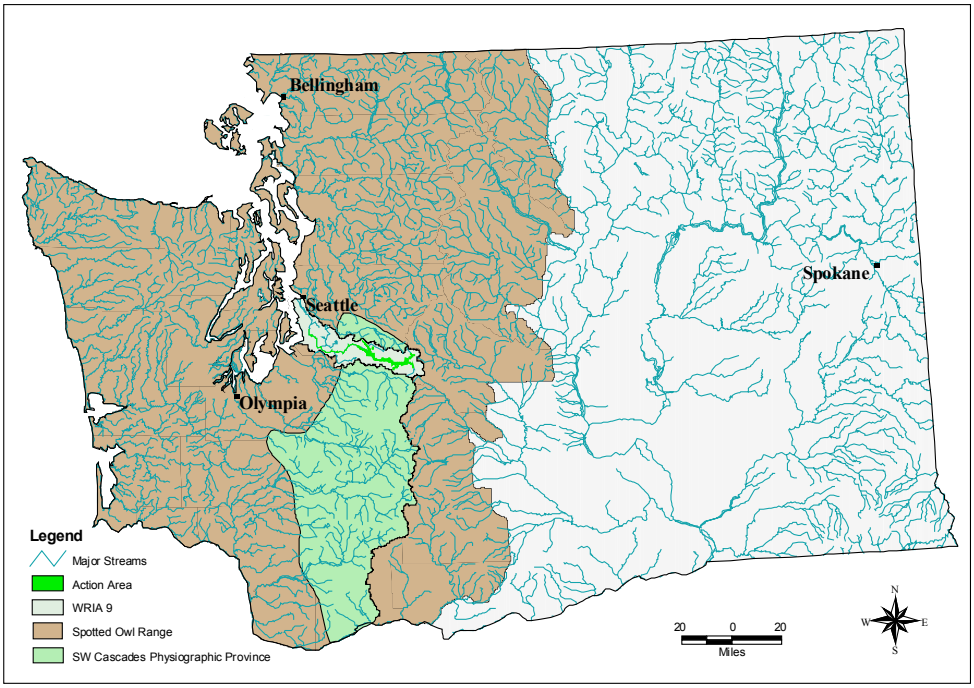

Figure 4-10. Geographic scope of the cumulative effects analysis areas.

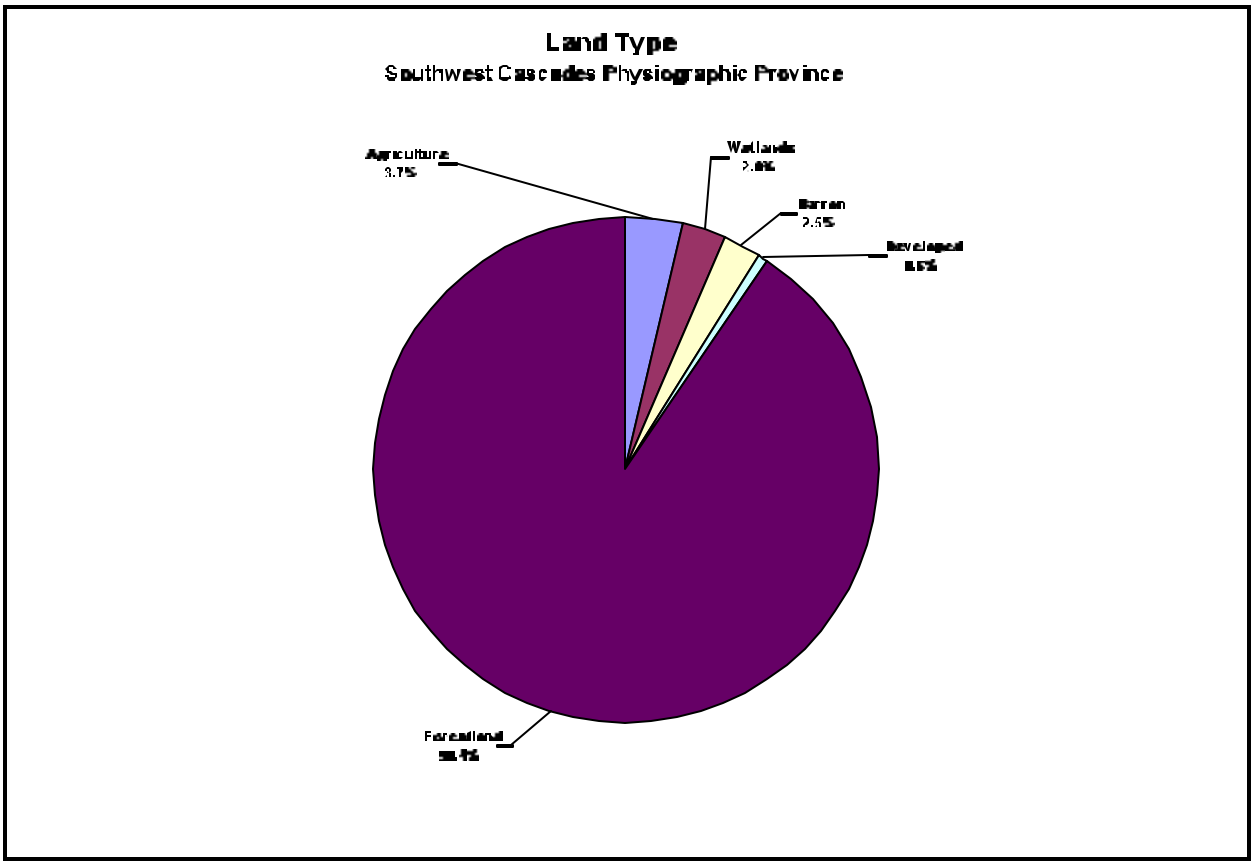

Figure 4-11. Land Type: Southwest Cascades Physiographic Province.

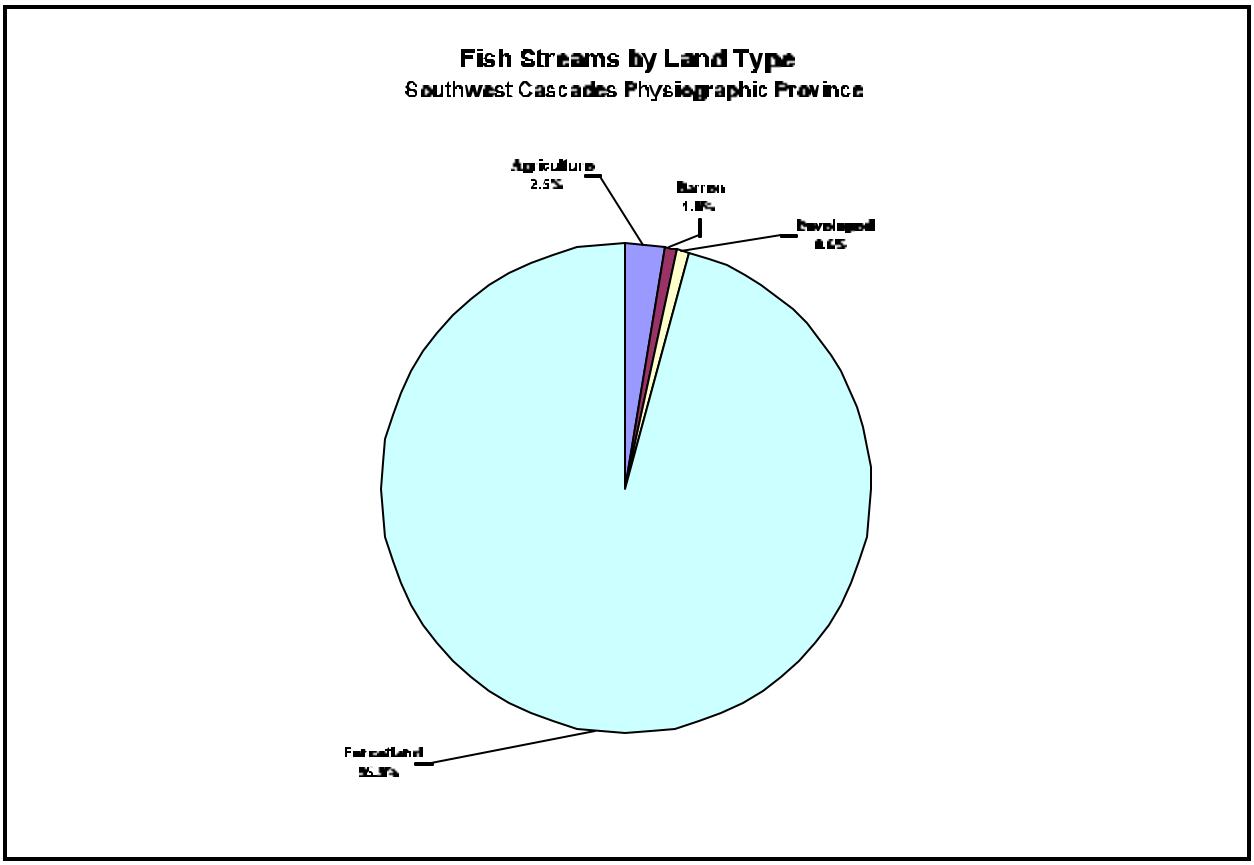

Figure 4-12. Fish streams by Land Type: Southwest Cascades Physiographic Province.

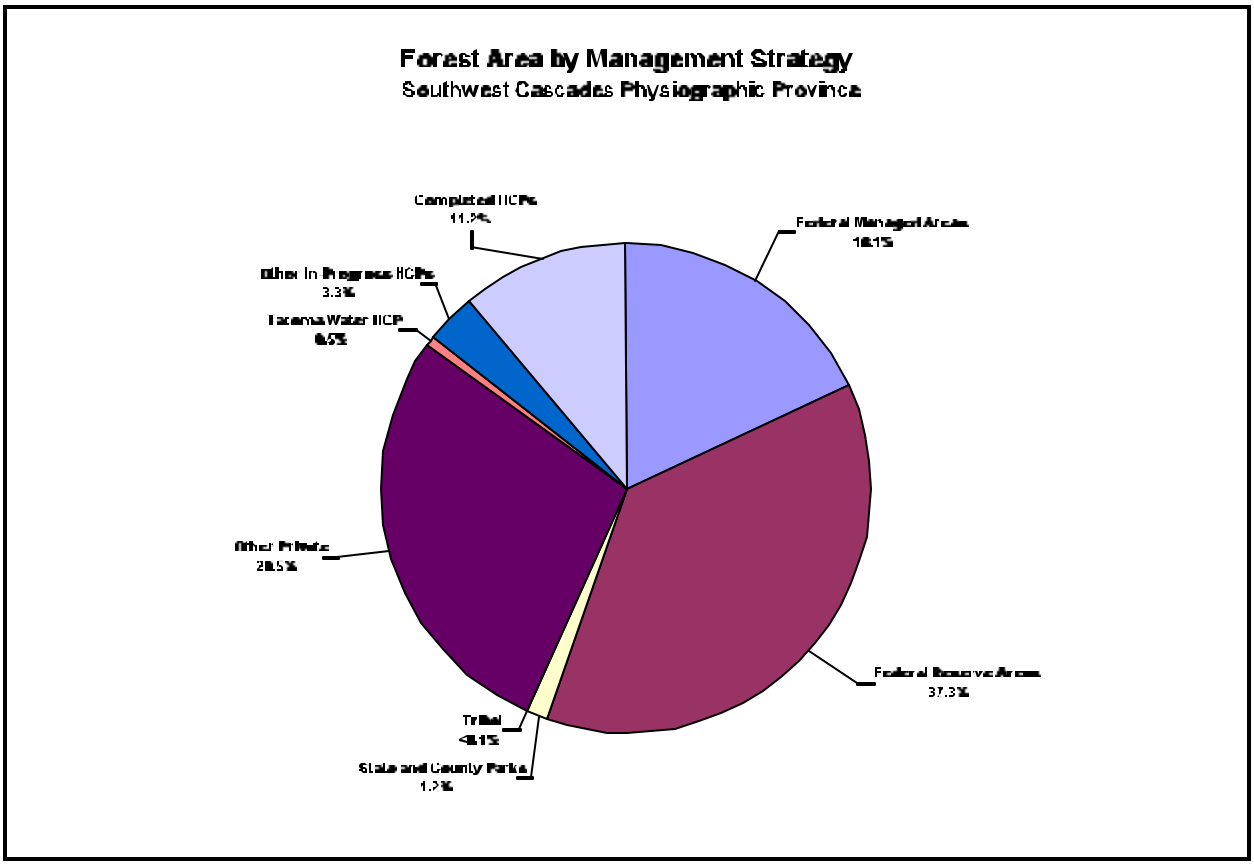

Figure 4-13. Forest Area by Management Strategy: Southwest Cascades Physiographic Province.

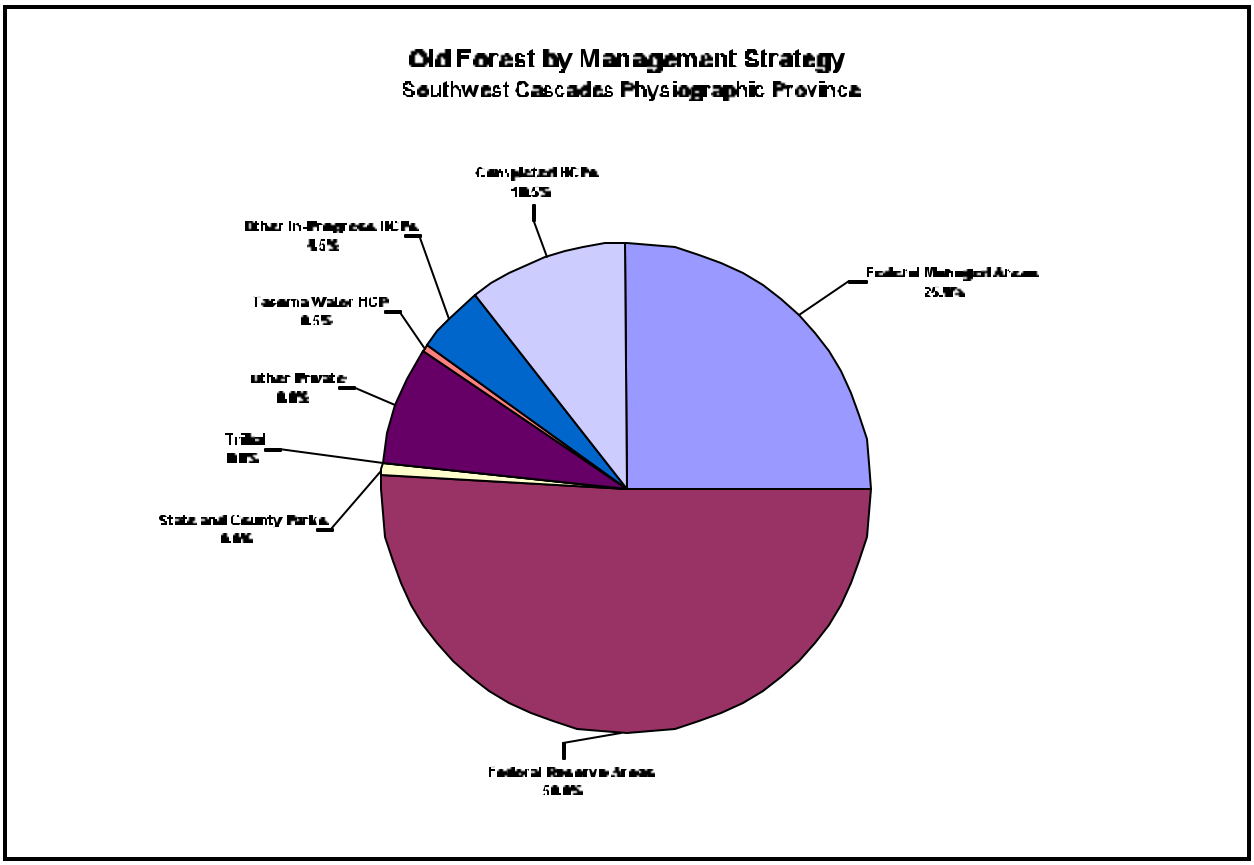

Figure 4-14. Old Forest by Management Strategy: Southwest Cascades Physiographic Province.

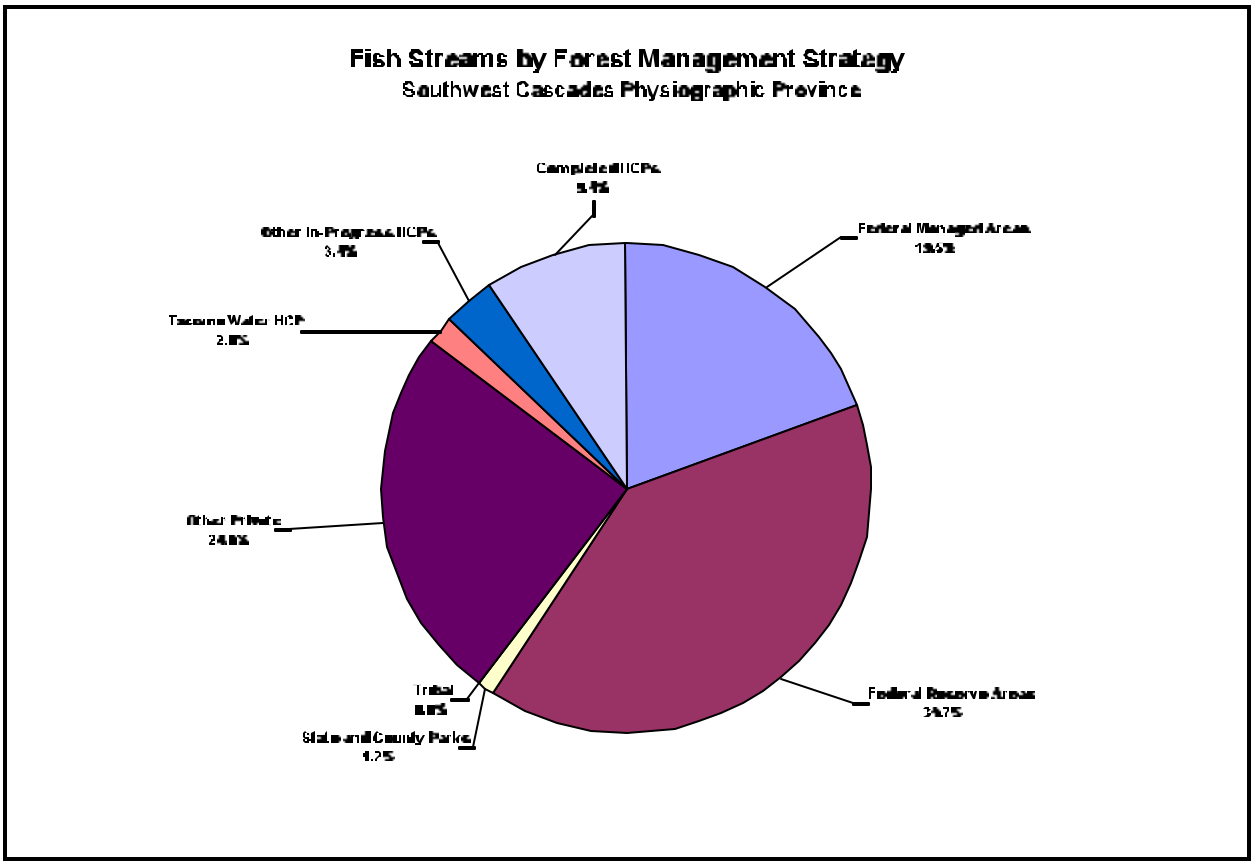

Figure 4-15. Fish Streams by Management Strategy: Southwest Cascades Physiographic Province.

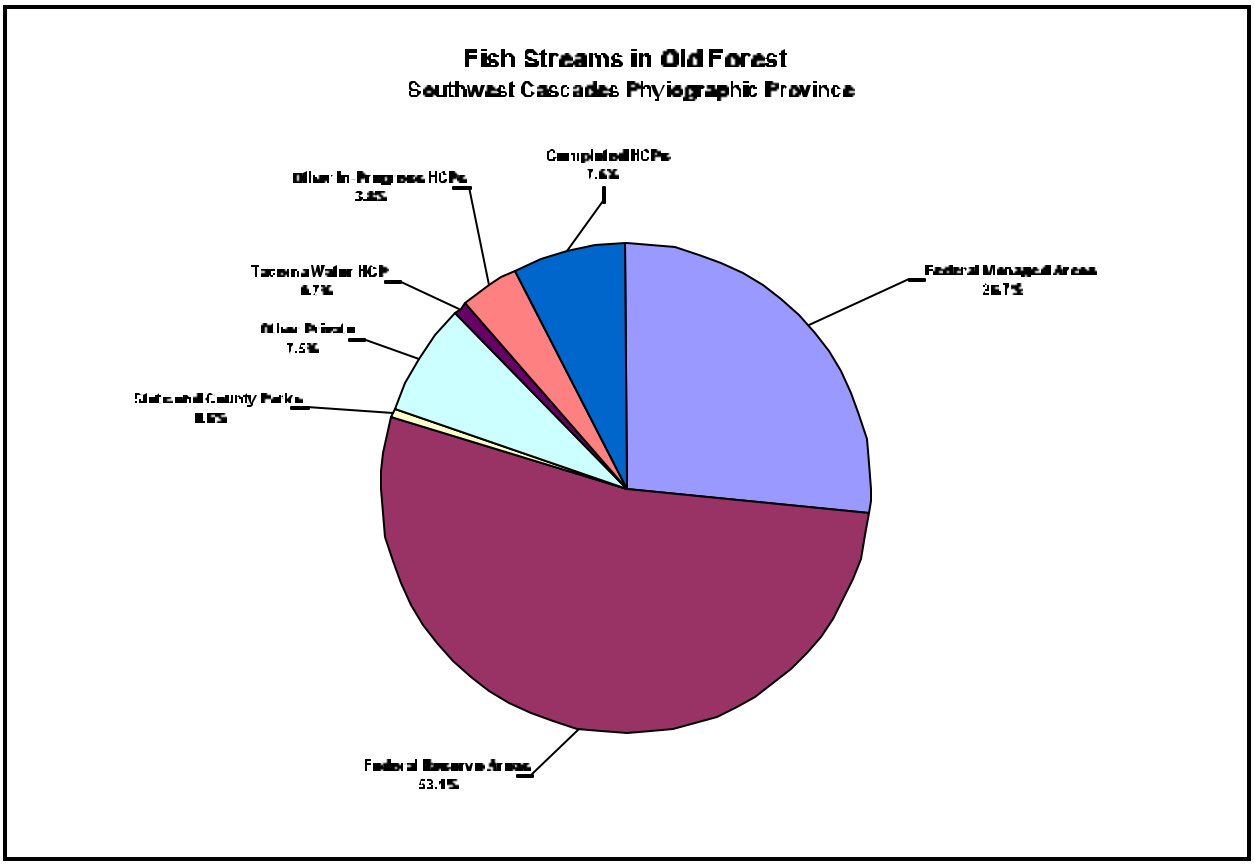

Figure 4-16. Fish Streams in Old Forest: Southwest Cascades Physiographic Province.

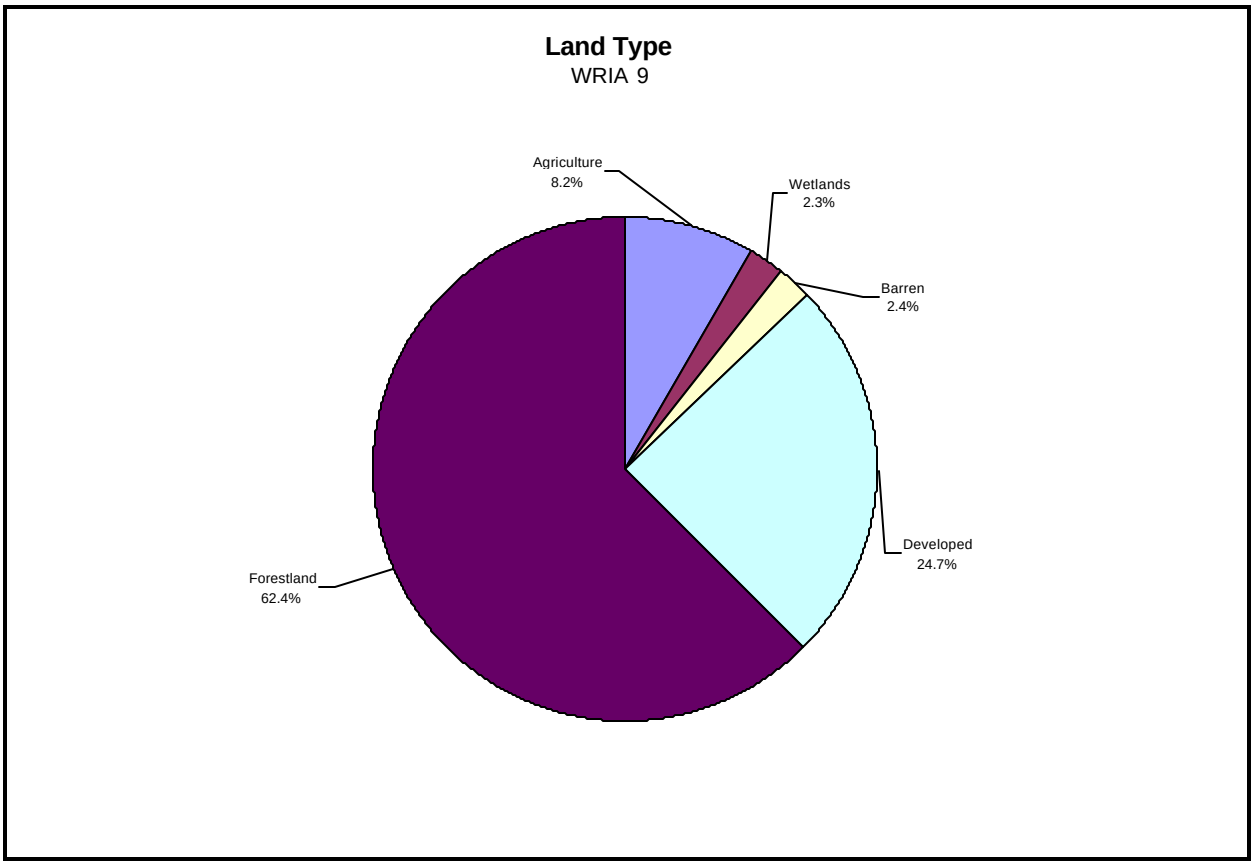

Figure 4-17. Land Type: WRIA 9.

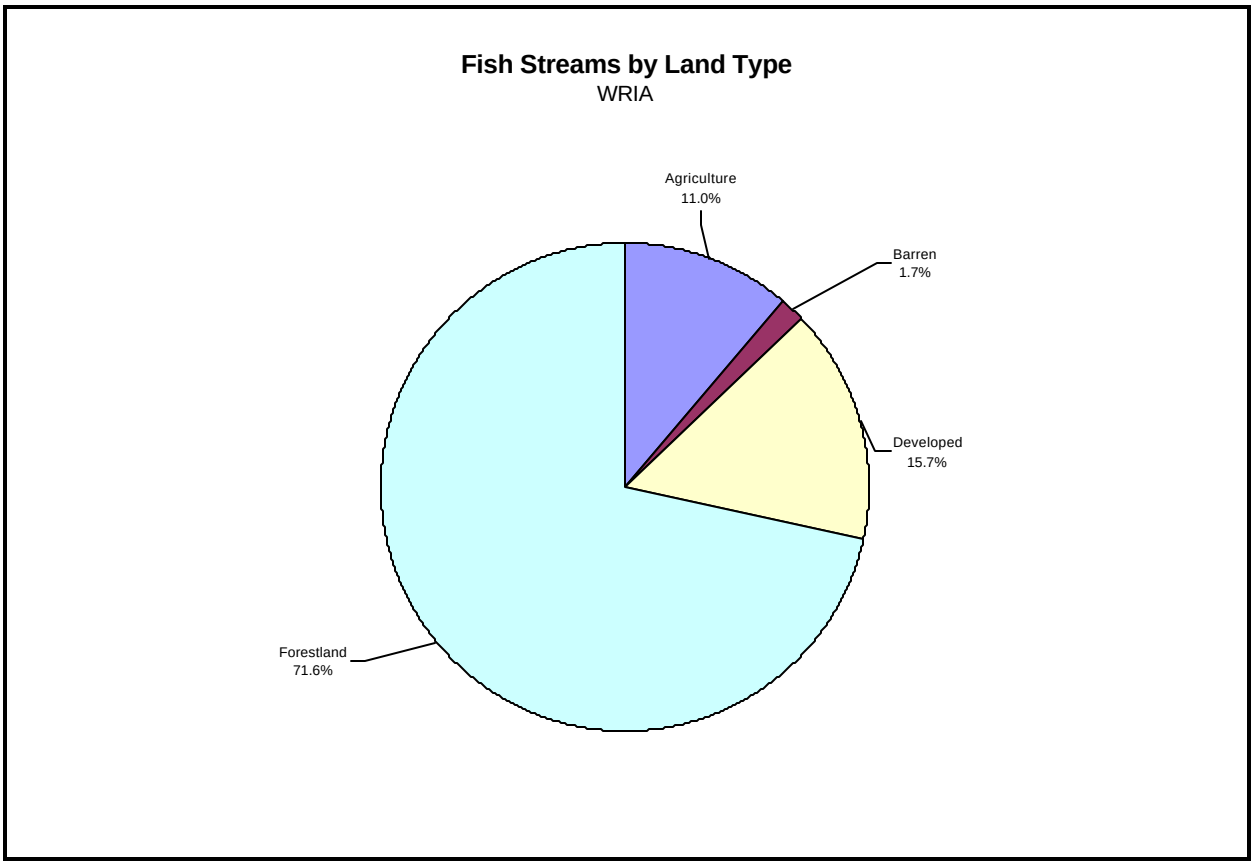

Figure 4-18. Fish Streams by Land Type: WRIA 9.

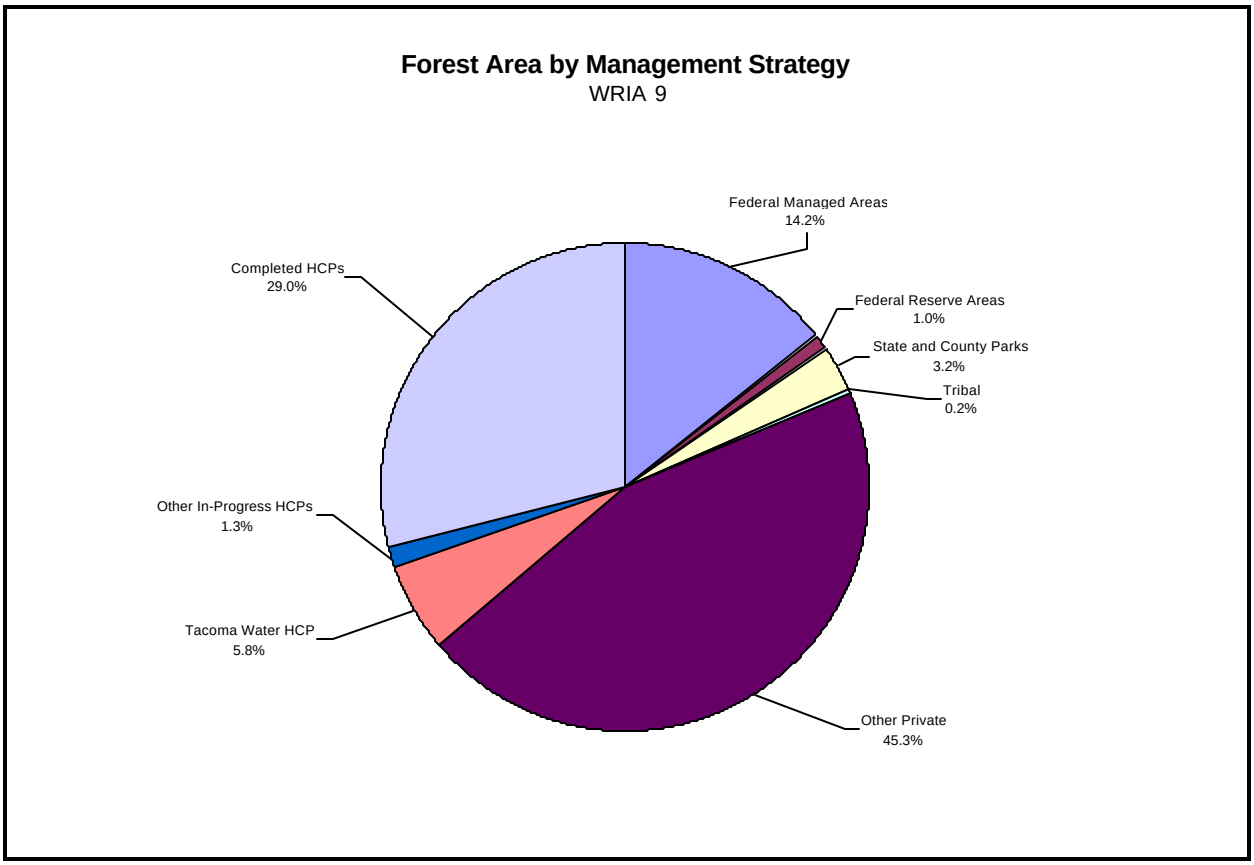

Figure 4-19. Forest Area by Management Strategy: WRIA 9.

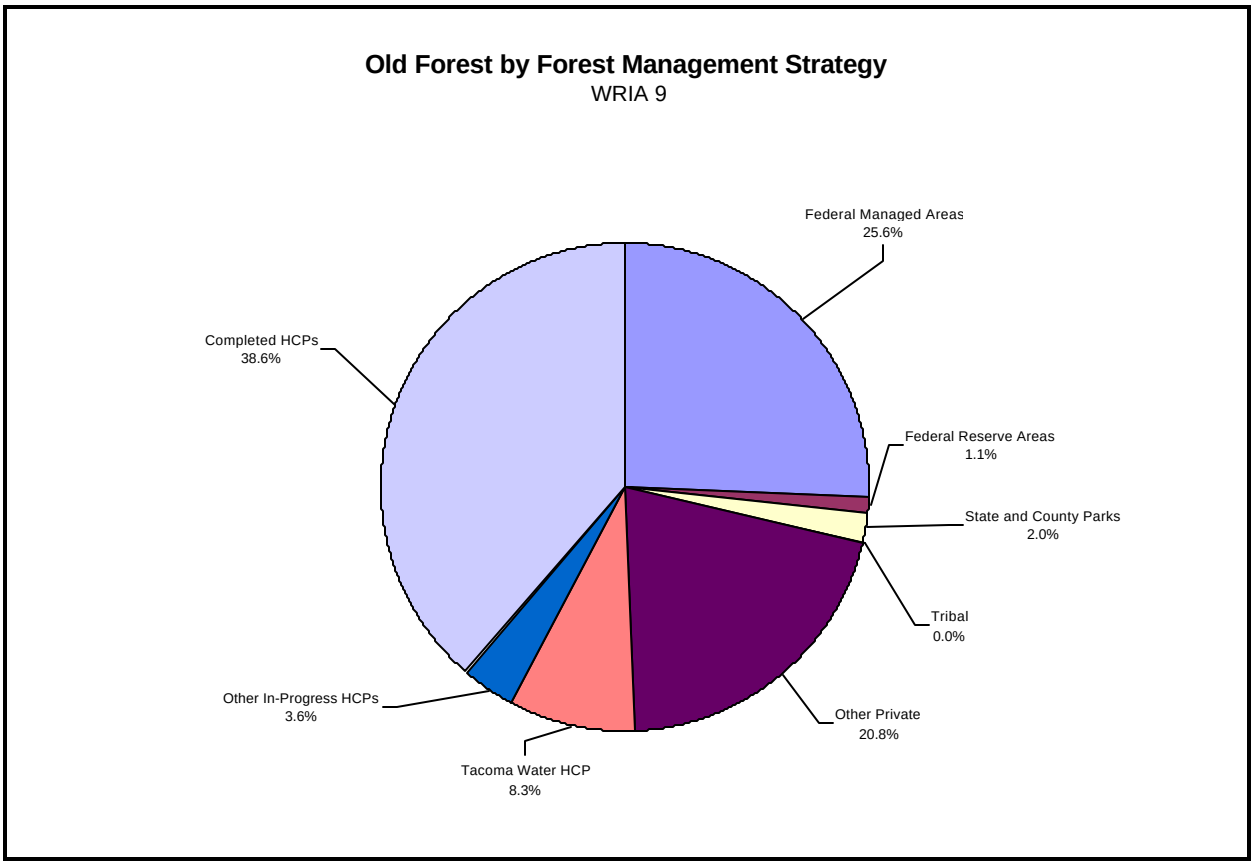

Figure 4-20. Old Forest by Management Strategy: WRIA 9.

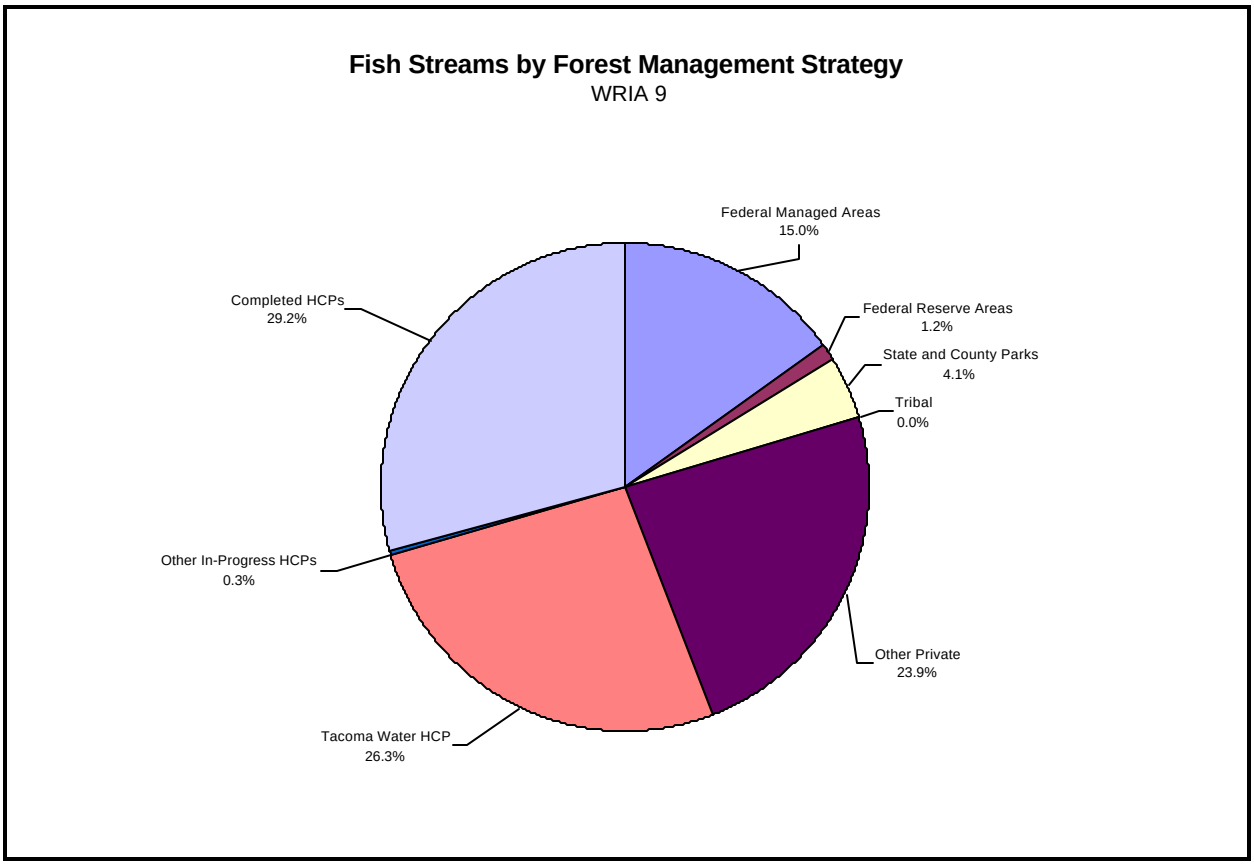

Figure 4-21. Fish Streams by Forest Management Strategy: WRIA 9.

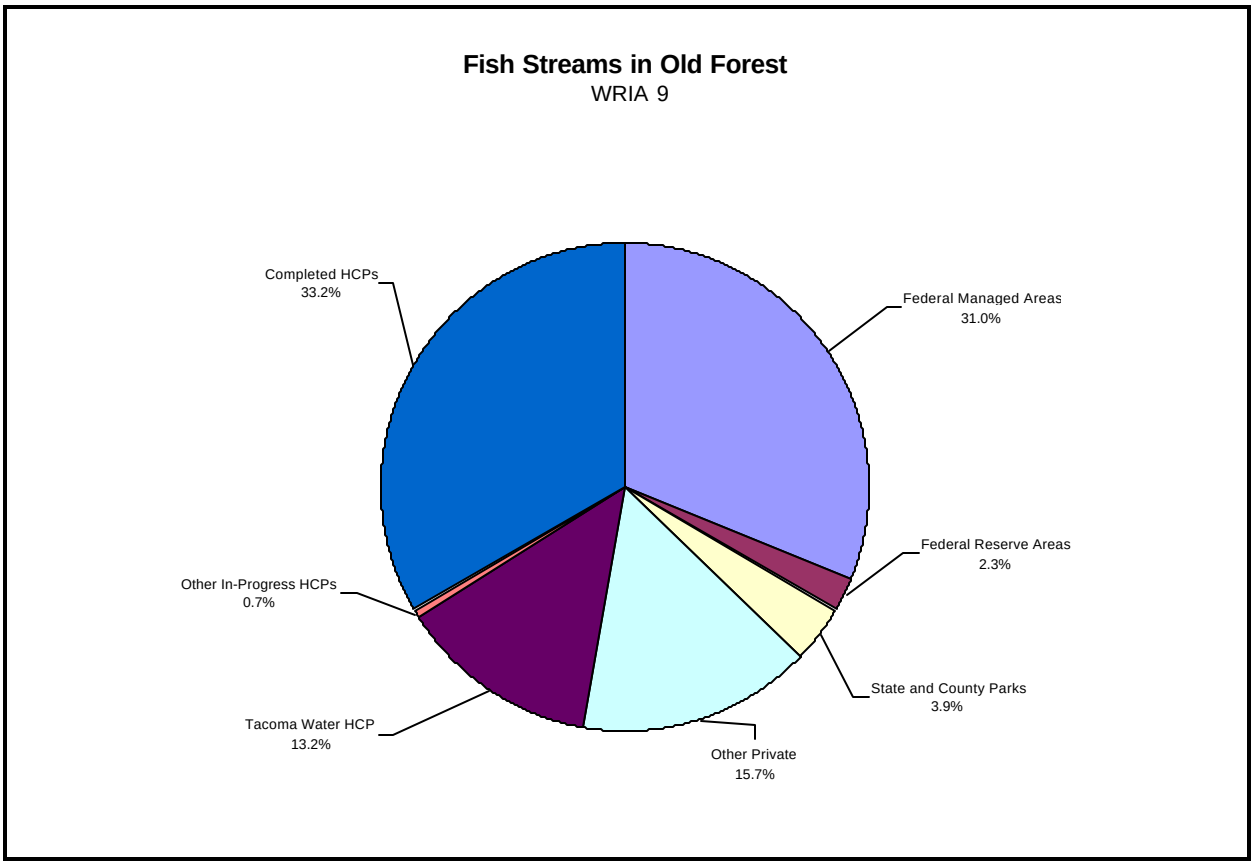

Figure 4-22. Fish Streams in Old Forest: WRIA 9.

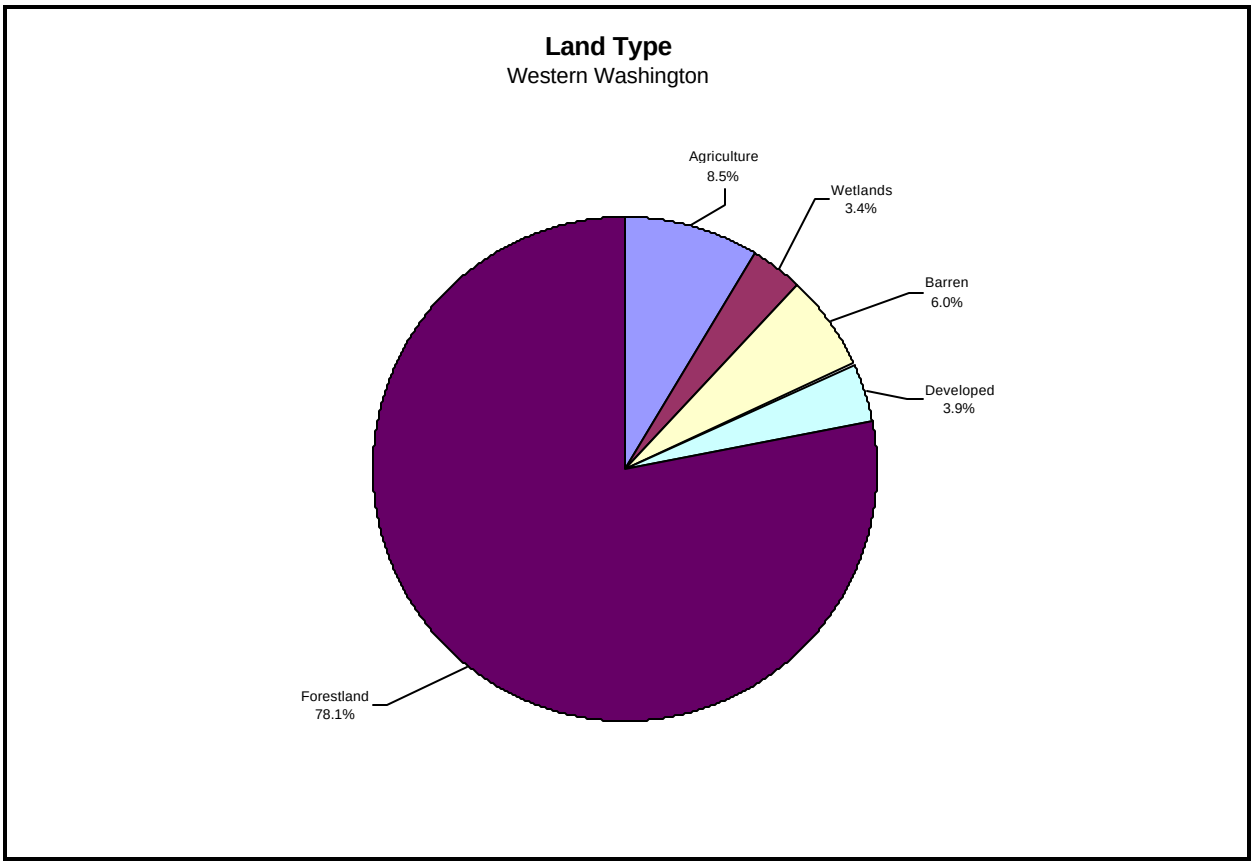

Figure 4-23. Land Type: Western Washington.

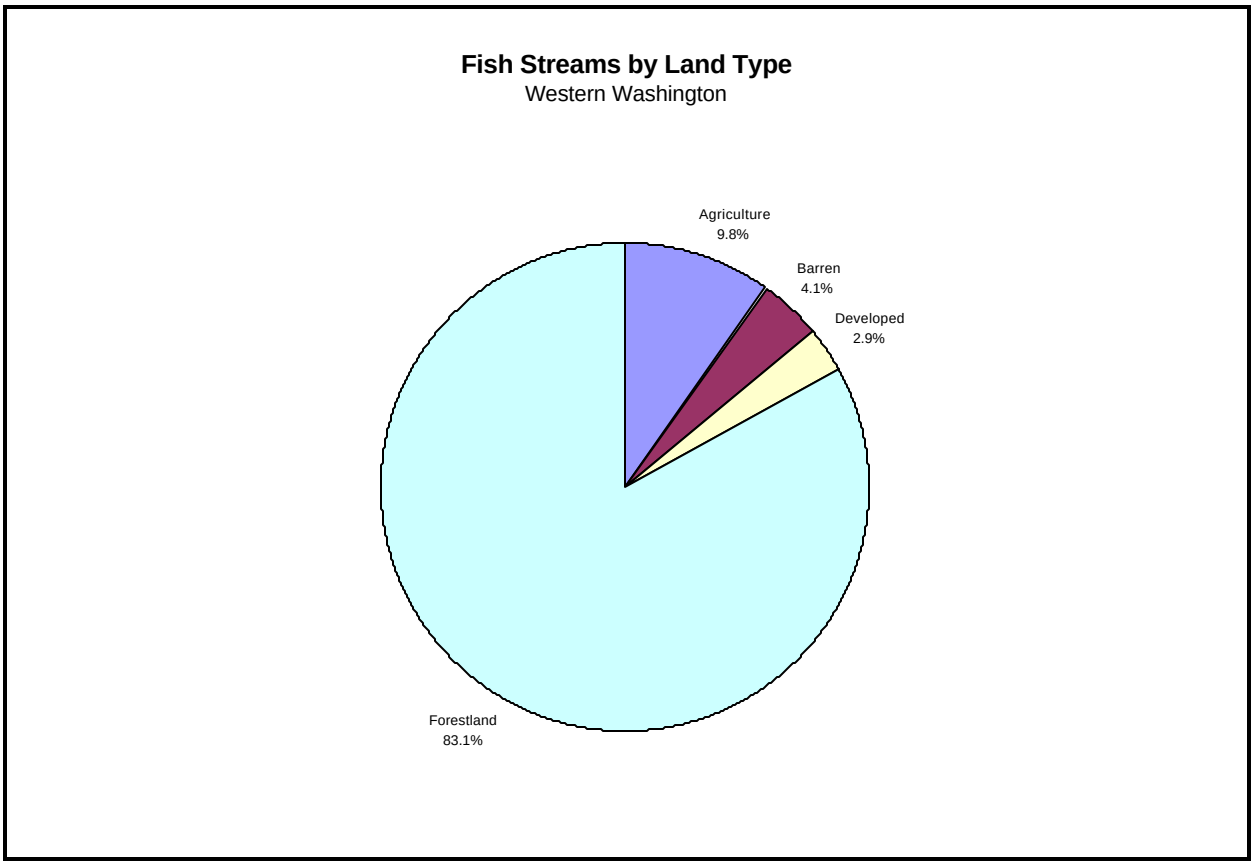

Figure 4-24. Fish Streams by Land Type: Western Washington.

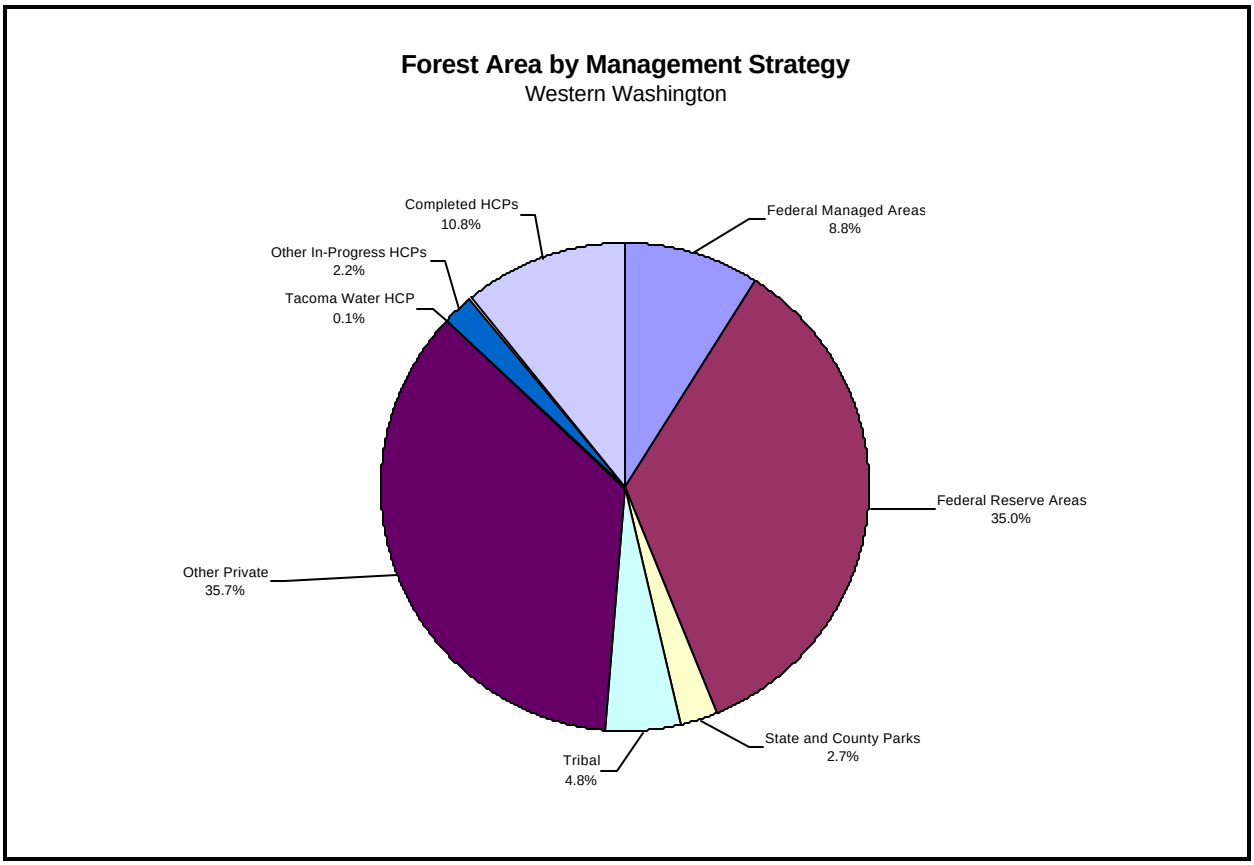

Figure 4-25. Forest Area by Management Strategy: Western Washington.

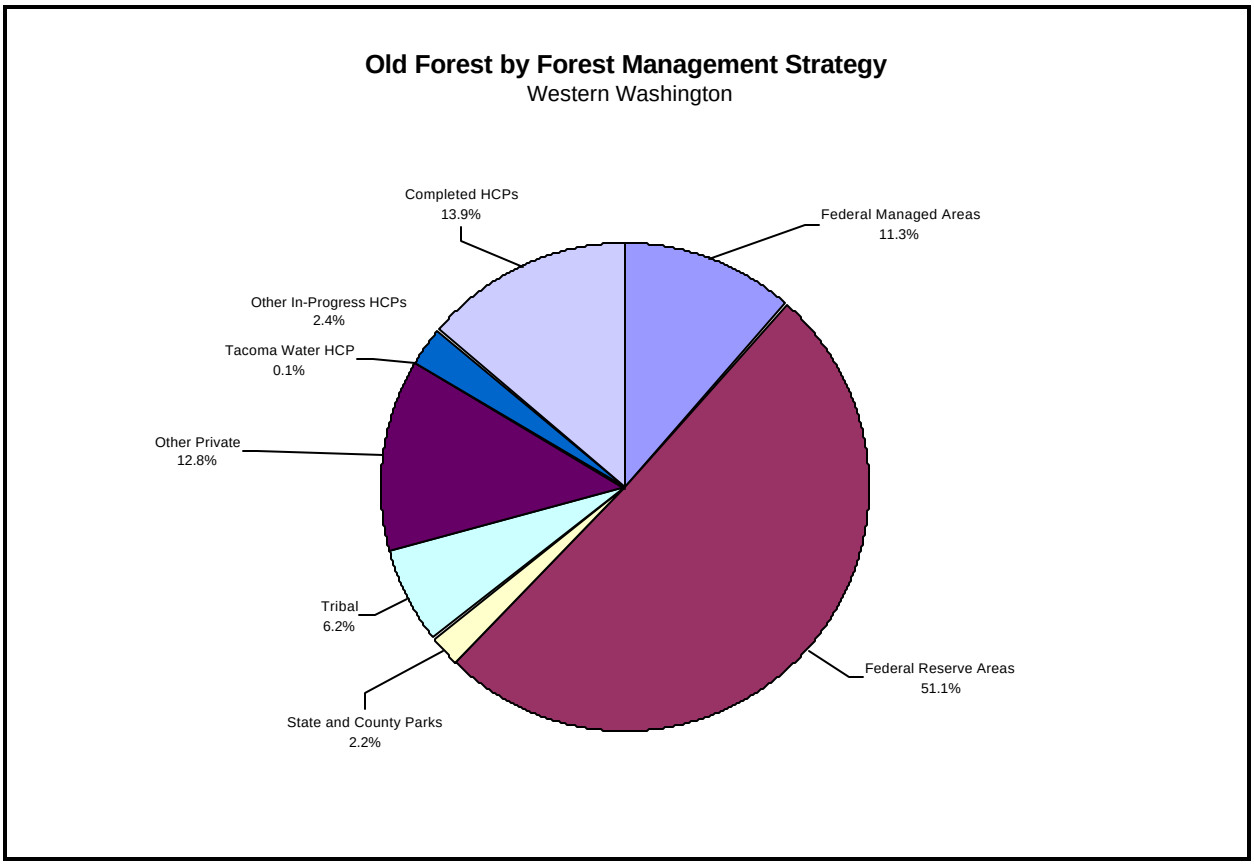

Figure 4-26. Old Forest by Forest Management Strategy: Western Washington.

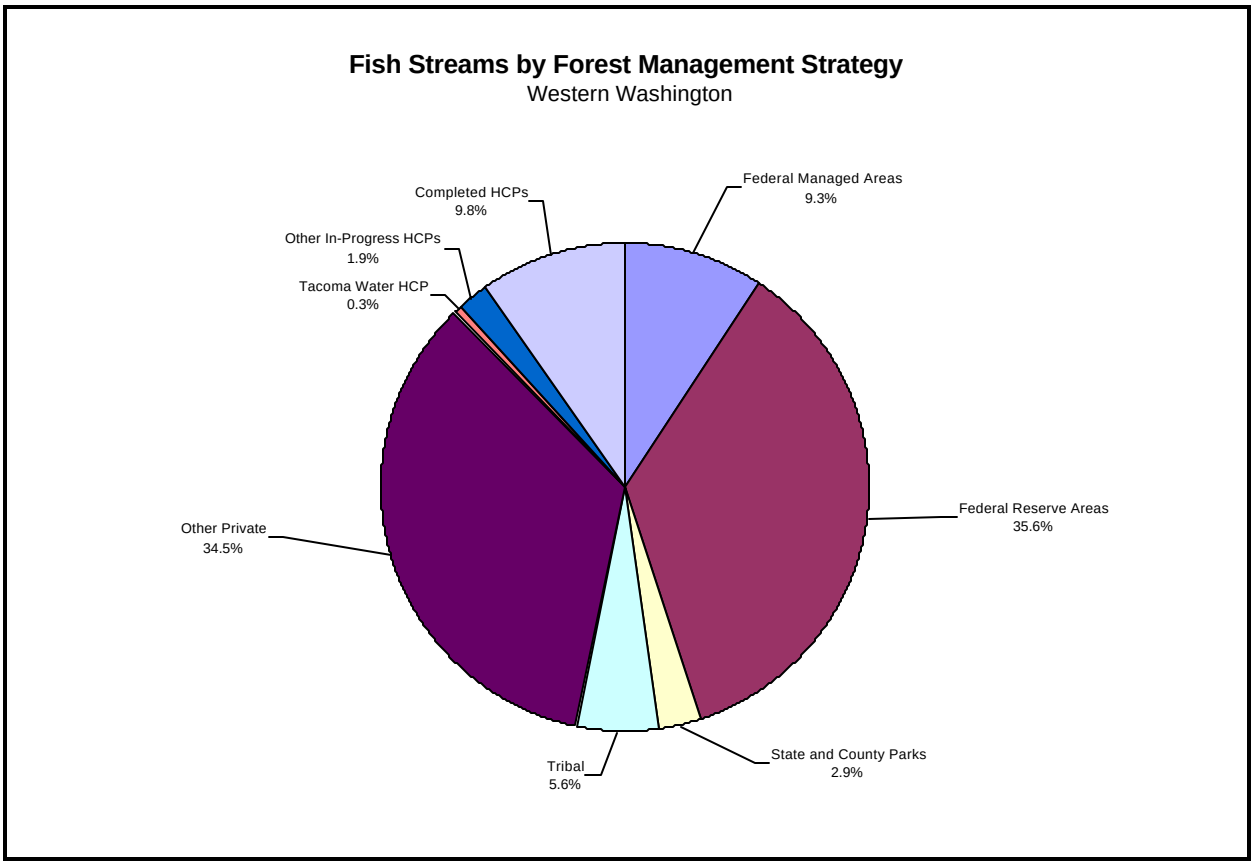

Figure 4-27. Fish Streams by Forest Management Strategy: Western Washington.

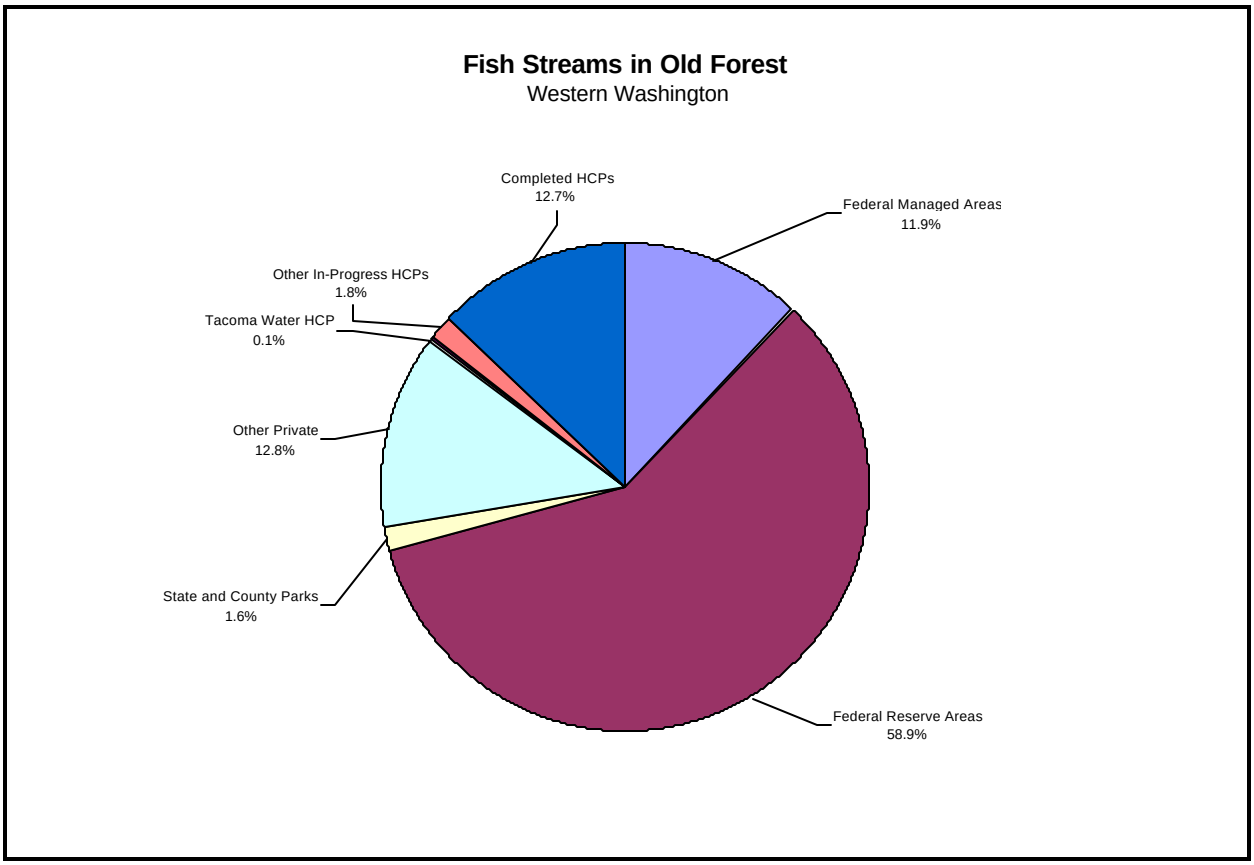

Figure 4-28. Fish Streams in Old Forest: Western Washington.

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Table B-1. Changes in survival values for outmigrating chinook salmon fry in the Green River under EIS Alternatives B and C from those predicted under the No Action Alternative, 1964-1995. Survival values were calculated based uponmethodologies provided by Wetheral (1971).

Year	Total of Daily Survival Difference from Alternative A (%)			
	Lower River		Middle River	
	Alternative B	Alternative C	Alternative B	Alternative C
1964	0.83	0.83	1.08	3.20
1965	-0.35	-0.35	-0.03	4.82
1966	0.02	0.02	0.16	4.97
1967	-0.26	-0.26	-0.10	4.48
1968	-0.20	-0.20	-0.38	5.00
1969	-0.82	-0.82	-0.90	2.11
1970	0.11	0.11	0.34	5.14
1971	-0.98	-0.98	-1.27	2.03
1972	-0.71	-0.71	-0.94	1.99
1973	-0.23	-0.23	-0.26	4.75
1974	0.33	0.33	0.56	2.44
1975	-1.12	-1.12	-1.31	2.27
1976	-1.71	-1.71	-1.57	3.05
1977	-0.75	-0.75	-0.98	4.51
1978	-1.06	-1.06	-1.00	4.54
1979	-0.42	-0.42	-0.11	4.73
1980	0.54	0.54	0.81	5.85
1981	-2.23	-2.23	-2.86	1.75
1982	-0.56	-0.56	-0.45	4.53
1983	1.78	1.78	1.83	6.75
1984	0.12	0.12	0.33	4.75
1985	0.49	0.49	0.61	4.62
1986	0.40	0.40	0.66	5.54
1987	0.14	0.14	0.29	4.68
1988	-0.09	-0.09	0.15	4.83
1989	0.49	0.49	0.41	5.17
1990	0.58	0.58	0.55	4.63
1991	0.09	0.09	0.23	5.50
1992	1.70	1.70	1.83	7.00
1993	-1.13	-1.13	-1.33	3.34
1994	3.52	3.52	3.65	8.25
1995	1.78	1.78	1.99	6.73
Mean	0.01	0.01	0.06	4.50
Minimum	-2.23	-2.23	-2.86	1.75
Maximum	3.52	3.52	3.65	8.25

Table B-2. Comparison of mainstem spawning habitat values for chinook salmon in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Spawning Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	67.0	66.1	66.1	111.3	110.4	104.9
1965	45.4	51.8	51.8	88.1	96.7	122.8
1966	44.9	52.6	52.6	78.2	89.3	106.2
1967	42.1	46.6	46.6	74.6	82.7	102.6
1968	59.4	60.5	60.5	83.3	86.9	74.8
1969	60.7	63.8	63.8	105.5	109.3	121.3
1970	50.5	56.0	56.0	88.7	97.1	113.3
1971	53.3	61.1	61.1	80.2	89.9	97.5
1972	63.8	65.4	65.4	104.8	107.0	115.8
1973	41.1	46.6	46.6	73.1	82.0	107.4
1974	48.9	56.0	56.0	85.3	93.8	117.3
1975	45.3	51.0	51.0	74.1	81.1	90.8
1976	58.2	63.9	63.9	101.3	108.6	122.6
1977	54.6	53.1	53.1	90.7	88.8	99.4
1978	66.2	66.0	66.0	105.9	106.4	111.3
1979	37.6	43.1	43.1	75.3	82.0	117.3
1980	47.2	55.8	55.8	80.2	91.2	106.2
1981	65.2	65.2	65.2	109.2	109.3	121.2
1982	56.5	63.4	63.4	96.1	105.4	115.0
1983	44.9	53.4	53.4	73.6	84.5	98.1
1984	60.1	64.8	64.8	97.5	105.9	112.0
1985	36.2	44.6	44.6	65.4	78.6	96.6
1986	41.4	48.1	48.1	76.3	86.0	106.5
1987	21.0	27.0	27.0	51.9	64.3	105.3
1988	37.8	44.5	44.5	64.4	72.5	87.9
1989	27.9	34.3	34.8	50.9	64.9	96.0
1990	31.9	43.2	43.2	54.5	68.3	79.8
1991	27.5	34.4	34.4	53.1	67.7	98.6
1992	54.3	56.0	56.0	85.4	89.7	101.7
1993	33.6	49.0	49.0	70.2	89.3	120.7
1994	37.3	41.0	41.0	67.4	76.5	98.6
1995	36.7	41.5	41.6	58.8	69.5	80.4
Mean	46.8	52.2	52.2	80.5	88.6	104.7
Minimum	21.0	27.0	27.0	50.9	64.3	74.8
Maximum	67.0	66.1	66.1	111.3	110.4	122.8

Table B-3. Comparison of side channel habitat area among EIS Alternatives during the chinook salmon spawning period (September through November) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	11.3	10.4	12.7
1965	5.2	5.3	7.3
1966	7.6	7.5	9.5
1967	7.7	7.6	9.6
1968	13.6	12.9	14.9
1969	6.8	6.5	8.5
1970	7.2	7.1	9.1
1971	9.5	9.3	11.3
1972	7.6	7.3	9.2
1973	6.7	6.8	8.7
1974	5.6	5.8	7.6
1975	12.3	12.1	14.0
1976	6.5	6.4	8.4
1977	12.1	11.5	13.6
1978	8.7	8.2	10.2
1979	4.2	4.4	6.2
1980	8.2	8.3	10.2
1981	7.0	6.7	8.6
1982	7.3	7.2	9.2
1983	9.7	9.8	11.7
1984	7.6	7.4	9.4
1985	10.2	10.3	12.2
1986	9.8	9.9	11.8
1987	3.3	3.7	5.4
1988	11.0	10.8	12.7
1989	7.6	7.8	9.6
1990	16.7	16.8	18.6
1991	5.8	6.1	7.8
1992	8.4	8.1	10.0
1993	4.2	4.8	6.6
1994	8.2	8.1	10.1
1995	14.5	14.4	16.2
Mean	8.5	8.4	10.3
Minimum	3.3	3.7	5.4
Maximum	16.7	16.8	18.6

Table B-4. Comparison of mainstem spawnable widths and dewatered widths during the chinook salmon spawning period in the middle Green River among EIS Alternatives, 1964-1995. Spawnable width and dewatered width values were calculated from transect cross-section and stage-discharge data collected by Ecology during its instream flow study (Caldwell and Hirschey 1989).

Year	Spawnable Width (ft)			Dewatered Width (ft)		
	Alternative A	**Alternative B**	**Alternative C**	**Alternative A**	**Alternative B**	**Alternative C**
1964	137.0	136.3	138.1	7.5	7.9	7.2
1965	132.1	132.2	134.0	0.0	0.0	0.0
1966	133.9	133.9	135.7	2.7	2.4	2.6
1967	134.0	133.9	135.7	3.8	4.0	3.9
1968	138.8	138.2	139.8	2.9	3.0	2.7
1969	133.4	133.2	134.9	1.0	1.0	0.8
1970	133.6	133.6	135.4	4.6	5.1	4.9
1971	135.4	135.4	137.0	5.0	5.3	4.7
1972	134.1	133.8	135.5	2.4	2.4	1.9
1973	133.1	133.1	134.9	1.7	1.9	1.6
1974	132.4	132.6	134.3	1.9	2.1	1.6
1975	137.2	137.2	138.7	5.4	5.7	5.3
1976	133.1	133.1	134.9	0.4	0.2	0.1
1977	137.1	136.6	138.4	9.0	9.8	9.2
1978	135.0	134.6	136.3	3.4	3.0	2.9
1979	131.1	131.3	133.0	0.0	0.0	0.0
1980	132.8	133.0	134.6	4.4	3.9	3.9
1981	133.6	133.4	135.0	1.8	1.2	1.3
1982	133.8	133.7	135.5	1.9	1.8	1.7
1983	135.4	135.5	137.2	4.0	3.7	3.6
1984	134.2	134.1	135.7	0.7	0.5	0.7
1985	135.7	135.9	137.5	7.4	7.3	7.0
1986	135.1	135.3	137.0	12.1	12.6	12.4
1987	130.1	130.6	132.3	0.0	0.0	0.0
1988	136.4	136.4	138.0	3.7	4.1	3.6
1989	133.6	133.9	135.6	4.1	4.7	4.0
1990	139.9	140.1	141.5	9.6	9.8	9.3
1991	132.2	132.5	134.1	5.3	5.6	5.5
1992	134.7	134.4	136.2	2.6	2.2	2.2
1993	131.0	131.7	133.4	4.2	3.7	3.7
1994	134.3	134.3	136.0	8.0	7.5	7.7
1995	138.7	138.7	140.2	9.2	9.2	8.7
Mean	134.5	134.5	136.1	4.1	4.1	3.9
Minimum	130.1	130.6	132.3	0.0	0.0	0.0
Maximum	139.9	140.1	141.5	12.1	12.6	12.4

Table B-5. Comparison of continuously wetted side channel area (i.e., two-day low flow event) among EIS Alternatives during the chinook salmon incubation period (November through mid-February) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Continuously Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	-	-	-
1965	7.2	6.3	8.3
1966	3.4	5.0	6.1
1967	6.6	5.8	7.7
1968	7.4	6.5	8.5
1969	9.0	8.3	10.0
1970	5.2	5.2	6.3
1971	6.0	6.0	7.1
1972	11.7	10.9	12.6
1973	5.9	5.8	7.1
1974	6.1	6.1	7.2
1975	4.2	4.6	5.8
1976	13.1	12.3	13.9
1977	6.1	6.0	7.2
1978	9.0	8.2	10.0
1979	5.6	5.6	6.7
1980	3.7	4.3	5.6
1981	3.8	4.9	6.1
1982	5.9	5.9	7.0
1983	6.8	6.6	7.9
1984	4.6	5.6	6.9
1985	6.4	6.3	7.5
1986	6.7	6.6	7.8
1987	6.1	5.8	7.2
1988	2.8	3.5	4.3
1989	9.5	8.6	9.8
1990	3.0	3.8	5.1
1991	8.4	8.2	9.4
1992	2.7	3.4	4.2
1993	6.0	6.0	7.1
1994	3.3	4.7	5.9
1995	9.4	8.5	10.4
Mean	6.3	6.3	7.6
Minimum	2.7	3.4	4.2
Maximum	13.1	12.3	13.9

Table B-6. Comparison of mainstem juvenile rearing habitat values for chinook salmon in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Juvenile Rearing Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	17.8	19.5	19.5	23.3	24.4	23.6
1965	25.3	28.7	28.7	25.8	28.2	26.2
1966	29.6	33.7	33.7	27.2	30.1	27.0
1967	26.2	30.6	30.6	26.7	30.1	27.6
1968	28.7	31.6	31.6	27.5	29.8	27.0
1969	25.0	28.2	28.2	27.4	29.3	26.9
1970	25.9	29.7	29.7	26.0	28.6	26.3
1971	17.5	19.5	19.5	23.4	25.0	24.0
1972	16.3	17.2	17.2	22.8	23.3	22.7
1973	43.9	47.7	47.7	34.4	37.3	32.9
1974	15.0	15.8	15.8	22.6	23.4	22.9
1975	21.3	24.2	24.2	25.1	27.2	25.3
1976	23.7	28.4	28.4	25.2	28.4	26.0
1977	40.1	43.8	43.8	31.9	34.4	30.7
1978	37.1	41.5	41.5	31.4	34.4	30.6
1979	28.5	31.4	31.4	27.2	29.1	27.0
1980	29.7	32.1	32.1	28.5	30.4	27.7
1981	28.9	31.3	31.3	28.6	30.3	28.0
1982	23.9	27.3	27.3	25.5	28.1	26.0
1983	37.2	39.5	39.5	31.6	33.5	30.1
1984	19.0	21.2	21.2	23.9	25.5	24.2
1985	31.0	34.3	34.3	28.2	30.5	28.0
1986	32.2	34.6	34.6	29.3	30.7	28.1
1987	32.4	34.3	34.3	29.1	30.6	28.3
1988	25.2	27.7	27.7	25.8	27.2	25.2
1989	29.5	31.4	31.4	28.7	30.4	27.7
1990	19.3	20.3	20.3	23.7	24.3	23.2
1991	23.3	25.7	25.7	25.8	27.8	25.5
1992	49.4	50.5	50.5	37.1	38.5	35.6
1993	25.5	28.6	28.6	26.0	27.8	25.6
1994	38.9	39.4	39.4	31.8	32.5	29.4
1995	35.9	38.1	38.1	31.0	33.1	30.4
Mean	28.2	30.9	30.9	27.6	29.5	27.2
Minimum	15.0	15.8	15.8	22.6	23.3	22.7
Maximum	49.4	50.5	50.5	37.1	38.5	35.6

Table B-7. Comparison of wetted side channel areas among EIS Alternatives during the rearing period (mid-February through June) of the chinook salmon fry in the middle Green River, 1964-1994. Surface area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	10.3	8.8	9.7
1965	5.5	5.4	6.9
1966	8.0	6.6	8.5
1967	7.1	5.7	6.8
1968	6.9	6.7	8.0
1969	7.9	6.6	8.3
1970	6.1	6.0	7.7
1971	10.7	9.7	10.7
1972	11.3	10.0	11.7
1973	5.3	5.9	7.3
1974	12.5	11.2	12.2
1975	10.0	8.0	9.7
1976	7.9	6.7	8.9
1977	5.2	5.0	6.2
1978	5.5	5.5	6.6
1979	5.8	4.8	6.1
1980	6.5	5.7	6.8
1981	6.5	6.5	7.6
1982	6.4	6.2	7.5
1983	4.1	5.5	6.6
1984	10.2	8.9	9.9
1985	5.5	5.5	7.1
1986	4.1	4.8	6.1
1987	4.0	4.0	5.5
1988	5.8	5.8	7.0
1989	5.3	5.2	6.6
1990	8.9	7.8	10.2
1991	7.5	6.9	9.1
1992	3.6	3.7	5.1
1993	6.8	6.8	7.9
1994	3.6	5.1	6.3
1995	3.9	4.8	6.0
Mean	6.8	6.4	7.8
Minimum	3.6	3.7	5.1
Maximum	12.5	11.2	12.2

Table B-8. Changes in survival values for outmigrating coho salmon fry in the Green River under EIS Alternatives B and C from those predicted under the No Action Alternative, 1964-1995. Survival values were calculated based upon methodologies provided by Wetheral (1971).

Year	Total of Daily Survival Difference from Alternative A (%)			
	Lower River		Middle River	
	Alternative B	Alternative C	Alternative B	Alternative C
1964	1.74	1.74	2.42	4.33
1965	1.15	1.15	3.32	8.10
1966	0.67	0.67	2.68	7.59
1967	1.19	1.19	3.22	7.59
1968	0.72	0.72	1.03	6.46
1969	0.49	0.49	1.70	4.51
1970	1.32	1.32	3.04	7.80
1971	-0.29	-0.29	0.45	3.46
1972	-0.34	-0.34	0.26	3.02
1973	0.01	0.01	0.06	5.01
1974	0.84	0.84	1.86	3.61
1975	-0.50	-0.50	0.00	3.25
1976	-0.78	-0.78	1.36	5.92
1977	-0.04	-0.04	-0.12	5.47
1978	0.49	0.49	0.97	6.46
1979	0.74	0.74	3.10	7.94
1980	1.71	1.71	4.49	9.62
1981	-2.27	-2.27	-3.13	1.44
1982	0.80	0.80	2.76	7.58
1983	3.26	3.26	4.84	9.74
1984	0.94	0.94	2.79	7.18
1985	1.75	1.75	3.43	7.48
1986	1.37	1.37	2.24	7.04
1987	1.34	1.34	3.50	7.88
1988	0.31	0.31	2.38	7.28
1989	1.14	1.14	2.41	7.35
1990	1.42	1.42	3.18	7.41
1991	0.83	0.83	1.48	6.78
1992	2.06	2.06	2.24	7.41
1993	-0.44	-0.44	1.57	6.24
1994	5.07	5.07	6.06	10.74
1995	3.49	3.49	5.49	10.17
Mean	0.94	0.94	2.22	6.62
Minimum	-2.27	-2.27	-3.13	1.44
Maximum	5.07	5.07	6.06	10.74

Table B-9. Comparison of mainstem spawning habitat values for coho salmon in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Spawning Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	41.5	45.2	45.2	59.7	65.6	51.8
1965	65.2	67.9	67.9	83.5	89.1	78.1
1966	43.8	46.5	46.5	61.9	66.2	60.1
1967	50.2	53.4	53.4	65.6	71.1	64.2
1968	26.9	30.4	30.4	46.2	50.1	41.5
1969	61.0	64.2	64.2	80.8	85.8	70.5
1970	54.2	57.8	57.8	73.2	78.3	66.9
1971	39.9	41.9	41.9	56.7	60.7	53.4
1972	51.9	54.4	54.4	72.1	76.4	63.5
1973	47.4	49.6	49.6	66.5	70.3	65.7
1974	56.4	58.2	58.2	75.7	79.0	72.2
1975	32.4	33.9	33.9	54.5	56.7	52.6
1976	65.9	70.2	70.2	82.5	89.6	74.9
1977	41.6	44.0	44.0	64.0	67.3	57.0
1978	51.2	54.3	54.3	70.1	73.9	60.9
1979	59.7	61.3	61.3	79.7	82.6	80.0
1980	44.3	46.8	46.8	65.3	69.5	62.5
1981	54.5	57.0	57.0	76.0	79.6	67.0
1982	51.1	54.9	54.9	71.7	77.1	64.1
1983	44.4	46.5	46.5	64.1	68.7	61.0
1984	55.1	58.5	58.5	74.1	79.4	66.6
1985	55.0	59.0	59.0	74.8	80.9	71.8
1986	52.2	56.3	56.3	72.5	78.2	67.7
1987	72.7	74.8	74.8	86.2	93.0	96.4
1988	36.2	38.4	38.4	55.3	58.4	53.6
1989	46.9	50.0	50.0	63.3	69.1	67.9
1990	32.0	33.9	33.9	53.3	56.5	52.2
1991	54.1	57.4	57.4	67.3	75.5	75.1
1992	53.1	56.6	56.6	69.4	74.0	61.3
1993	63.8	66.2	66.2	81.7	86.8	81.6
1994	43.9	46.4	46.4	61.4	66.0	62.5
1995	33.7	36.0	36.0	50.8	55.8	52.0
Mean	49.4	52.2	52.2	68.1	72.9	64.9
Minimum	26.9	30.4	30.4	46.2	50.1	41.5
Maximum	72.7	74.8	74.8	86.2	93.0	96.4

Table B-10. Comparison of side channel habitat area among EIS Alternatives during the coho salmon spawning period (September through January) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	14.2	13.4	15.3
1965	7.7	7.6	9.3
1966	13.9	13.6	15.3
1967	11.7	11.2	13.0
1968	16.6	15.9	17.7
1969	8.8	8.3	10.1
1970	10.2	9.8	11.6
1971	13.3	13.0	14.7
1972	13.3	12.8	14.6
1973	11.9	11.6	13.3
1974	10.5	10.3	12.0
1975	20.3	20.1	21.6
1976	7.8	7.4	9.3
1977	17.7	17.0	18.8
1978	11.0	10.4	12.2
1979	9.6	9.5	11.1
1980	13.4	13.3	14.9
1981	10.2	9.7	11.4
1982	12.1	11.7	13.5
1983	13.1	13.0	14.6
1984	9.2	8.8	10.6
1985	10.4	10.2	11.9
1986	11.3	11.0	12.8
1987	5.1	5.3	6.9
1988	14.5	14.1	15.8
1989	12.9	12.7	14.4
1990	19.2	18.9	20.5
1991	9.9	9.8	11.4
1992	10.0	9.4	11.3
1993	7.9	8.0	9.7
1994	12.7	12.4	14.1
1995	18.9	18.5	20.1
Mean	12.2	11.8	13.6
Minimum	5.1	5.3	6.9
Maximum	20.3	20.1	21.6

Table B-11. Comparison of mainstem spawnable widths and dewatered widths during the coho salmon spawning period in the middle Green River among EIS Alternatives, 1964-1995. Spawnable width and dewatered width values were calculated from transect cross-section and stage-discharge data collected by Ecology during its instream flow study (Caldwell and Hirschey 1989).

Year	Spawnable Width (ft)			Dewatered Width (ft)		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	138.9	138.3	139.8	5.8	6.0	5.5
1965	134.1	133.9	135.5	2.1	2.0	2.0
1966	138.4	138.2	139.6	6.2	6.1	6.3
1967	137.0	136.7	138.2	6.0	6.0	5.8
1968	140.6	140.0	141.4	4.5	4.4	4.2
1969	134.9	134.5	136.1	1.2	1.4	1.0
1970	135.9	135.7	137.2	4.2	4.2	4.3
1971	138.2	138.0	139.4	3.5	3.5	3.4
1972	138.0	137.7	139.1	7.4	9.1	8.4
1973	136.8	136.6	138.1	4.5	4.3	4.5
1974	136.0	135.9	137.3	5.1	5.7	5.2
1975	142.6	142.5	143.7	8.5	9.1	8.9
1976	134.2	134.0	135.6	3.4	3.2	3.4
1977	140.8	140.3	141.7	11.7	12.3	11.9
1978	136.7	136.3	137.7	3.8	3.6	3.5
1979	135.1	135.0	136.4	6.4	6.2	6.3
1980	138.0	138.0	139.3	6.8	6.5	6.3
1981	135.9	135.6	137.0	3.5	3.7	3.6
1982	137.0	136.7	138.2	5.5	6.2	6.0
1983	137.8	137.8	139.2	4.9	4.9	4.9
1984	135.3	135.0	136.5	1.4	1.4	1.4
1985	135.9	135.8	137.3	7.4	7.3	7.0
1986	136.4	136.2	137.7	7.5	8.8	7.6
1987	131.6	131.9	133.3	4.4	5.2	4.4
1988	139.2	138.9	140.2	3.6	3.9	3.7
1989	137.5	137.4	138.9	6.2	6.7	6.3
1990	141.9	141.7	143.0	8.3	8.6	8.2
1991	135.5	135.5	136.9	6.8	7.1	6.9
1992	136.1	135.6	137.1	2.2	1.9	1.8
1993	134.1	134.3	135.7	3.9	4.0	3.7
1994	137.7	137.5	138.9	6.9	6.4	6.7
1995	141.9	141.6	142.9	8.5	8.4	8.1
Mean	137.2	137.0	138.4	5.4	5.6	5.4
Minimum	131.6	131.9	133.3	1.2	1.4	1.0
Maximum	142.6	142.5	143.7	11.7	12.3	11.9

Table B-12. Comparison of continuously wetted side channel area (i.e., two-day low flow event) among EIS Alternatives during the coho salmon incubation period (December through mid-April) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Continuously Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	-	-	-
1965	10.1	8.3	9.3
1966	6.3	6.1	7.4
1967	10.2	8.3	9.3
1968	7.4	6.5	8.3
1969	7.9	7.7	8.7
1970	6.5	6.3	7.6
1971	8.1	7.9	9.1
1972	11.7	10.9	12.6
1973	5.3	6.2	7.9
1974	9.6	8.7	10.4
1975	7.3	6.7	8.3
1976	10.4	8.3	9.3
1977	6.6	6.1	7.7
1978	8.6	8.2	9.3
1979	6.2	6.2	7.3
1980	7.8	7.4	8.8
1981	3.9	3.9	6.1
1982	8.1	8.0	9.1
1983	6.8	6.8	7.9
1984	4.6	5.6	6.9
1985	6.4	6.3	7.5
1986	6.7	6.6	7.8
1987	7.6	7.6	8.6
1988	3.6	3.7	5.0
1989	9.3	8.5	9.6
1990	8.9	8.0	9.9
1991	8.4	8.2	9.4
1992	4.8	6.6	8.0
1993	6.0	6.0	7.1
1994	5.9	5.9	7.0
1995	9.5	8.3	9.3
Mean	7.4	7.1	8.4
Minimum	3.6	3.7	5.0
Maximum	11.7	10.9	12.6

Table B-13. Comparison of mainstem juvenile rearing habitat values for coho salmon in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Juvenile Rearing Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	28.7	31.5	31.5	27.5	29.2	25.7
1965	44.3	46.3	46.3	34.4	35.9	31.8
1966	40.6	43.0	43.0	32.5	34.2	30.0
1967	40.2	42.5	42.5	32.6	34.3	30.9
1968	34.0	36.2	36.2	29.9	31.4	27.8
1969	40.4	42.7	42.7	33.6	35.2	30.6
1970	42.0	44.1	44.1	33.4	34.9	31.1
1971	31.6	33.1	33.1	29.2	30.4	27.3
1972	33.2	34.9	34.9	29.7	30.7	27.2
1973	47.8	49.7	49.7	36.2	37.7	33.3
1974	35.0	36.1	36.1	30.8	31.7	28.7
1975	33.2	34.8	34.8	30.2	31.4	28.0
1976	39.8	43.0	43.0	32.2	34.2	29.6
1977	45.2	47.9	47.9	34.4	36.1	31.5
1978	43.7	46.6	46.6	34.4	36.3	31.5
1979	47.5	48.7	48.7	35.9	36.9	33.4
1980	41.6	42.9	42.9	33.9	35.0	30.9
1981	40.8	42.9	42.9	34.0	35.5	31.1
1982	39.9	41.9	41.9	32.6	34.2	30.0
1983	41.8	43.5	43.5	33.7	35.1	30.5
1984	35.3	37.1	37.1	30.9	32.1	28.7
1985	45.3	47.3	47.3	35.1	36.6	32.4
1986	44.6	46.0	46.0	34.7	35.7	31.6
1987	50.9	52.3	52.3	37.5	38.7	35.4
1988	40.2	41.5	41.5	32.5	33.5	30.0
1989	42.2	43.7	43.7	34.0	35.2	31.8
1990	32.9	33.3	33.3	29.9	30.3	27.5
1991	40.4	42.2	42.2	33.0	34.5	31.2
1992	50.6	52.1	52.1	37.1	38.2	34.6
1993	43.8	46.1	46.1	34.2	35.7	31.1
1994	45.2	45.9	45.9	34.6	35.3	31.7
1995	41.0	42.8	42.8	33.2	34.6	31.4
Mean	40.7	42.6	42.6	33.1	34.4	30.6
Minimum	28.7	31.5	31.5	27.5	29.2	25.7
Maximum	50.9	52.3	52.3	37.5	38.7	35.4

Table B-14. Comparison of wetted side channel areas among EIS Alternatives during the rearing period (year-round) of the coho salmon juveniles in the middle Green River, 1964-1994. Surface area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	15.3	14.5	16.2
1965	11.3	11.0	12.5
1966	11.1	10.7	12.3
1967	12.3	11.9	13.4
1968	13.0	12.5	14.1
1969	11.2	10.8	12.3
1970	10.8	10.4	11.9
1971	14.7	14.2	15.8
1972	16.4	15.8	17.3
1973	9.3	9.0	10.5
1974	15.0	14.5	16.0
1975	15.8	15.4	16.9
1976	11.7	11.2	12.9
1977	11.4	10.9	12.5
1978	9.7	9.1	10.7
1979	10.2	10.0	11.4
1980	11.4	11.1	12.6
1981	10.9	10.4	11.9
1982	12.5	12.1	13.6
1983	11.0	10.6	12.1
1984	12.8	12.3	13.8
1985	10.0	9.7	11.3
1986	10.7	10.4	12.0
1987	8.4	8.2	9.7
1988	12.0	11.6	13.2
1989	11.4	11.1	12.7
1990	15.6	15.3	16.7
1991	12.3	12.0	13.5
1992	8.6	8.3	9.8
1993	10.1	9.7	11.3
1994	10.4	10.2	11.7
1995	12.7	12.4	13.8
Mean	11.9	11.5	13.0
Minimum	8.4	8.2	9.7
Maximum	16.4	15.8	17.3

Table B-15. Changes in survival values for outmigrating chum salmon fry in the Green River under EIS Alternatives B and C from those predicted under the No Action Alternative, 1964-1995. Survival values were calculated based upon methodologies provided by Wetheral (1971).

Year	Total of Daily Survival Difference from Alternative A (%)			
	Lower River		Middle River	
	Alternative B	Alternative C	Alternative B	Alternative C
1964	-2.54	-2.54	-3.48	-0.19
1965	-3.91	-3.91	-4.87	-1.02
1966	-1.59	-1.59	-2.25	1.09
1967	-4.90	-4.90	-6.19	-1.62
1968	-2.49	-2.49	-3.33	0.91
1969	-3.96	-3.96	-5.04	-1.93
1970	-3.20	-3.20	-4.07	0.01
1971	-3.22	-3.22	-5.11	-1.51
1972	-0.83	-0.83	-1.96	0.37
1973	-1.59	-1.59	-1.99	2.99
1974	-1.76	-1.76	-3.74	-0.89
1975	-2.63	-2.63	-3.85	0.23
1976	-4.08	-4.08	-5.25	-1.62
1977	-3.37	-3.37	-4.13	0.27
1978	-6.13	-6.13	-7.04	-2.36
1979	-2.93	-2.93	-3.92	-0.20
1980	-2.61	-2.61	-3.91	-0.19
1981	-1.77	-1.77	-2.24	2.00
1982	-3.38	-3.38	-4.89	-0.68
1983	-3.37	-3.37	-4.87	-0.37
1984	-2.24	-2.24	-3.51	0.31
1985	-2.55	-2.55	-2.93	0.32
1986	-1.82	-1.82	-2.44	1.64
1987	-3.10	-3.10	-4.27	-0.52
1988	-0.94	-0.94	-1.41	1.37
1989	-1.61	-1.61	-3.27	-0.01
1990	-1.64	-1.64	-2.82	0.32
1991	-1.19	-1.19	-2.48	1.34
1992	0.04	0.04	-0.28	4.64
1993	-2.97	-2.97	-4.12	-0.55
1994	-2.15	-2.15	-3.22	0.74
1995	-4.25	-4.25	-5.71	-1.12
Mean	-2.65	-2.65	-3.71	0.12
Minimum	-6.13	-6.13	-7.04	-2.36
Maximum	0.04	0.04	-0.28	4.64

Table B-16. Comparison of mainstem spawning habitat values for chum salmon in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Spawning Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	35.9	38.2	38.2	61.4	67.5	54.8
1965	58.4	59.4	59.4	93.3	99.2	83.3
1966	29.5	31.6	31.6	52.1	55.8	48.1
1967	46.4	48.9	48.9	65.6	72.8	57.6
1968	25.1	27.7	27.7	48.7	53.0	44.4
1969	56.8	58.8	58.8	89.3	95.8	79.1
1970	47.4	50.2	50.2	71.8	78.2	63.6
1971	21.9	25.1	25.1	39.5	42.1	37.6
1972	43.0	44.8	44.8	70.2	75.8	63.2
1973	32.7	35.7	35.7	55.8	60.7	50.7
1974	40.4	42.0	42.0	70.3	74.6	66.0
1975	11.3	12.4	12.4	36.1	36.8	35.7
1976	63.6	64.7	64.7	91.5	100.8	79.8
1977	26.9	29.8	29.8	48.4	52.6	44.3
1978	43.6	46.3	46.3	64.4	70.1	57.3
1979	46.6	48.3	48.3	79.6	85.2	78.2
1980	26.8	29.3	29.3	49.2	53.7	45.6
1981	49.4	51.9	51.9	78.2	84.1	69.0
1982	44.3	46.7	46.7	68.1	75.0	60.2
1983	26.1	29.0	29.0	47.9	52.3	45.0
1984	53.1	57.5	57.5	70.7	79.0	61.3
1985	56.4	58.0	58.0	87.8	94.6	77.4
1986	46.6	49.8	49.8	66.9	75.1	58.5
1987	61.4	64.5	64.5	95.7	104.4	109.1
1988	18.1	20.3	20.3	39.6	41.5	37.8
1989	32.9	35.8	35.8	52.6	57.6	50.1
1990	19.2	21.0	21.0	43.7	46.2	41.2
1991	44.2	46.7	46.7	67.5	74.2	64.1
1992	47.4	51.1	51.1	62.6	69.1	55.7
1993	50.1	51.8	51.8	84.9	91.1	83.5
1994	35.5	39.6	39.6	49.4	55.3	44.3
1995	18.7	20.3	20.3	41.9	44.0	39.9
Mean	39.4	41.8	41.8	63.9	69.3	59.0
Minimum	11.3	12.4	12.4	36.1	36.8	35.7
Maximum	63.6	64.7	64.7	95.7	104.4	109.1

Table B-17. Comparison of side channel habitat area among EIS Alternatives during the chum salmon spawning period (November through January) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	16.8	16.1	17.6
1965	9.9	9.3	10.9
1966	18.9	18.2	19.6
1967	14.6	13.8	15.4
1968	18.9	18.2	19.7
1969	10.1	9.4	11.0
1970	13.1	12.4	14.0
1971	17.7	17.0	18.4
1972	17.2	16.5	18.0
1973	16.6	15.9	17.4
1974	14.3	13.8	15.3
1975	28.0	27.4	28.7
1976	9.5	8.7	10.4
1977	24.3	23.6	25.0
1978	13.5	12.8	14.4
1979	13.0	12.8	14.1
1980	19.0	18.3	19.8
1981	12.2	11.6	13.1
1982	15.8	15.1	16.7
1983	18.3	17.6	19.1
1984	11.6	10.8	12.5
1985	11.9	11.3	12.8
1986	15.4	14.6	16.2
1987	6.2	6.3	7.6
1988	18.9	18.3	19.7
1989	18.8	18.1	19.6
1990	25.3	24.7	26.0
1991	14.2	13.6	15.1
1992	12.3	11.6	13.2
1993	10.5	10.3	11.7
1994	17.2	16.4	18.0
1995	26.7	26.0	27.4
Mean	16.0	15.3	16.8
Minimum	6.2	6.3	7.6
Maximum	28.0	27.4	28.7

Table B-18. Comparison of mainstem spawnable widths and dewatered widths during the chum salmon spawning period in the middle Green River among EIS Alternatives, 1964-1995. Spawnable width and dewatered width values were calculated from transect cross-section and stage-discharge data collected by Ecology during its instream flow study (Caldwell and Hirschey 1989).

Year	Spawnable Width (ft)			Dewatered Width (ft)		
	Alternative A	**Alternative B**	**Alternative C**	**Alternative A**	**Alternative B**	**Alternative C**
1964	140.6	140.0	141.2	6.2	6.4	5.9
1965	135.8	135.3	136.6	2.1	2.0	2.0
1966	142.1	141.6	142.7	6.7	6.5	6.7
1967	139.4	138.8	140.1	6.1	6.0	5.9
1968	141.9	141.4	142.5	5.2	5.0	4.8
1969	135.9	135.4	136.7	1.2	1.4	1.0
1970	138.2	137.7	138.9	4.2	4.2	4.3
1971	141.6	141.1	142.1	3.7	3.5	3.5
1972	140.8	140.2	141.4	8.5	10.4	9.5
1973	140.4	139.8	141.0	4.5	4.3	4.5
1974	138.9	138.5	139.6	5.1	5.7	5.2
1975	148.0	147.6	148.4	8.9	9.5	9.3
1976	135.7	135.0	136.5	3.4	3.2	3.4
1977	145.3	144.9	145.9	12.2	12.5	12.1
1978	138.7	138.1	139.3	3.9	3.7	3.6
1979	137.6	137.4	138.5	6.4	6.2	6.3
1980	142.2	141.7	142.8	6.8	6.5	6.3
1981	137.5	137.0	138.2	4.0	4.4	4.1
1982	139.6	139.0	140.3	5.7	6.3	6.3
1983	141.7	141.3	142.4	5.0	4.9	4.9
1984	137.2	136.6	137.9	1.4	1.4	1.4
1985	137.2	136.7	138.0	7.3	7.1	6.8
1986	139.5	138.9	140.2	7.5	8.8	7.6
1987	132.5	132.6	133.8	4.4	5.2	4.4
1988	142.5	142.0	143.1	3.4	3.7	3.5
1989	142.0	141.5	142.6	6.2	6.7	6.3
1990	146.0	145.6	146.5	9.7	9.8	9.5
1991	139.0	138.6	139.8	6.8	7.1	6.9
1992	137.9	137.4	138.6	2.1	1.9	1.8
1993	136.2	136.1	137.3	3.9	4.0	3.7
1994	141.3	140.7	141.8	6.8	6.3	6.6
1995	147.3	146.8	147.8	9.9	9.9	9.6
Mean	140.0	139.5	140.7	5.6	5.8	5.6
Minimum	132.5	132.6	133.8	1.2	1.4	1.0
Maximum	148.0	147.6	148.4	12.2	12.5	12.1

Table B-19. Comparison of continuously wetted side channel area (i.e., two-day low flow event) among EIS Alternatives during the chum salmon incubation period (December through mid-April) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Continuously Wetted Side Channel Area (Acres)		
	Alternative A	Alternative B	Alternative C
1964	-	-	-
1965	10.1	8.3	9.3
1966	6.3	6.1	7.4
1967	10.2	8.3	9.3
1968	7.4	6.5	8.3
1969	7.9	7.7	8.7
1970	6.5	6.3	7.6
1971	8.1	7.9	9.1
1972	11.7	10.9	12.6
1973	5.3	6.2	7.9
1974	9.6	8.7	10.4
1975	7.3	6.7	8.3
1976	10.4	8.3	9.3
1977	6.6	6.1	7.7
1978	8.6	8.2	9.3
1979	6.2	6.2	7.3
1980	7.8	7.4	8.8
1981	3.9	3.9	6.1
1982	8.1	8.0	9.1
1983	6.8	6.8	7.9
1984	4.6	5.6	6.9
1985	6.4	6.3	7.5
1986	6.7	6.6	7.8
1987	7.6	7.6	8.6
1988	3.6	3.7	5.0
1989	9.3	8.5	9.6
1990	8.9	8.0	9.9
1991	8.4	8.2	9.4
1992	4.8	6.6	8.0
1993	6.0	6.0	7.1
1994	5.9	5.9	7.0
1995	9.5	8.3	9.3
Mean	7.4	7.1	8.4
Minimum	3.6	3.7	5.0
Maximum	11.7	10.9	12.6

Table B-20. Comparison of mainstem juvenile rearing habitat values for chum salmon in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Juvenile Rearing Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	17.8	19.5	19.5	23.3	24.4	23.6
1965	25.3	28.7	28.7	25.8	28.2	26.2
1966	29.6	33.7	33.7	27.2	30.1	27.0
1967	26.2	30.6	30.6	26.7	30.1	27.6
1968	28.7	31.6	31.6	27.5	29.8	27.0
1969	25.0	28.2	28.2	27.4	29.3	26.9
1970	25.9	29.7	29.7	26.0	28.6	26.3
1971	17.5	19.5	19.5	23.4	25.0	24.0
1972	16.3	17.2	17.2	22.8	23.3	22.7
1973	43.9	47.7	47.7	34.4	37.3	32.9
1974	15.0	15.8	15.8	22.6	23.4	22.9
1975	21.3	24.2	24.2	25.1	27.2	25.3
1976	23.7	28.4	28.4	25.2	28.4	26.0
1977	40.1	43.8	43.8	31.9	34.4	30.7
1978	37.1	41.5	41.5	31.4	34.4	30.6
1979	28.5	31.4	31.4	27.2	29.1	27.0
1980	29.7	32.1	32.1	28.5	30.4	27.7
1981	28.9	31.3	31.3	28.6	30.3	28.0
1982	23.9	27.3	27.3	25.5	28.1	26.0
1983	37.2	39.5	39.5	31.6	33.5	30.1
1984	19.0	21.2	21.2	23.9	25.5	24.2
1985	31.0	34.3	34.3	28.2	30.5	28.0
1986	32.2	34.6	34.6	29.3	30.7	28.1
1987	32.4	34.3	34.3	29.1	30.6	28.3
1988	25.2	27.7	27.7	25.8	27.2	25.2
1989	29.5	31.4	31.4	28.7	30.4	27.7
1990	19.3	20.3	20.3	23.7	24.3	23.2
1991	23.3	25.7	25.7	25.8	27.8	25.5
1992	49.4	50.5	50.5	37.1	38.5	35.6
1993	25.5	28.6	28.6	26.0	27.8	25.6
1994	38.9	39.4	39.4	31.8	32.5	29.4
1995	35.9	38.1	38.1	31.0	33.1	30.4
Mean	28.2	30.9	30.9	27.6	29.5	27.2
Minimum	15.0	15.8	15.8	22.6	23.3	22.7
Maximum	49.4	50.5	50.5	37.1	38.5	35.6

Table B-21. Comparison of wetted side channel areas among EIS Alternatives during the rearing period (mid-February through June) of the chum salmon fry in the middle Green River, 1964-1994. Surface area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	10.3	8.8	9.7
1965	5.5	5.4	6.9
1966	8.0	6.6	8.5
1967	7.1	5.7	6.8
1968	6.9	6.7	8.0
1969	7.9	6.6	8.3
1970	6.1	6.0	7.7
1971	10.7	9.7	10.7
1972	11.3	10.0	11.7
1973	5.3	5.9	7.3
1974	12.5	11.2	12.2
1975	10.0	8.0	9.7
1976	7.9	6.7	8.9
1977	5.2	5.0	6.2
1978	5.5	5.5	6.6
1979	5.8	4.8	6.1
1980	6.5	5.7	6.8
1981	6.5	6.5	7.6
1982	6.4	6.2	7.5
1983	4.1	5.5	6.6
1984	10.2	8.9	9.9
1985	5.5	5.5	7.1
1986	4.1	4.8	6.1
1987	4.0	4.0	5.5
1988	5.8	5.8	7.0
1989	5.3	5.2	6.6
1990	8.9	7.8	10.2
1991	7.5	6.9	9.1
1992	3.6	3.7	5.1
1993	6.8	6.8	7.9
1994	3.6	5.1	6.3
1995	3.9	4.8	6.0
Mean	6.8	6.4	7.8
Minimum	3.6	3.7	5.1
Maximum	12.5	11.2	12.2

Table B-22. Changes in survival values for outmigrating steelhead trout fry in the Green River under EIS Alternatives B and C from those predicted under the No Action Alternative, 1964-1995. Survival values were calculated based upon methodologies provided by Wetheral (1971).

Year	Total of Daily Survival Difference from Alternative A (%)			
	Lower River		Middle River	
	Alternative B	Alternative C	Alternative B	Alternative C
1964	1.74	1.74	2.37	4.28
1965	1.15	1.15	1.83	6.60
1966	0.67	0.67	1.06	5.98
1967	1.19	1.19	1.75	6.12
1968	0.72	0.72	0.76	6.19
1969	0.49	0.49	0.81	3.62
1970	1.32	1.32	1.90	6.66
1971	-0.29	-0.29	-0.17	2.84
1972	-0.34	-0.34	-0.20	2.57
1973	0.01	0.01	0.03	4.98
1974	0.84	0.84	1.64	3.39
1975	-0.50	-0.50	-0.49	2.76
1976	-0.78	-0.78	-0.23	4.34
1977	-0.04	-0.04	-0.14	5.45
1978	0.49	0.49	0.86	6.35
1979	0.74	0.74	1.42	6.26
1980	1.71	1.71	2.41	7.54
1981	-2.27	-2.27	-2.91	1.65
1982	0.80	0.80	1.34	6.16
1983	3.26	3.26	3.66	8.56
1984	0.94	0.94	1.66	6.04
1985	1.75	1.75	2.05	6.11
1986	1.37	1.37	1.89	6.70
1987	1.34	1.34	1.84	6.22
1988	0.31	0.31	0.80	5.70
1989	1.14	1.14	1.45	6.39
1990	1.42	1.42	1.74	5.97
1991	0.83	0.83	1.30	6.60
1992	2.06	2.06	2.26	7.43
1993	-0.44	-0.44	-0.22	4.45
1994	5.07	5.07	5.48	10.17
1995	3.49	3.49	4.11	8.79
Mean	0.94	0.94	1.31	5.71
Minimum	-2.27	-2.27	-2.91	1.65
Maximum	5.07	5.07	5.48	10.17

Table B-23. Comparison of mainstem spawning habitat values for steelhead trout in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Spawning Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	59.1	58.5	58.5	81.6	80.9	76.9
1965	79.4	76.8	76.8	104.7	102.9	97.7
1966	75.1	72.8	72.8	101.5	98.1	92.1
1967	88.3	85.7	85.7	119.8	116.8	113.6
1968	91.7	91.6	91.6	123.6	122.8	115.7
1969	55.7	56.7	56.7	77.2	79.3	76.3
1970	81.4	79.7	79.7	107.4	106.2	99.9
1971	60.6	62.7	62.7	84.5	88.9	83.8
1972	54.5	55.1	55.1	80.4	82.3	78.3
1973	97.5	98.9	98.9	135.0	137.7	137.1
1974	44.0	44.0	44.0	67.6	68.5	66.8
1975	73.6	73.9	73.9	102.3	103.4	98.7
1976	69.1	69.4	69.4	93.2	95.8	90.4
1977	92.2	94.0	94.0	124.6	126.6	120.8
1978	94.4	93.7	93.7	128.7	129.6	125.8
1979	78.1	76.2	76.2	100.9	101.1	95.8
1980	74.1	72.6	72.6	103.2	101.4	98.0
1981	83.3	84.6	84.6	111.7	114.0	108.2
1982	85.1	82.3	82.3	111.1	109.3	104.1
1983	94.9	95.3	95.3	131.4	132.3	129.0
1984	68.1	67.2	67.2	92.1	92.3	86.3
1985	73.0	70.4	70.4	96.6	93.0	88.0
1986	88.2	86.9	86.9	118.0	116.2	111.1
1987	79.8	78.6	78.6	106.7	106.2	102.2
1988	65.8	63.4	63.4	90.8	88.3	83.1
1989	66.8	65.0	65.0	94.2	92.3	87.7
1990	67.6	66.7	66.7	88.5	86.9	81.0
1991	75.5	73.2	73.2	103.5	99.9	93.1
1992	85.8	91.4	91.4	116.2	129.0	136.1
1993	68.8	69.6	69.6	92.0	94.4	88.6
1994	80.5	86.0	86.0	106.2	116.5	113.4
1995	95.8	94.5	94.5	130.9	129.3	126.7
Mean	76.5	76.2	76.2	103.9	104.4	100.2
Minimum	44.0	44.0	44.0	67.6	68.5	66.8
Maximum	97.5	98.9	98.9	135.0	137.7	137.1

Table B-24. Comparison of side channel habitat area among EIS Alternatives during the steelhead spawning period (April through June) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	18.9	18.2	19.1
1965	13.1	12.3	13.4
1966	13.9	13.1	14.2
1967	12.5	11.7	12.8
1968	12.0	11.2	12.3
1969	16.5	15.7	16.7
1970	13.0	12.2	13.3
1971	16.9	16.1	17.1
1972	21.6	21.0	22.0
1973	8.9	8.2	9.3
1974	20.9	20.3	21.2
1975	15.9	15.1	16.2
1976	14.1	13.2	14.3
1977	10.4	9.7	10.8
1978	10.2	9.4	10.5
1979	13.5	12.8	13.9
1980	12.8	12.2	13.2
1981	12.6	11.9	13.0
1982	13.6	12.8	13.9
1983	10.3	9.8	10.8
1984	15.8	15.0	16.1
1985	13.7	13.0	14.0
1986	12.0	11.4	12.4
1987	12.5	11.9	12.9
1988	15.3	14.7	15.7
1989	14.4	13.8	14.8
1990	16.2	15.6	16.6
1991	14.1	13.4	14.5
1992	7.0	6.8	7.9
1993	14.9	14.1	15.1
1994	11.0	10.7	11.7
1995	9.9	9.4	10.4
Mean	13.7	13.0	14.1
Minimum	7.0	6.8	7.9
Maximum	21.6	21.0	22.0

Table B-25. Comparison of mainstem spawnable widths and dewatered widths during the steelhead trout spawning period in the middle Green River among EIS Alternatives, 1964-1995. Spawnable width and dewatered width values were calculated from transect cross-section and stage-discharge data collected by Ecology during its instream flow study (Caldwell and Hirschey 1989).

Year	Spawnable Width (ft)			Dewatered Width (ft)		
	Alternative A	**Alternative B**	**Alternative C**	**Alternative A**	**Alternative B**	**Alternative C**
1964	147.0	147.1	147.4	2.5	3.0	2.2
1965	145.0	144.7	145.3	1.6	1.4	1.0
1966	145.4	145.4	145.9	1.6	1.4	1.0
1967	143.6	143.2	144.0	2.8	2.6	1.9
1968	143.5	143.4	144.2	1.9	1.9	2.2
1969	145.3	145.2	145.6	1.6	2.4	1.8
1970	144.6	144.6	145.2	2.3	2.1	1.3
1971	146.4	146.3	146.7	1.6	1.5	0.8
1972	147.3	147.3	147.7	2.1	2.3	1.8
1973	140.3	140.6	141.7	1.1	0.1	0.0
1974	147.8	147.8	148.1	2.9	3.0	2.3
1975	145.5	145.3	145.8	2.8	3.2	2.2
1976	146.0	145.7	146.3	1.5	1.9	1.5
1977	142.8	142.7	143.5	1.5	1.1	0.9
1978	142.8	142.1	143.1	0.9	1.8	1.6
1979	144.9	144.7	145.3	2.0	2.5	2.3
1980	144.8	144.7	145.4	1.7	2.3	1.9
1981	144.1	143.8	144.5	1.6	1.7	1.4
1982	144.4	144.0	144.7	2.6	2.1	1.4
1983	141.8	141.9	142.8	1.6	1.9	1.4
1984	145.9	145.9	146.4	1.6	1.4	0.8
1985	145.5	145.5	146.0	2.4	1.8	1.3
1986	143.2	143.3	144.1	1.9	1.6	1.1
1987	144.2	144.0	144.7	1.4	2.0	1.6
1988	146.3	146.2	146.7	1.4	1.3	1.3
1989	145.8	145.8	146.4	1.5	1.7	1.6
1990	145.9	145.9	146.4	2.2	2.0	1.5
1991	145.2	145.3	145.8	1.4	1.2	1.7
1992	137.1	138.7	140.4	1.5	2.8	1.8
1993	145.7	145.5	146.0	0.7	1.2	0.9
1994	141.3	142.6	143.5	2.2	1.8	1.5
1995	142.0	141.9	142.8	0.4	1.4	0.0
Mean	144.4	144.4	145.1	1.8	1.9	1.4
Minimum	137.1	138.7	140.4	0.4	0.1	0.0
Maximum	147.8	147.8	148.1	2.9	3.2	2.3

Table B-26. Comparison of continuously wetted side channel area (i.e., two-day low flow event) among EIS Alternatives during the steelhead trout incubation period (March through August) in the middle Green River, 1964-1994. Habitat area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Continuously Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	-	-	-
1965	3.6	4.3	6.4
1966	4.0	4.8	6.8
1967	3.7	4.3	6.4
1968	3.7	4.6	6.7
1969	4.9	4.9	6.9
1970	3.7	3.8	6.0
1971	5.9	5.4	7.8
1972	6.6	5.6	8.4
1973	3.3	4.4	6.5
1974	6.9	5.9	8.7
1975	3.8	4.9	6.9
1976	3.5	4.9	6.9
1977	3.4	3.8	5.9
1978	4.3	4.3	6.4
1979	3.7	3.7	5.9
1980	3.8	4.3	6.4
1981	3.5	3.9	6.1
1982	3.5	4.6	6.6
1983	4.1	5.2	6.6
1984	4.8	4.8	6.9
1985	3.6	3.8	6.0
1986	3.7	4.3	6.1
1987	3.5	3.7	5.5
1988	3.9	4.3	6.6
1989	3.3	3.8	6.0
1990	4.1	4.7	6.8
1991	3.8	4.5	6.6
1992	3.4	3.7	5.1
1993	7.8	6.6	9.5
1994	3.4	4.4	6.3
1995	3.2	3.8	5.9
Mean	4.2	4.5	6.6
Minimum	3.2	3.7	5.1
Maximum	7.8	6.6	9.5

Table B-27. Comparison of mainstem juvenile rearing habitat values for steelhead trout in the lower and middle Green River among EIS Alternatives, 1964-1995. Potential habitat area values calculated from weighted usable area and flow functions developed by Ecology (Caldwell and Hirschey 1989).

Year	Mean Mainstem Juvenile Rearing Habitat Area (Acres)					
	Lower River			Middle River		
	Alternative A	Alternative B	Alternative C	Alternative A	Alternative B	Alternative C
1964	53.7	56.3	56.3	58.7	62.0	55.0
1965	68.8	70.8	70.8	70.0	74.0	70.6
1966	67.7	70.2	70.2	68.1	72.6	67.0
1967	64.0	66.4	66.4	65.7	70.3	67.4
1968	61.9	64.7	64.7	64.0	67.7	61.3
1969	67.0	69.8	69.8	70.8	74.7	68.7
1970	67.5	70.1	70.1	68.7	72.9	68.9
1971	53.8	57.1	57.1	58.9	62.5	57.8
1972	55.8	57.6	57.6	61.4	63.6	58.3
1973	73.7	76.1	76.1	74.7	79.2	75.5
1974	55.3	57.2	57.2	61.4	63.9	60.5
1975	55.6	58.2	58.2	61.0	64.7	60.2
1976	65.9	69.1	69.1	67.9	72.9	66.8
1977	72.6	74.7	74.7	73.9	76.9	71.9
1978	74.1	76.5	76.5	75.7	79.5	72.8
1979	69.8	71.4	71.4	71.6	74.3	72.9
1980	65.3	67.6	67.6	69.4	72.7	68.5
1981	69.8	72.0	72.0	73.2	76.0	70.2
1982	65.4	67.8	67.8	67.5	72.0	66.9
1983	68.7	71.1	71.1	71.7	75.3	69.3
1984	60.7	63.8	63.8	64.3	67.6	62.4
1985	71.5	73.4	73.4	72.0	76.1	72.5
1986	70.0	72.1	72.1	71.3	74.9	70.7
1987	73.3	75.0	75.0	73.7	76.9	76.7
1988	62.8	64.8	64.8	65.0	68.3	65.1
1989	63.7	65.9	65.9	66.2	69.7	68.4
1990	52.6	54.4	54.4	58.0	60.5	57.5
1991	63.1	65.3	65.3	65.0	69.5	66.8
1992	75.0	77.3	77.3	74.9	78.5	76.0
1993	70.0	72.8	72.8	71.0	75.4	69.7
1994	68.2	71.1	71.1	68.5	72.7	69.9
1995	64.8	67.4	67.4	66.5	70.6	68.0
Mean	65.4	67.8	67.8	67.8	71.5	67.3
Minimum	52.6	54.4	54.4	58.0	60.5	55.0
Maximum	75.0	77.3	77.3	75.7	79.5	76.7

Table B-28. Comparison of wetted side channel areas among EIS Alternatives during the rearing period (year-round) of the steelhead trout juveniles in the middle Green River, 1964-1994. Surface area values calculated from side channel area and flow functions developed in support of the AWS project (USACE 1998, Appendix F1).

Year	Wetted Side Channel Area (Acres)		
	Alternative A	**Alternative B**	**Alternative C**
1964	15.3	14.5	16.2
1965	11.3	11.0	12.5
1966	11.1	10.7	12.3
1967	12.3	11.9	13.4
1968	13.0	12.5	14.1
1969	11.2	10.8	12.3
1970	10.8	10.4	11.9
1971	14.7	14.2	15.8
1972	16.4	15.8	17.3
1973	9.3	9.0	10.5
1974	15.0	14.5	16.0
1975	15.8	15.4	16.9
1976	11.7	11.2	12.9
1977	11.4	10.9	12.5
1978	9.7	9.1	10.7
1979	10.2	10.0	11.4
1980	11.4	11.1	12.6
1981	10.9	10.4	11.9
1982	12.5	12.1	13.6
1983	11.0	10.6	12.1
1984	12.8	12.3	13.8
1985	10.0	9.7	11.3
1986	10.7	10.4	12.0
1987	8.4	8.2	9.7
1988	12.0	11.6	13.2
1989	11.4	11.1	12.7
1990	15.6	15.3	16.7
1991	12.3	12.0	13.5
1992	8.6	8.3	9.8
1993	10.1	9.7	11.3
1994	10.4	10.2	11.7
1995	12.7	12.4	13.8
Mean	11.9	11.5	13.0
Minimum	8.4	8.2	9.7
Maximum	16.4	15.8	17.3

List of Acronyms

cfs	cubic feet per second
CAA	Clean Air Act
dbh	diameter at breast height
DEIS	Draft Environmental Impact Statement
DNR	Washington Department of Natural Resources
DPS	Distinct Population Segment
Ecology	Washington Department of Ecology
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FEIS	Final Environmental Impact Statement
fps	feet per second
HCP	Habitat Conservation Plan
IFIM	Instream Flow Incremental Methodology
ITP	Incidental Take Permit
LWD	large woody debris
Metro	King County Metro
mgd	million gallons per day
MIT/TPU Agreement	Muckleshoot Indian Tribe/Tacoma Public Utilities Agreement
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Units
PM_{10}	Particulate matter of 10 microns or less
RM	River Mile
RMZ	Riparian Management Zone
ROD	Record of Decision
Tacoma Water	City of Tacoma Water Division
UGA	City of Tacoma Urban Growth Area
UMA	Upland Management Area
USACE	U.S. Army Corps of Engineers
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAU	Watershed Administrative Unit
WDFW	Washington State Department of Fish and Wildlife
WNHP	Washington Natural Heritage Program

River Mile locations of geological features mentioned in this FEIS are listed on the inside back cover.