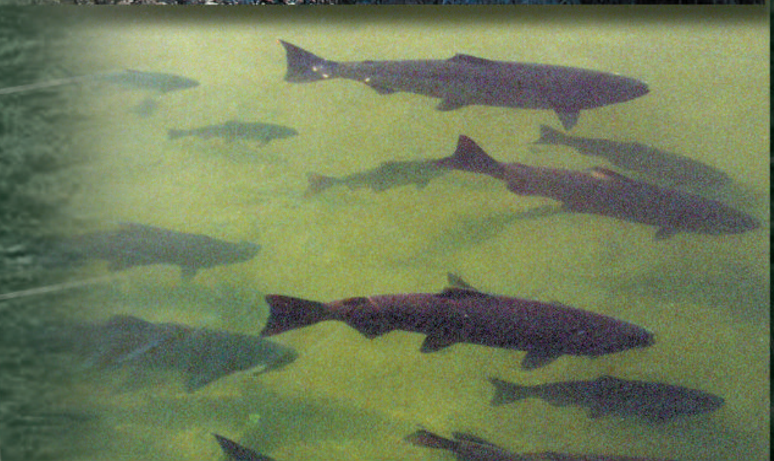
Final Environmental Impact Statement

DUNGENESS RIVER AGRICULTURAL WATER USERS ASSOCIATION COMPREHENSIVE WATER CONSERVATION PLAN



November 2003

Prepared by:

FOSTER WHEELER ENVIRONMENTAL CORPORATION

Prepared for:

State of Washington Department of Ecology

FINAL

ENVIRONMENTAL IMPACT STATEMENT
DUNGENESS RIVER

AGRICULTURAL WATER USERS ASSOCIATION

NOVEMBER 2003

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Acronyms

AESI	Associated Earth Sciences, Inc.
AFW	Agriculture, Fish, and Water
bls	below land surface
BOR	U.S. Bureau of Reclamation
CFR	Code of Federal Regulations
cfs	cubic feet per second
CIDMP	Comprehensive Irrigation District Management Program/Plan
Conservation Plan	Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
DEIS	Draft Environmental Impact Statement
DEM	Digital Elevation Model
DNS	Declaration of Non-significance
DO	dissolved oxygen
DOH	Washington Department of Health
DPM	Deep Percolation Model
DQ Plan	Dungeness-Quilcene Water Resources Management Plan, 1994
DRMT	Dungeness River Management Team
DS	Declaration of Significance
E	estuarine
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EM	emergent marsh
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FEIS	Final Environmental Impact Statement
F Co	Federal Species of Concern
FO	forested wetland
FT	Federally threatened
ft^3/day	cubic foot per day
ft/day	foot per day
FW	forested wetland
GIS	Geographic Information System
gpm	gallon per minute
GSC	Geologic Survey of Canada
HPA	Hydraulic Project Approval
IFIM	Instream Flow Incremental Methodology
JSKT	Jamestown S'Klallam Tribe
LD-CF	lined-ditch constant flux
LD-CH	lined-ditch constant head
LUD	Land Use District

mgd	million gallons per day
mg/L	milligram per liter
MOU	Memorandum of Understanding
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOAA Fisheries	Formerly names National Marine Fisheries Service
NWI	National Wetland Inventory
OW	open water
PEM	palustrine emergent
PFO	palustrine forested wetland
PGG	Pacific Groundwater Group
PHS	Priority Habitats and Species
POW	palustrine open water
PSCRPT	Puget Sound Cooperative River Basin Team
PSS	palustrine scrub-shrub
PUD	Public Utility District
PUD #1	Public Utility District # 1
RCW	Revised Code of Washington
Refuge	Dungeness National Wildlife Refuge
Regional Plan	Sequim-Dungeness Regional Comprehensive Plan
RIP	riparian
RM	river mile
SASSI	Salmon and Steelhead Stock Inventory
SEPA	State Environmental Policy Act
SC	State Candidate for Listing
SM	State Monitored
SS	State Sensitive
SS	scrub-shrub wetland
ST	State Threatened
TAG	Technical Advisory Group
TMDL	total maximum daily load
TRS	Township, Section, Range
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
USGS Study	Hydrogeologic Assessment of the Sequim-Dungeness Area, Blake Thomas 1999
USFWS	U.S. Fish and Wildlife Service
WAC	Washington Administrative Code
WADOT	Washington Department of Transportation
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife, formerly named Washington Department of Fisheries
WM	wet meadow
WSDNR	Washington State Department of Natural Resources
WUA	Dungeness Agricultural Water Users Association

Environmental Impact Statement Fact Sheet

Project Title

Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan

Project Description

The project area of the Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan (Conservation Plan) is located in the eastern portion of Clallam County, Washington, in approximately 50 square miles of the coastal plain surrounding Sequim, Washington. The purpose of the Conservation Plan is to reduce diversion of water by Water Users Association (WUA) member companies and districts from the Dungeness River for irrigation and domestic uses to the minimum practicable, thus increasing streamflow in the Dungeness River itself and increasing the chances of survival of federally listed species of salmonids and other stocks of concern, such as pink salmon. The Conservation Plan contains sufficient detail at the project level to permit environmental analysis specific to the projects it contains. These include piping leaky open ditches (108 projects), combining adjacent canals into one pipe (3 projects), building re-regulating reservoirs to control or eliminate tailwater discharge (17 to 20 projects), and abandoning a canal and providing ground water in its place (1 project).

Name and Address of Proponent

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List of Permits and Approvals

- Building Permits (Clallam County, City of Sequim)
- Hydraulic Project Approval (HPA)
- Floodplain Management Permit (may be required for work performed within 100-year floodplains.)
- Shoreline Substantial Development Permits may be required; however, exemptions to Shoreline Permits exist for some irrigation related activities.

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Date of Issue of the Draft EIS

November 27, 2002

Date of Issue of the Final EIS

November 25, 2003

Agency Action and Projected Date for Action

Washington State Department of Ecology (Ecology) approval of the Conservation Plan, December 3, 2003

Subsequent Environmental Review

This EIS covers both programmatic and project elements for the Conservation Plan; therefore, no subsequent State Environmental Policy Act (SEPA) review for individual project elements will be needed.

EIS Availability

You can obtain a copy of the EIS by:

- Requesting a paper or electronic copy from:

  Donna Nicholson
  Shorelands and Environmental Assistance Program
  Southwest Regional Office, Department of Ecology
  P.O. Box 47775
  Olympia, WA 98504-7775
  (360) 407-7058

- Viewing a copy at one of the following locations:

  Port Angeles and Sequim Public Libraries
  Jamestown S'Klallam Tribe
  Clallam County Courthouse
  Clallam Conservation District
  City of Sequim City Offices

- You may also visit Ecology's Web site to view the Summary (Chapter 1) and Table of Contents: (http://www.ecy.wa.gov/programs/wr/AWSF/dwua_eis.html)

1. Summary

1.1 Summary

The purpose of the Dungeness River Agricultural Water Users Association Conservation Plan (Conservation Plan), the subject of this Final Environmental Impact Statement (EIS), is to reduce diversion of water by Water Users Association (WUA) member companies and districts from the Dungeness River for irrigation and domestic uses to the minimum practicable. This will increase streamflow in the Dungeness River and will increase the chances of survival of federally listed species of salmonids, including chinook salmon, Hood Canal summer chum, bull trout, and other stocks of concern, such as pink salmon. This is needed to ensure compliance with the Federal Endangered Species Act (ESA). Projects proposed in the Conservation Plan include piping leaky open ditches, combining adjacent canals, building re-regulating reservoirs, and abandoning a canal. Nonproject elements of the plan include a public education program, a drought response plan, improved gaging and measuring systems, and the combination of the seven districts and companies into two entities, one west of and one east of the Dungeness River.

Two alternatives to full implementation of the proposed Conservation Plan include an alternative that selects the most economically efficient projects (Alternative 4) and an alternative that minimizes adverse impacts to important streams and wetlands (Alternative 6).

The most significant area of controversy surrounds the artificial enhancement of shallow aquifer ground water and small-stream flow due to irrigation conveyance system losses. This artificial enhancement has, over the years of irrigation use, increased the shallow aquifer water level. This, in turn, has made more water available for pumping in wells and has expanded natural wetlands and increased natural streamflow levels in small creeks. At the same time, the conveyance losses have required excessive diversion of water from the Dungeness River, especially during low-flow periods. Artificial enhancement of the shallow aquifer ground water (and consequently small streams and wetlands) will continue under Alternative 1 (No Action) and in selected areas under Alternative 6 (Minimized Impact to Small Streams and Wetlands). Excess diversion has adverse impacts on habitat for Dungeness River fish, including those federally listed as well as local critically depressed stocks of other species.

Issues addressed in the EIS are included in two categories:

1. Reduced Dungeness River streamflow due to diversions for irrigation has an impact on fish species.
2. Increased efficiency of irrigation water delivery system will reduce the quantity of tailwater entering small streams and water entering the shallow aquifer in at least some places in the project area and could have an impact on wetlands, creeks, and human uses of the shallow aquifer.

The Conservation Plan is itself a large mitigation plan to minimize the impacts of continued diversion of Dungeness River water. Any direct or indirect use of Dungeness River water to mitigate for impacts to wetlands, creeks, or human uses of the shallow aquifer, including water from the shallow aquifer in possible hydraulic continuity with the river, would reduce the effectiveness of this mitigation plan and could decrease the chances for recovery of salmonid species dependent on the river.

This analysis and EIS are not part of a phased review but are partially dependent on the work published in the Conservation Plan, incorporated in this document by reference. Groundwater modeling developed in 2003 was used for the impact analysis included in this Final Environmental Impact Statement (FEIS) rather than relying on the previous modeling effort used in the Draft EIS. This FEIS was issued November 25, 2003.

2. Proposal Description

2.1 Purpose and Need for Action

The action considered in this proposal is Washington State Department of Ecology (Ecology) approval of the implementation of the Sequim-Dungeness Water Users Association Comprehensive Water Conservation Plan (Conservation Plan), which is incorporated herein by reference. The proponent is the Sequim-Dungeness Water Users Association (WUA) and the decision-maker is the Washington State Department of Ecology. The implementation would occur in the Sequim-Dungeness area of Clallam County, Washington.

The Conservation Plan was designed and presented by the WUA for Ecology funding approval as part of the WUA's strategy to reduce the WUA's diversion of water from the Dungeness River. The purpose of the Conservation Plan is to reduce diversion of water from the Dungeness River to the minimum practicable, thus increasing streamflow in the Dungeness River itself and increasing the chances of survival of federally listed species (Puget Sound chinook, Hood Canal summer chum, bull trout) and other critical salmon stocks.

Reducing diversions from the Dungeness River is proposed as a proactive measure to avoid sanctions that could be imposed by the National Oceanic and Atmospheric Administration (NOAA) Fisheries in the future under Section (9)(a) of the Endangered Species Act (ESA) for unpermitted "take" of threatened species. The WUA has already taken many actions to reduce diversions. This Conservation Plan represents the next critical step in compliance with the terms and conditions of the 4(d) rules promulgated for the threatened salmonid species that use the Dungeness River during part of their life cycle (65FR42421). In a parallel process to Ecology's consideration of this proposal, the WUA is engaged in a pilot Comprehensive Irrigation District Management Plan (CIDMP) to explicitly comply with ESA and the Clean Water Act (CWA) under an agreement developed through the Agriculture, Fish, and Wildlife (AFW) process in the state of Washington. This Conservation Plan is the key element that the CIDMP proposal builds upon.

This EIS is written to augment and supplement the environmental analysis conducted for the SEPA Checklist that was completed in 1999 for the Conservation Plan. On November 17, 1999 the Agnew Irrigation District, as lead agency under SEPA, signed a Declaration of Non-Significance (DNS) based on the analysis conducted and the Checklist summary. Litigation filed by Graysmarsh LLC resulted in the withdrawal of the DNS.[1] Ecology took over as Lead Agency and issued a Declaration of Significance (DS) on July 17, 2002. This EIS examines the environmental consequences of the implementation of the Conservation Plan and presents the analysis as one of the tools the Lead Agency must use in reaching a decision whether to approve the funding, and therefore the implementation, of the Conservation Plan.

2.1.1 Dungeness River Salmon

Salmon and other fish have used the Dungeness River for spawning and residence for as long as people can remember. Salmon were a mainstay of the diet of the S'Klallam people before EuroAmerican settlers first occupied land in this area and were an important food

[1] Petition in Superior Court, Clallam County, WA, February 16, 2000, 00-2-00133-1

source for both S'Klallam people and the settlers through the 1940s (Gunther 1927, Eckert 1998). The Jamestown S'Klallam Tribe currently relies on salmon in the Dungeness River as its major fishery resource. The salmon need Dungeness River water, and several species depend on the river for spawning during the lowest flow times, in late August and early September. These species include the Dungeness spring chinook run, the summer chum, and the bull trout (all listed as threatened in 1999). Please see Section 4.5.1 for details on these species.

The salmonid species populations that use the Dungeness River have been in decline for decades, and have reached critically low numbers in recent years. Decline is due to a number of factors, including historic and recent overfishing at sea, logging impacts in headwater tributaries, and significant modification of the channel of the river itself with flood control dikes, armoring, and dredging. Another important factor is late-season streamflow, because the naturally low streamflows in the late summer and early fall have been further decreased by irrigation water withdrawals (Haring 1999).

2.1.2 Dungeness River Streamflow

The Dungeness River has a bimodal flow. That is, there is a rain-fed flow peak and a snowmelt-fed flow peak and they do not occur at the same time. The Dungeness River is reliably at its lowest flow in late August and September during times of ongoing crop demand for water (see Figure 2.1-1 for average monthly precipitation and flows, 1996-1997).

The WUA has recognized the importance of reducing diversions by increasing efficiency and has been actively working to minimize diversions since the late 1970s when flood irrigation was banned. The WUA is composed of all of the irrigation districts and

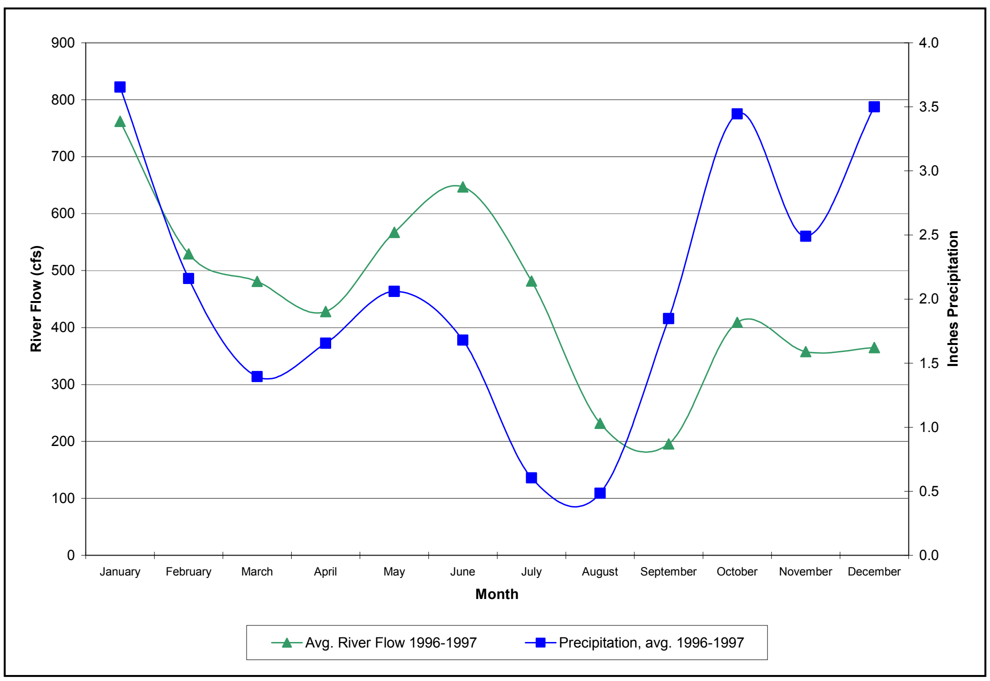

Figure 2.1-1. Dungeness Area Precipitation (Lower Watershed, Average 1996-1997) and Dungeness River Flows (1996-1997) Above Diversion Outtakes

companies that divert or use Dungeness River water under Washington State water rights to supply irrigation water to customers.

Irrigation water includes water used for domestic, irrigation, and stock-watering purposes under state law. The irrigation companies and districts were started in the 1890s and early 1900s to supply irrigation water by gravity to farmers in the Dungeness River area, which is in a rain shadow of the Olympic Mountains and receives less than 20 inches of rain a year.

Originally supplying a large valley of independent family farmers over as many as 14,000 acres, these companies and districts now supply water to about 6,000 acres. While irrigation companies supply water only to members in the company, irrigation districts are taxing authorities that can and do levy a tax on all residents within their designated boundaries. In turn, they are obliged under the law to supply water to all residents who request it. Water supply to each resident is determined by a formula that specifies acreage irrigated and amount of domestic use, if any. As a result, when farms are subdivided into rural residences, there is not necessarily a decline in water demand, although timing of use may change.

The water demand from the Dungeness River varies during the year. Rainfall in the area is limited and falls mostly in the winter months of September through April. Although the Sequim-Dungeness area has mild weather for Washington, the growing season for crops is mostly limited to April to September, precisely the time of least rainfall. Thus the demand for diverted water is highest during the growing season when flows in the river are naturally at their lowest.

In cooperation with the Jamestown S'Klallam Tribe (JSKT) and state and federal agencies, the WUA has already made significant reductions in diversions to improve streamflow conditions for fisheries during the irrigation season. Low streamflow conditions in the Dungeness River contribute to the decline of fisheries resource. For example, average diversions for the irrigation season in late 1979 were over 120 cubic feet per second (cfs) (40 percent of the Dungeness River mean flow during the irrigation season as measured above all outtakes), but average diversions in the 2000 irrigation year (mid-April to mid-September) were only 52 cfs (13 percent of the Dungeness River mean flow during the irrigation season as measured above all outtakes) (WUA 2000) (Figure 2.1-2). These reductions have been accomplished by changing irrigation methods, reducing demand through education, and increasing the efficiency of the irrigation system. Ecology's late season water leases in the 2001 drought reduced diversion by 5 cfs. Prior to the proposal of the Conservation Plan in 1999, the WUA and its member irrigation companies and districts had already taken several important actions to reduce diversions. The single most influential of these was a conversion away from flood irrigation, completed in the late 1970s. Requiring efficient on-farm use of water has decreased diversions. However, as the area continues to change in land use from agriculture to dispersed rural residences, programs to efficiently allocate and control residential water use, including landscaping and domestic use, are also important.

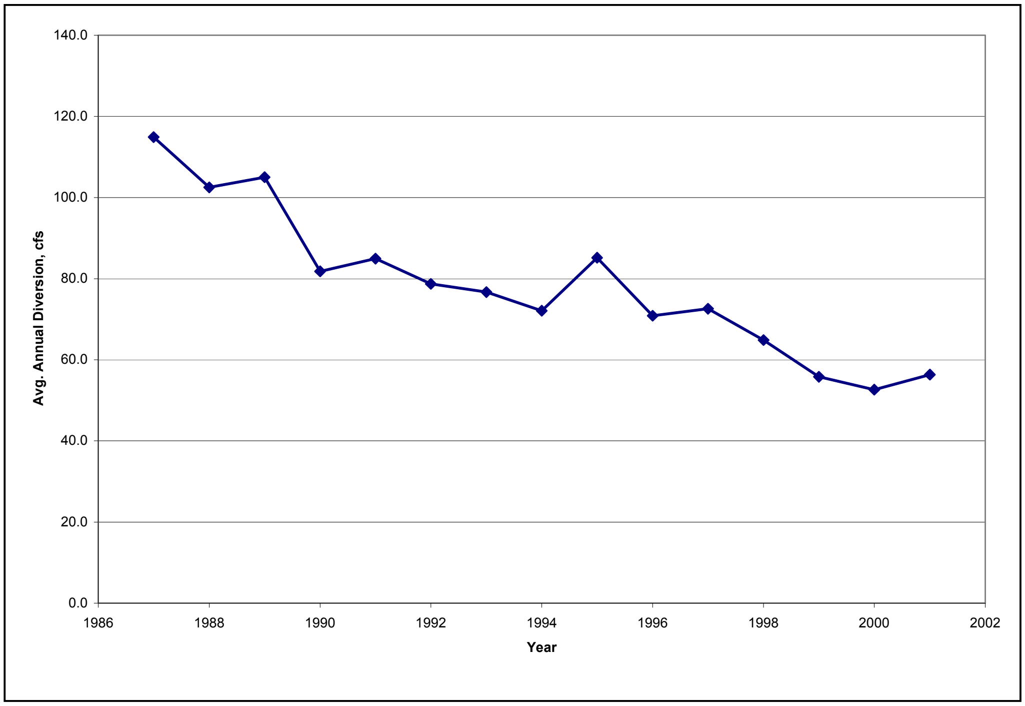

Figure 2.1-2. Average Annual Diversions for Irrigation from the Dungeness River (1987-2001)

2.2 Planning Elements

2.2.1 Introduction

The Conservation Plan contains sufficient detail at the project level to permit environmental analysis specific to the projects it contains. These projects include piping leaky open ditches (113 projects), combining adjacent canals into one pipe (3 projects), building re-regulating reservoirs to control or eliminate tailwater discharge (16 to 20 projects), and abandoning a canal and providing ground water in its place (1 project). See Section 2.3.2 for more detail. All of the ditches within the WUA irrigation system were considered for piping. Some ditches were eliminated due to cost or necessity. Some ditches will be abandoned or combined. At the same time, it is an area-wide plan and qualifies for "Non-Project Action" level treatment. Non-Project Actions are defined by the Washington Administrative Code (WAC) that defines the implementation of the State Environmental Policy Act (SEPA) to include "The adoption of any policy, plan, or program that will govern the development of a series of connected actions" (WAC 197-11-704). Because approving this Conservation Plan for funding under Referendum 38 constitutes its adoption by Ecology, the Conservation Plan qualifies for non-project evaluation.

In this section, the non-project or planning elements will be addressed and the relationship of this Conservation Plan to other processes, including federal, state, and local planning processes, will be examined. Chapters 3 through 7 analyze the environmental effects of the projects themselves and look at subsets of those projects as alternative approaches to achieving the goal of increased streamflow in the Dungeness River during low flow periods.

The Conservation Plan proposes a series of connected actions focused on improving the efficiency of the irrigation water delivery system in order to reduce diversions from the river during low flow periods. These actions are considered part of the routine normally undertaken by irrigation entities. These entities must maintain their diversion, conveyance, and distribution systems to provide efficient service to their customers as a condition of their water rights. This plan is unique in that it contains a comprehensive proposal to reduce conveyance losses and to increase water use efficiencies across all the member irrigation entities. What is more, it proposes reorganization of the entities to improve water service, an education plan to reduce wasted water (especially by residential users), and a Drought Response Plan to incorporate the WUA's obligation to limit diversions to no more than 50 percent of the flow in the river (Montgomery Water Group Inc. 1999).

2.2.2 Impacts of Planning (Non-Structural) Elements

The Conservation Plan covers both specific projects and non-structural improvements. The non-structural improvements are regional in nature and consist of changes to the operations and maintenance of the system (Appendix A-1). By themselves they do not directly contribute to the conservation of water. However, they reduce costs for administration of the system, improve measurement for identification of ongoing conveyance loss or inefficient water use, and provide for both ongoing maintenance and a specific Drought Response Plan if water use must be curtailed to meet the "50 percent of river flow" restriction.

Improvements in measurement, gauging, and flow control of the system can identify areas of continuing conveyance losses as well as areas of inefficient water use by irrigators or domestic users. This provides the information necessary to target particular users for educational programs or other measures to encourage or require better water use efficiency, and also to target remaining portions of the conveyance and distribution system for replacement or improvement, ultimately resulting in water conservation.

More emphasis on funding for maintenance of open ditches can reduce conveyance loss by reducing evapotranspiration from vegetation occupying the ditches, and is an interim measure recommended for application across all irrigation entities. This measure also can reduce the amount of water diversion needed from the Dungeness River by reducing water demand from encroaching vegetation.

Finally, a Drought Response Plan (part of the overall Conservation Plan) has been prepared and allows for efficient and prioritized response to exceptionally dry conditions because the WUA must restrict its outtakes to no more than 50 percent of the Dungeness River flow. The preparation of the Drought Response Plan itself does not save water, but its implementation (if needed) will allow the WUA to meet its obligations under its Trust Water Right in an efficient and fair manner.

2.2.3 Impacts of Nonstructural (Planning) Elements

While these nonstructural changes all contribute to water conservation and therefore to a lessened need to divert water from the Dungeness River, their impact has not been quantified. However, when quantifying the impacts of the project elements on the environment, it is important to realize that they would be implemented in the context of overall water conservation. For example, in an extreme low-flow year, the Drought Response Plan would take effect to ensure that the WUA's commitment to limit diversions from the Dungeness River would be enforced.

2.2.4 Relationship To Other Planning Processes

The WUA Conservation Plan is a key element in the larger set of contributions to salmon recovery in Washington State in general and in the Dungeness River area in particular. It is related to and incorporated into several planning efforts, including watershed planning, salmon recovery planning, flood hazard management, and general county planning (Clallam County 1995a and 1995b). It is the central building block in a pilot program to respond to both the ESA and the CWA requirements with a CIDMP in cooperation with NOAA Fisheries and the United States Fish and Wildlife Service (USFWS). In addition, the WUA entered into a Trust Water Right agreement with Ecology, the first in the state, to document its historic and current water use and to provide for a transfer of some of its traditional and adjudicated water rights to streamflow.

These current planning efforts are based on and have grown out of earlier planning efforts and a unique climate of cooperation found in the Dungeness River area. Since the formation in the late 1980s of the Dungeness River Management Team (DRMT) to consider water resource management and to produce a flood hazard management plan under Clallam County authority, stakeholder groups have worked together to formulate a series of plans. An early predecessor of the state's current watershed planning framework, the Dungeness-Quilcene Plan (DQ Plan) (one of two water resource planning pilots mandated by the Washington State Legislature), established the framework for future plans regarding the Dungeness River (Ecology 1994). In the DQ Plan, increasing fish habitat was an important goal. The WUA agreement to reduce diversions while fisheries interests restored habitat was a cornerstone of the plan.

Clark and Clark (1996) provide an extensive annotated bibliography of reports and published literature, including various plans for this area. Since the publication of that bibliography, other planning processes have been completed and several more are underway. Chapter 1 of the East WRIA 18 watershed management plan (Entrix 2003) details many other federal, state, and local planning processes that are being conducted in this area. Because all plans include concern for river restoration and habitat improvement, the goal of the Conservation Plan is recognized and supported in all the planning processes.

Relationship to Watershed and Salmon Recovery Planning

The purposes of watershed planning under House Bill 2514 (RCW 90.82) are to assess the status of water resources and to determine how to meet competing demands for water. The initiating governments signed an agreement on December 9, 1998 to begin the watershed planning process for Water Resource Inventory Area 18 (WRIA 18), containing the larger watersheds of the Elwha and Dungeness Rivers, as well as the watersheds of smaller creeks. WRIA 18 planning was divided into West (Elwha River and Morse Creek) and East (Bagley Creek and east through the Dungeness River watershed and including the creeks that drain into Sequim Bay). The East WRIA 18 plan (including related areas from adjoining WRIA 17, creeks that drain into Sequim Bay) is nearing completion, with the draft watershed plan issued mid 2003 (Entrix 2003).

The East WRIA 18 2514 planning process is founded and draws heavily on the DQ Plan (Ecology 1994), which detailed recommendations for watershed improvement and addressed all the major problems identified in the area. The DQ Plan recommended that, among other things, management of the water in the irrigation systems be improved (recommendation C-2 in Chapter 6 of the DQ Plan).

Salmon recovery planning under House Bill 2496 is incorporated as part of watershed planning. While watershed planning is much broader and addresses more issues, salmon population recovery is an essential goal and is the focus of 2496 planning. The Salmon Recovery Fund Board (familiarly known as the SRF Board or "surfboard") has already approved funds for carrying out irrigation system improvements as a way to reduce diversions and improve streamflow. The Limiting Factors Analysis funded through 2496 lists increasing streamflow in the Dungeness River through reducing irrigation conveyance losses as essential to restoration of salmon populations now listed as threatened under the ESA.

County Plans

Clallam County published the Sequim-Dungeness Regional Comprehensive Plan (Regional Plan) for the area in 1995 as a companion document to the overall County Comprehensive Plan, also published in 1995 (Clallam County 1995a,b). The Regional Plan recognizes that "Irrigation is critical to continued agricultural production" and also that "Ground water is also recharged in some places by irrigation ditches" (Section 31.03.190 of the Clallam County Code). County policy is detailed in Section 31.03.195 for ground water protection. Though this section does not provide specific recommendations for irrigation system improvement or maintenance, it does generally recommend "Conservation and efficiency strategies for water resources be developed and implemented region-wide to provide the most efficient use of all water resources."

In addition, the County passed a Critical Areas Ordinance in 2001 (Section 27.12 of the Clallam County Code) that covers wetlands, aquatic habitat conservation areas (including shorelines of the state), wildlife habitat, geologically hazardous areas, frequently flooded areas, and critical aquifer recharge areas. The ordinance details delineation and buffers for wetlands (Section 27.12.210) and for aquatic and wildlife habitat (Section 27.12.310). Furthermore, Clallam County Code Section 31.02.320 (Environment and Open Space Goals) encourages the protection of quantity and quality of essential aquifers for current and future needs through water conservation measures for all land uses.

ESA/CWA compliance through CIDMP

The WUA has engaged in a pilot project to complete a CIDMP. The CIDMP is designed to meet the requirements of both the ESA and the CWA by designing an implementation plan. The Conservation Plan will form the basis for federal recognition for actions already taken to conserve water, protect listed species and enable salmon recovery, and will comply with the CWA under the total maximum daily load (TMDL) program.

> "The ultimate goal of this process is to protect and enhance our state's natural resources while simultaneously providing Irrigation Districts assurances that completion of their management plans will allow them to achieve compliance with the Endangered Species and Clean Water Acts. This groundbreaking process integrates these acts through a voluntary, incentive-based approach." Washington State's Agriculture, Fish and Wildlife (AFW) cover letter for the Guidelines for Preparation of Comprehensive Irrigation District Management Plans (Washington State Conservation Commission 2001).

The CIDMP process is under way now (Winter 2002-2003) and is dependent in large part on the water conservation actions described in the Conservation Plan for compliance with ESA and CWA. Because it is a separate federal process, it will be subject to a separate analysis and review under the National Environmental Policy Act (NEPA).

Relationship to WUA Trust Water Right

The WUA constituent companies and districts together hold water rights for diverting water from the Dungeness River for irrigation and other consumptive uses, developed at the turn of the twentieth century and originally adjudicated in 1924. That adjudication permitted withdrawals of significantly more water from the Dungeness River than is present during critical low flows.

In 1998, the WUA's constituent members all signed a Trust Water Right Memorandum of Understanding (MOU) with Ecology (Washington State Legislature 1998). That MOU formally recognized the WUA's efforts in water conservation and set forth procedures for quantifying, transferring to the trust water rights program, and reallocating saved water under Chapter 90.42 of the Revised Code of Washington (RCW). Ecology tentatively determined that the WUA members held water rights allowing an instantaneous diversion of up to 156 cfs and an annual volume of 29,250 acre-feet, though diversions within the past 20 years have been less than 140 cfs (26,250 acre-feet).

The trust water rights program encourages the WUA to continue conserving water and transfers saved water to a temporary trust. That trust is held instream until needed and takes a priority date immediately junior to the original certificates (ranging from 1895 to 1917). Up to one-third of the trust water is held for diversion and consumptive use by the WUA if needed for their adjudicated purposes. The remaining two-thirds are allocated to streamflow maintenance and remain permanently in the river. This includes water conserved under this Conservation Plan. For example, if the WUA were to save 30 cfs from diversion by implementing the Conservation Plan, WUA members would be entitled to re-direct up to 10 cfs for beneficial uses. This would leave only 20 cfs of saved water in the Dungeness River for instream flow. This trust water rights program provides the legal mechanism to protect the WUA from loss of water rights as their conservation efforts move forward and allows for future irrigation development. It also guarantees that the trust-saved water will not be reallocated to some new use but will be retained in the river either to improve streamflow or to be withdrawn by WUA members.

The Trust Water Right MOU also allows the WUA to spread saved water onto formerly irrigated acres up to 7,000 acres. The currently irrigated amount was determined to be 6,500 acres for the 1998 MOU and was listed as 5,794 acres in the WUA 2001 Irrigated Land Report (WUA 2001). Water to serve the difference could require diversions from the river. Historically, the WUA has calculated deliveries based on 0.02 cfs per acre.

2.3 Project Elements

2.3.1 Introduction

The Conservation Plan contains a series of discrete projects. Each of these projects addresses a specific local water loss problem or inefficient distribution problem. As each project is constructed, there may be pragmatic modifications made in the initial design to better fit field conditions, but each will successfully address the identified water loss or distribution problem. Some of these projects have been completed by the WUA since the publication of the Conservation Plan in 1999 (see Appendix B for a summary table). This EIS will address the Conservation Plan as written in 1999, as Alternative 2. Other alternatives that have been developed reflect different approaches to determining priorities for completion, as well as a no action alternative, and will also be analyzed based on the Conservation Plan as written.

2.3.2 Description of Project Elements

Structural improvements consist of changes in irrigation facilities. The structural improvements reviewed for this study include:

- Replacing existing open ditches with pipelines to reduce the amount of water that seeps out of the porous ditch into the ground (seepage loss);
- Combining canal systems to reduce seepage losses;
- Abandoning reaches of existing canal and replacing the water supply with ground water;
- Constructing re-regulating reservoirs either on-farm or in-line to reduce diversions and the amount of unused water that is discharged at the end of a ditch (tailwater);
- Constructing additional measuring weirs and control boxes to control and measure flow throughout the system; and
- Investigating use of treated wastewater from the City of Sequim to supplant irrigation water supplied to Highland District users, thereby reducing diversions from the Dungeness River.

The last measure is represented by a project common to all action alternatives that assumes that 1 cfs of Highland District diversions can be saved by using Sequim treated wastewater for irrigation in the Highland service area. As of its 2001 report, the City of Sequim is adding 0.1 cfs to Bell Creek as surface flow and discharging the remainder of the treated wastewater not used for irrigation at Carey Blake Park or at the City Shop directly to saltwater. The feasibility of making 1 cfs available for irrigation in the Highland District has not been confirmed by the City of Sequim.

Most of the projects are open ditch replacement (113 projects in the overall Conservation Plan), and if all were implemented, diversion from the Dungeness River could be reduced by 30.2 cfs. Anywhere improvements were recommended, additional measurement and flow control devices were calculated as part of the new construction. The Conservation Plan identifies these projects by irrigation company or district (see Section 3.2 for summary tables).

Each of the structural projects recommended has been engineered for the site. Pipe sizing, length, and estimated leakage for each segment are detailed in Chapter 6 of the Conservation Plan. In addition, control boxes for measuring flow into laterals and periodic measurement weirs within the laterals are also included in the calculations. Piping calculations for combining adjacent canals into one pipe are provided. The project-by-project calculations were used in determining impact to ground water of the various alternatives (see Section 5.3 and Appendix A).

There are three projects for combining canal systems represented in all action alternatives, though no extra water savings are identified because each of the canals will either be piped separately or combined, minimizing conveyance loss in either case. These projects include the first reach of the Clallam Company and Cline District ditches, the Independent Company ditch from either of its diversions, and the Eureka Company ditch north of State Route 101.

The authors of the Conservation Plan examined three areas for possible canal abandonment and replacement with ground water use, but recommended only one. The other two areas, while feasible for replacement, involve costs of developing a ground water system that approximate or exceed the costs of the proposed piping. Also, maintenance of a ground water system is more expensive, including but not limited to the cost of the fuel or electricity needed to pump the water. The only area recommended for abandonment is a reach of the Cline District system, where switching current customers to a ground water system installed by the district would save 2.5 cfs of diversion demand.

A total of 17 re-regulating reservoirs are included in the Conservation Plan, with additional reservoirs recommended for the Highland District that are not specifically located. The Conservation Plan has since been modified to include only 16 reservoirs, eliminating the one planned on SP-5. While both on-farm and in-line reservoirs were initially considered, only in-line reservoirs were included in water savings and cost calculations because on-farm reservoirs would probably be constructed by individual farmers and not by the WUA or one of its member entities. These reservoirs allow for the reduction or elimination of tailwater, and therefore reduction of diversions at the river, provided that adequate hydraulic controls exist at the reservoir. Tailwater is water that is discharged at the end of an irrigation water delivery system without having been put to use. It results from the diversion of more water than the users need to make sure there is water in the ditch when each user is permitted to use it. Reservoirs capture and store flow that is in excess of immediate irrigation needs and release it on demand. If all the reservoirs recommended were constructed the total additional water savings for Dungeness River diversion would be 4.7 cfs during the irrigation season, including an estimated 0.5 cfs savings for the Highland District reservoirs.

2.4 Issues Identified During Project Preparation and Scoping

The central, driving issue for the WUA and for the federal agencies responsible for enforcement of the ESA is:

1. ***Reduced Dungeness River stream flow during low-flow periods due to diversions for irrigation has an impact on fish species.***

The Conservation Plan was prepared and would be implemented in response to the low habitat quantity and quality for anadromous salmonids in the Dungeness River. NOAA Fisheries then listed the Puget Sound chinook and the Hood Canal summer run chum salmon, both of which use the Dungeness River to spawn and rear, as threatened under ESA in 1999 (64FR14308 and 64FR14508). USFWS also listed the bull trout in 1999. These listings added significant urgency to the need to take all prudent actions to reduce to the extent practical the adverse impact of continued withdrawals of water from the Dungeness River for irrigation and domestic purposes. NOAA Fisheries and the USFWS have denied other irrigation entities elsewhere in the region access to water for diversion in the last 2 years where streamflow was determined to be critical for the survival of the salmon and where the entities had not taken all practical steps to minimize their diversions.

The second major issue that arose during the Conservation Plan assembly and after its publication was:

2. ***Increased efficiency of the irrigation water delivery system will reduce the quantity of tailwater entering small streams and water entering the shallow aquifer in at least some places in the project area and could have an impact on wetlands, creeks, and human uses of the shallow aquifer.***

The artificial recharge of ground water from water wasted in inefficient conveyance and distribution systems and the continued need for tailwater discharge from parts of the irrigation system over the last 100 years has enhanced natural wetlands and small streams and has formed artificial wetlands. In legal action taken against the WUA at the publication of a DNS in 1999 for this Conservation Plan, Graysmarsh LLC asserted that “The Water

Conservation Plan is a major action having a probable significant adverse environmental impact" because of the proposed reduction of historically wasted ground water and surface water[2]. Based on that initial petition and on a public scoping meeting held June 30, 2002, the following subissues were identified:

> ***2a. Wetlands: reduced ground water and tailwater supply to wetlands may change function, size, duration, and species composition (flora, terrestrial wildlife, aquatic wildlife) in wetlands developed over time using excess irrigation water.***
>
> ***2b. Small streams: reduced ground water and tailwater supply to small streams may reduce their streamflow, possibly impacting aquatic species, including but not limited to listed salmonid species.***
>
> ***2c. Water supplies: reduced shallow aquifer levels may impact access to water for people currently using or expecting to use the shallow aquifer.***
>
> ***2d. Dungeness River: reduced shallow aquifer levels may impact ground water recharge of the Dungeness River, reducing streamflow in the mainstem with consequences as detailed in 1, above.***
>
> ***2e. Reduced shallow aquifer levels and reduced tailwater input to small streams may increase concentrations of water contaminants (though will not affect overall quantities of contaminants).***

[2] Petition in Superior Court, Clallam County, WA, February 16, 2000, 00-2-00133-1.

3. Alternatives

3.1 Introduction

This chapter describes the development of alternative actions for reducing diversions for irrigation and domestic use from the Dungeness River. Chapter 3 explains and compares the four alternatives selected for detailed study (Alternatives 1, 2, 4, and 6) and discusses the alternatives considered but eliminated from detailed study (Alternatives 3 and 5). The context in which these alternatives are considered is laid out in Chapter 4, Affected Environment, and the impacts for each of the alternatives is discussed and analyzed in Chapter 5, Environmental Impacts.

Alternatives selected for detailed study must feasibly attain or approximate the proposal's objectives; that is, they must meet the Purpose and Need for the action (Chapter 2). Compared to the proposal, as described in Alternative 2, the alternatives selected for detailed study reduce the amount of water saved and, for a variety of reasons, maintain some of the inefficiencies in the conveyance systems of the WUA membership. If the only objective were to maximize streamflow in the Dungeness, these alternatives would not qualify under SEPA for consideration. However, the other issues brought up in scoping and early project review require consideration of alternatives that address other concerns.

Please note that this EIS does not identify a preferred alternative. Ecology had not indicated a preference at the time of the analysis, and SEPA does not require that a preferred alternative be identified. In fact, Ecology may choose an alternative that is intermediate in effect within the range of alternatives herein examined, and will choose the set of mitigation measures it considers appropriate for this project at the time of project decision, estimated to occur in late 2003. The identification of the Conservation Plan as the "proposal" does not indicate any preference for Alternative 2, but merely reflects the language provided in the administrative code related to SEPA (WAC-197-11-784).

The Washington State Department of Ecology (Ecology) conducted scoping for this project starting in July of 2002. The purpose of scoping was to narrow the focus of the EIS to a discussion of probable significant adverse impacts of the proposal, to identify reasonable alternatives that meet the goals identified by the Dungeness River Agricultural Water Users Association, to suggest potential mitigation measures, and to eliminate from detailed study those impacts that are not significant.

The Declaration of Significance, which withdrew the initial Declaration of Nonsiginificance issued by the Agnew Irrigation District, also announced the beginning of the scoping period. The scoping period ran from the date of the announcement (July 17, 2002) to August 13, 2002. A public meeting was held July 31, 2002, and comments were received during that time, including a suggestion for an alternative that would "define a subset of projects with less impact on habitat in irrigation-augmented wetlands and small streams". One letter was received from Perkins Coie, attorneys representing Graysmarsh LLC.

Issues raised during scoping included the function of wetlands, aesthetic values and property values (in regards to ditches often thought of as "streams"), public safety (in regards to open ditches), consideration of wildlife other than listed salmonids, and impacts to wetland forest composition.

3.2 Alternative 1—No Action

Alternative 1 represents the current condition in the Dungeness River area. The Dungeness River, according to the recent Habitat Limiting Factors WRIA 18 Report (Haring 1999) has been adversely impacted by water withdrawals for irrigation and by massive channel modifications for flood control. If diversions are not reduced, the irrigation system will continue to have a significant adverse impact on streamflow in the Dungeness River and will continue to be a significant impediment to salmon population and habitat restoration.

The artificially enhanced wetlands and streams are considered aesthetically and recreationally valuable by private and public users.

Whether or not the Conservation Plan is implemented, numerous additional projects that affect the aquifers and surface water flows will be implemented by various entities in the Sequim-Dungeness area. The most important group of projects consists of ongoing residential and commercial development, including increasing roads, driveways, and other impervious surfaces. Increasing impervious surfaces decreases aquifer recharge and increases surface storm runoff to creeks. Water supplies, including exempt wells, will be developed to support new housing, increasing withdrawals from at least the shallow aquifer (if not the second and third aquifers). Thus there will be continued changes in surface water flow and ground water availability, independent of the implementation of the Conservation Plan.

Under Alternative 1, the Conservation Plan would not be implemented in its entirety through state funding. However, several regulations and management plans would continue to be implemented within the project area. Table 3.2-1 provides a sample of actions that would occur.

3.3 Action Alternatives

3.3.1 Alternative 2—Proposed Full Plan Implementation (Chapter 6 of WUA Comprehensive Conservation Plan)

Alternative 2 includes the full Conservation Plan as described in Chapter 6 of the Conservation Plan without consideration of economic efficiency. It is described in Chapter 2 of this EIS as the proposal. It includes project or structural elements and non-project, non-structural elements. Completed as described in Chapter 6 of the Conservation Plan, this alternative would reduce average annual diversion from the Dungeness River by about 38.36 cfs.

Projects to be implemented under Alternative 2 are shown in Table 3.3-1 and on Figure 3.3-1.

3.3.2 Alternative 3—Pipe All Ditches

Alternative 3 would add to those projects proposed in Alternative 2 the piping of all of the ditches in the system, including the Agnew and Highland main ditches canals (a total of 88,128 feet or 16.7 miles), and approximately 10,607 feet (2 miles) of small portions of ditches not included in Alternative 2 due to very low conveyance loss.

The Agnew and Highland main ditches were not proposed for piping in Alternative 2, nor in Chapter 6 of the Conservation Plan, because they generally have very low conveyance losses. This is due to the nature of the substrate in which they were constructed (Vashon Till) and due to the accretion of very fine clay sediments on the bottom of the canals, preventing virtually all water loss. In addition, these large hillside canals provide significant stormwater interception and conveyance from runoff from upslope surfaces. If these canals were piped, the pipe would have to be installed in the canal itself. Pipe diameter has not

Table 3.2-1. A Sample of Current Condition Actions in the Dungeness River Area

	Title	Administrator	Issue(s)/Actions
Federal	Endangered Species Act	NOAA Fisheries and USFWS	Protect and restore populations of threatened and endangered species and their habitats.
	Clean Water Act	U.S. Environmental Protection Agency	Regulate discharges of pollutants into the waters of the United States.
	Comprehensive Irrigation District Management Plan	Sequim-Dungeness Valley Agricultural Water Users Association	Ensure ESA and CWA compliance for irrigation districts; reduce diversions from Dungeness River.
	Dungeness River Dike Maintenance	U.S. Army Corps of Engineers	Manage dike extended upstream to river mile (RM) 2.6 for flood control.
	Highway 101 work	U.S. Department of Transportation	Construct Highway 101 bypass of Sequim (completed in 1999) and maintain.
State	TMDL (Chapter 90.48 RCW)	Ecology	Implement the lower Dungeness/ Matriotti Creek TMDL.
	WRIA 18 Watershed Plan (90.82 RCW)	Clallam County, City of Port Angeles, Agnew Irrigation District, Jamestown S'Klallam Tribe, Elwha Klallam Tribe	Assess the status of water resources and determine how to balance competing demands for water.
	Washington Water Law	Ecology	Administer and regulate ground and surface water rights, determine beneficial use, manage use of waters of the state.
	Salmon Recovery Act (77.85 RCW)	Salmon Recovery Funding Board	Direct state and federal funds for salmon recovery activities.
	State roadwork (bridges)	Washington Department of Transportation (WADOT)	Fish habitat mitigation during repair and construction activities.
Local	Clallam County Comprehensive Plan	Clallam County (renewal under way)	Coordinate growth and development of the land and physical improvements in the unincorporated areas.
	Clallam County Critical Areas Ordinance	Clallam County	Identify and protect critical aquatic, wildlife, and wetland habitats.
	City of Sequim Comprehensive Plan	City of Sequim	Guide growth and development in the unincorporated areas of the regional planning area; identify urban areas where public facilities and services can be provided efficiently.
	Clean Water District (Including TMDL)	Clallam County	Provide a strategy to address fecal coliform pollution that is directly attributed to growth in the unincorporated rural areas of the county.
	DRMT priority projects	Dungeness River Management Team	Identify, coordinate, and promote critical salmon habitat restoration projects.
	WUA funded projects	WUA, Jamestown S'Klallam Tribe, Ecology	Complete individual piping and regulatory reservoir projects designed to reduce conveyance loss (see Appendix A for completed projects).
	City of Sequim wastewater treatment and reuse	City of Sequim Public Works	Re-use 100% of treated municipal wastewater for habitat enhancement; industrial uses; and landscape, agricultural, and golf course irrigation.
	Local roadwork (bridges)	Clallam County Public Works, City of Sequim Public Works	Fish habitat mitigation during repair and construction activities.
	2496 salmon recovery projects	North Olympic Lead Entity	Salmon recovery strategies for projects to improve habitat across WRIAs 18, 19, 20, and part of 17.

Table 3.3-1. Projects to be Implemented under Alternative 2 (Full Plan Implementation[1/])

	WUA Member Irrigation Entity (1996 structure, now altered)																		Total
	Agnew District		Dungeness Company		Cline District		Clallam Company		Dungeness District		Independent Company		Highland District		Sequim Prarie Company		Eureka Company		
Type of Project	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**Water Savings (cfs)**
Re-use Treated														1					**1**
Abandon Canal, Replace with GW						2.5													**2.5**
Regulated Reservoirs	A-RR	1	DC-RR	0.5	CL-RR	0.5	C-RR	0.5	DD-RR	0.5			H-RR	0.5	SP-RR	1.2			**5**
Pipe	A-1	n/a	DC-1	0.57	CL-3	0.12	C-1	0.31	DD-1	0.62	I-1	0.5	H-1	1.48	SP-1	0.09	E-1	0.09	
	A-4	0.32	DC-2	0.14	CL-4	0.06	C-2	0.05	DD-2	0.05	I-2	0.5	H-2	0.03	SP-2	0.37	E-M1	1.54	
	A-5	n/a	DC-4	0.05	CL-11	0.07	C-3	0.4	DD-3	n/a	I-3	0.4	H-3	n/a	SP-3	–			
	A-6	0.05	DC-5	–	CL-12	0.02	C-4	0.17	DD-4	0.05	I-4	0.08	H-4	0.01	SP-4	0.02			
	A-7	0.2	DC-7	–	CL-13	0.14	C-5	0.04	DD-5	0.03	I-M1	0.82	H-5	0.01	SP-5	0.39			
	A-8	0.21	DC-8	–	CL-14	0.05	C-M1	0.17	DD-M1	0.46	I-M2	0.57	H-6	0.02	SP-6	0.14			
	A-11	0.36	DC-11	–	CL-M1	0.19	C-M2	0.13	DD-M2	0.59	I-M3	0.79	H-7	0.02	SP-7	0.14			
	A-12	0.29	DC-M1	–	CL-M2	0.08	C-M3	0.09	DD-M3	2			H-8	n/a	SP-8	0.4			
	A-13	0.01	DC-M2	–	CL-M3	0.14	C-M4	0.26					H-9	0.03	SP-9	0.05			
	A-14	0.21	DC-M3	–	CL-M4	1.1							H-10	1.1	SP-M1	1.05			
	A-15	0.11	DC-M4	2.46	CL-M5	0.48							H-11	0.02	SP-M2	0.19			
	A-16	0.21			CL-M6	0.36							H-12	0.01	SP-M3	0.77			
	A-17	0.32			CL-M7	2.6							H-13	0.02	SP-M4	–			
	A-18	0.58											H-14	0.02					
	A-20	0.08											H-15	0.24					
	A-21	0.02											H-16	0.02					
	A-22	0.19											H-17	n/a					
	A-24	0.03																	
	A-25	0.03																	
	A-26	n/a																	
	A-27	0.02																	
	A-29	0.02																	
	A-30	0.2																	
	A-31	0.09																	
	A-34	0.01																	
	A-35	0.01																	
	A-36	0.12																	
	A-37	0.05																	
	A-38	0.19																	
	A-39	0.01																	
	A-M1	0.12																	
	A-M2	0.12																	
	A-M3	n/a																	
Subtotal for Piping Only		4.18		3.22		5.41		1.62		3.8		3.66		3.03		3.61		1.63	**30.16**
Total Water Savings:		**5.18**		**3.72**		**8.41**		**2.12**		**4.30**		**3.66**		**4.53**		**4.81**		**1.63**	**38.36**

1/ Alternative 2 – Full Plan Implementation is described in Chapter 6 of the Conservation Plan.

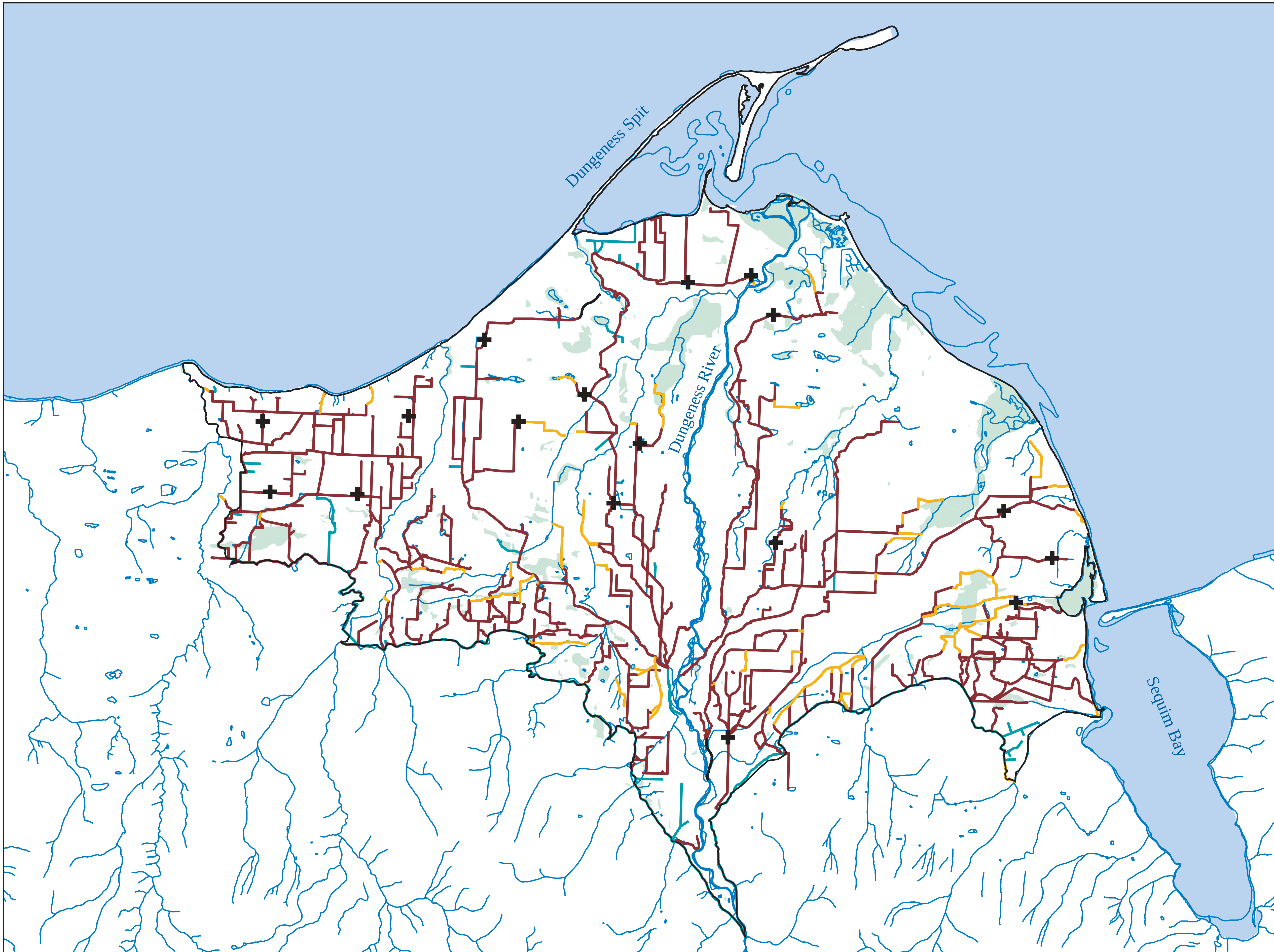

Figure 3.3-1
Location of Projects to be Implemented Under Alternative 2

Map Features

- EIS Boundary
- Wetlands
- Dungeness River
- Irrigation Ditches
- Streams
- Alternative 2
- Abandon / Combine
- Tailwater
- re-regulating reservoirs

Location Map

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Q:\projects_2002\dungeness\workdir\maps\Final_maps\Figure3_3-1mxd been calculated but is estimated at over 18 inches, which would partially fill the canal, reducing the stormwater carrying capacity of the canals.

Montgomery Water Group, in unpublished calculations, estimated that the conveyance loss from the Agnew main ditch not recommended for piping under the Conservation Plan would be 2.2 cfs, while conveyance loss for the Highland main ditch was less than 0.1 cfs. Because the piping of the main canals would be extremely expensive and would create significant storm water management problems for residences and farms downslope of the canals, Alternative 3 was not carried through the environmental analysis process.

3.3.3 Alternative 4—Proposed Economic Efficiency (Chapter 9 of WUA Comprehensive Conservation Plan)

As proposed in Chapter 6 of the Plan (see discussion in Section 3.3.1 – Alternative 2) and as calculated in 1997 dollars, the Conservation Plan would cost about $20 million and would save 38.36 cfs. Of these amounts, the piping projects alone in Chapter 6 would cost a total of $13,397,700 and would save 30.16 out of a total of 38.36 cfs for an average cost per cfs saved of $444,220. While cost estimates have not been completed for the Conservation Plan if implemented in 2003, it is safe to say that costs would be considerably higher due to inflation and to increases in materials and labor costs in excess of general inflation.

Chapter 9 of the Conservation Plan took economic efficiency into account and proposed only those piping projects that could be completed for $50,000 per cfs or less, and also included non-piping projects (re-regulated reservoirs, canal abandonment, re-use treated water).

Chapter 9 also included all pipe projects downstream of a proposed piping project so that the engineered sizes of pipe for the proposed project would be effective. Alternative 4 contains the Chapter 9 project set, summarized in Table 3.3-2 and illustrated in Figure 3.3-2.

Under Alternative 4, 48 projects originally proposed for implementation under the full plan would be eliminated. Alternative 4 would save 33.42 cfs from diversion from the Dungeness River. This savings is approximately 87 percent of the savings to be realized from the full implementation of the Conservation Plan's projects and would cost about 67 percent of the full implementation. Costs for piping projects in Chapter 9 were estimated to be $9,080,900 for a per-cfs cost of $360,067. This is in excess of the $50,000 per cfs limit because of the inclusion of many projects to protect upper pipe sizing and engineering.

3.3.4 Alternative 5—Proposed Intra-WUA Equity

The constituent members of the WUA range in size from the Eureka Company, which served 68 acres in 1996, to the Agnew District, which served 1,538 acres in 1996 (WUA 2001). A concern was raised during early scoping that the implementation of Alternative 4 or some version that ranked projects across the WUA without regard to the member entities would not equitably treat all entities. Therefore Alternative 5 was proposed, where the top 50 percent of projects, ranked by cfs saved, would be implemented within each entity. Approximately 35.8 cfs would be saved from diversion in the Dungeness River.

Alternative 5 would include all non-piping projects as found in Alternative 2. It would also include all pipe projects downstream of a proposed piping project so that the engineered sizes of pipe for the proposed project would be effective.

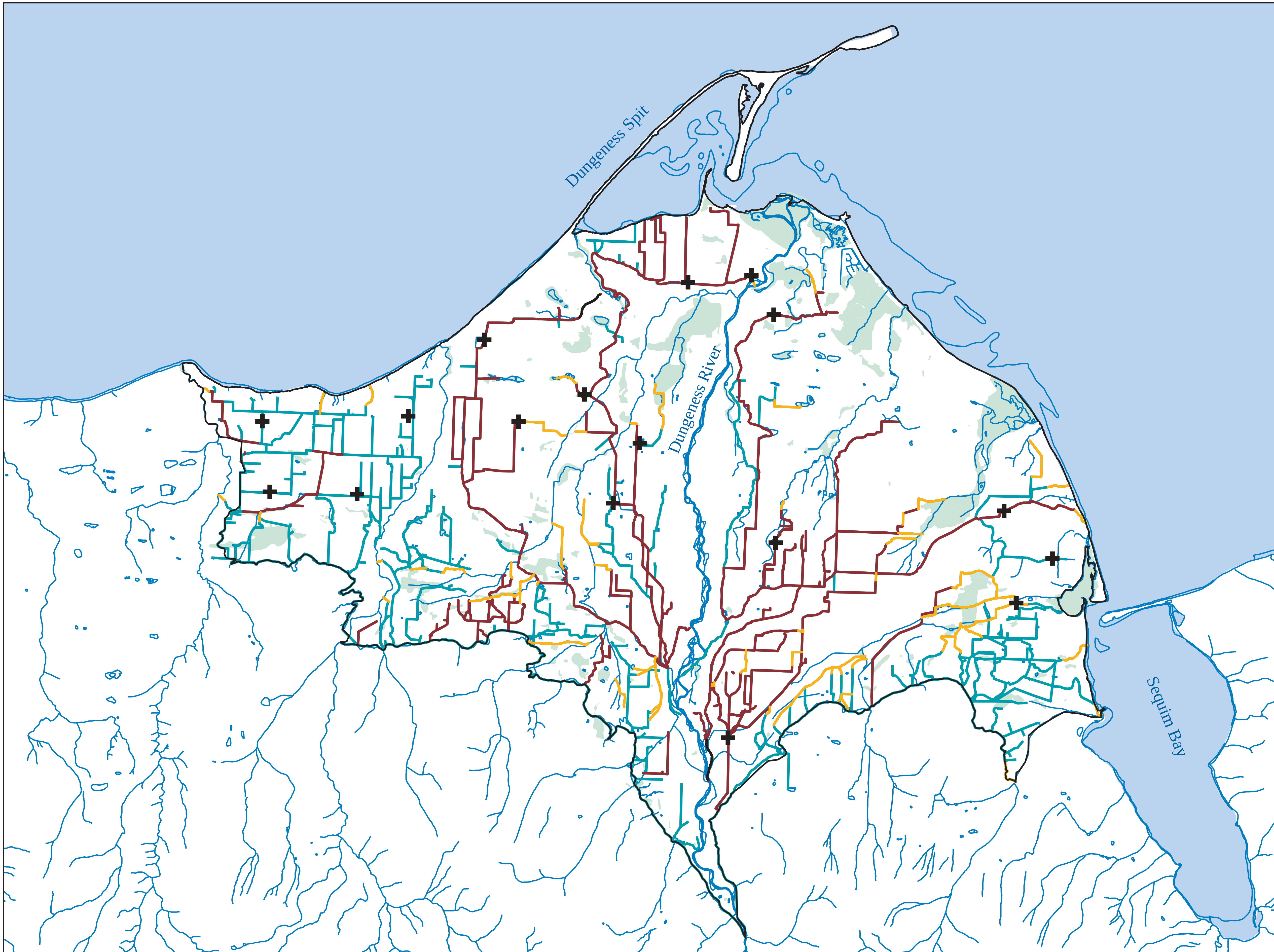
Alternative 5 would pipe many low-efficiency ditches in Agnew and Highland because, as large districts, they can reach relatively costly projects (low-efficiency in cost per cfs and in cfs saved) in their top 50 percent of potential water savings. Alternative 5 is intermediate in overall environmental impact between the proposed piping in Alternative 2 and the more

Table 3.3-2. Projects to be Implemented under Alternative 4 (Plan Implementation with Economic Efficiency[1/])

	WUA Member Irrigation Entity (1996 structure, now altered)																		Total
	Agnew District		Dungeness Company		Cline District		Clallam Company		Dungeness District		Independent Company		Highland District		Sequim Prarie Company		Eureka Company		
Type of Project	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**Water Savings (cfs)**
Re-Use Treated Water														1					**1**
Abandon Canal, Replace with GW						2.5													**2.5**
Regulated Reservoirs	A-RR	1	DC-RR	0.5	CL-RR	0.5	C-RR	0.5	DD-RR	0.5			H-RR	0.5	SP-RR	1.2			**5**
Pipe	A-4	0.32	DC-1	0.57	CL-3	0.12	C-1	0.31	DD-4	0.05	I-1	0.5	H-1	1.48	SP-1	0.09	E-1	0.09	
	A-8	0.21	DC-2	0.14	CL-4	0.06	C-2	0.05	DD-5	0.03	I-2	0.5	H-10	1.1	SP-2	0.37	E-M1	1.54	
	A-12	0.29	DC-4	0.05	CL-11	0.07	C-M1	0.17	DD-M1	0.46	I-3	0.4			SP-3	–			
	A-14	0.21	DC-5	–	CL-12	0.02	C-M2	0.13	DD-M2	0.59	I-4	0.08			SP-4	0.02			
	A-15	0.11	DC-7	–	CL-13	0.14	C-M3	0.09	DD-M3	2	I-M1	0.82			SP-5	0.39			
	A-20	0.08	DC-8	–	CL-14	0.05	C-M4	0.26			I-M2	0.57			SP-6	0.14			
	A-30	0.2	DC-11	–	CL-M1	0.19					I-M3	0.79			SP-M1	1.05			
	A-34	0.01	DC-M1	–	CL-M2	0.08									SP-M2	0.19			
	A-35	0.01	DC-M2	–	CL-M3	0.14									SP-M3	0.77			
	A-M1	0.12	DC-M3	–	CL-M4	1.1													
			DC-M4	2.46	CL-M5	0.48													
					CL-M6	0.36													
					CL-M7	2.6													
Subtotal for Piping Only		1.56		3.22		5.41		1.01		3.13		3.66		2.58		3.02		1.63	**25.22**
Total Water Savings:		**2.56**		**3.72**		**8.41**		**1.51**		**3.63**		**3.66**		**4.08**		**4.22**		**1.63**	**33.42**

1/ Alternative 4 – Plan Implementation with Economic Efficiency is described in Chapter 9 of the Conservation Plan.

Figure 3.3-2
Location of Projects to be Implemented Under Alternative 4



Map Features

- EIS Boundary
- Wetlands
- Dungeness River
- Irrigation Ditches
- Streams
- Alternative 4
- Abandon / Combine
- Tailwater
- re-regulating reservoirs

Location Map

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cost-conscious Alternative 4. While some of the same projects are present across all three alternatives, there are many projects deleted from Alternative 4 that are included in Alternative 5, and vice versa. Alternative 5 is intermediate in effect on the Dungeness River between Alternatives 2 and 4 and offers no clear environmental advantage over either. Finally, because it does not provide a clear improvement in equity for the member entities over Alternatives 2 and 4, Alternative 5 has been removed from full consideration in the environmental analysis.

3.3.5 Alternative 6—Minimized Impact to High-Value Streams and Wetlands

The projects proposed for Alternative 6 are a subset of the projects listed in Alternative 2 that are expected to reduce the effects to selected streams and a wetland.

This alternative was proposed by a Graysmarsh employee, Ms. Robin Berry in the public scoping meeting held July 31, 2002, in Sequim, Washington. Ms. Berry recommended that an alternative be developed that minimized impacts to "high-value" independent streams and wetlands. She was particularly concerned about Graysmarsh and referenced the study conducted by Associated Earth Sciences, Inc. (AESI) and the "zone of contribution" that the study identified (AESI 1999). This "zone of contribution" is shown in a map attached to the Graysmarsh comment letter, submitted by their attorneys at Perkins Coie LLP, and found in Appendix G of this EIS. The same map is found, with the irrigation ditches overlain, as Figure H.2-1 in Appendix H. Ditches clearly within the mapped "zone of contribution" were excluded from piping in this alternative. Ditches upgradient of the open southwest portion of the "zone of contribution" were not excluded from piping because it was Graysmarsh itself, not all of Gieren Creek, that was the focus of the "zone of contribution" delineation by AESI. See Appendix H.2 for more detail.

Wetlands

The wetland analysis (Section 4.4.2) shows that there are wetlands in the project area that either currently are highly functional or have a high potential to perform valuable wetland functions. Many of these wetlands are not significantly enhanced by irrigation-augmented ground water or tailwater leaving the irrigation system. Wetlands associated with the mouth of the Dungeness River, for example, will not be adversely affected by plan implementation because they depend on the marine environment for a significant portion of their water supply. Of the remaining large wetlands with high potential to perform wetland functions, the wetland associated with Gierin Creek, known as Graysmarsh, is likely to undergo the greatest change with full plan implementation.

Graysmarsh is now supplied in large part by ground water, some of which derives from leaking irrigation ditches, and is secondarily supplied by Gierin Creek. However, the largest part of the Graysmarsh area was a salt marsh until its private owners installed a tide gate on Gierin Creek, and channeled and shortened the creek itself. This work was started before the 1914 Clallam County Tax Assessor's maps were completed and was finished by 1930 (see R. Johnson Memorandum, Appendix H.1). The current owners purchased the property in 1945, and have maintained the tide gate and channeled condition of Gierin Creek (personal communication, Robin Berry, Graysmarsh employee to Penny Eckert, Foster Wheeler Environmental, 2002).

Streams

The presence of an adequate amount of water for spawning and rearing purposes is critical for fish. All fish listed as threatened under the ESA utilize the Dungeness River mainstem and side-channels throughout their life history. Chinook and bull trout juveniles use the Dungeness River and its tributaries for rearing and some limited spawning, but make only negligible use of the independent streams. Pink salmon use the Dungeness River mainstem almost exclusively. Hurd Creek below the hatchery and Matriotti Creek provide habitat, are known to support salmonids, and are the most productive of the Dungeness River tributaries. These creeks were not included in this alternative because they support the same species as the Dungeness River and the water is more effectively used in the mainstem to keep flow in the side channels. More information about the critical nature of side channel habitat is found in Section 4.5.1 and in Haring (1999).

Independent streams that drain directly to salt water are used by species not listed as endangered or threatened under the ESA, including chum (other than Hood Canal summer chum), coho, winter steelhead, and cutthroat trout. Siebert Creek, Gierin Creek, and Bell Creek below its fork in the first river mile are the most productive. Each of these streams has low-flow limitations at least during the summer, even with artificial additions of wasted irrigation ground and tailwater. Continued artificially enhanced flows would maintain the current productivity of these species in these creeks, at least as related to flows. The 2003 ground water model completed for the Conservation Plan showed a reduced amount of ground water flow to these creeks if all irrigation recharge were stopped. Table 5.3-4 summarizes the results of the 2003 model.

A zone of recharge has not been identified for Bell or Siebert Creeks. For the purposes of defining projects to be omitted from pipelining under Alternative 6, the ditches within the watersheds of Siebert Creek are included, the ditches contributing to the lower mile of Bell Creek are included, and the ditches within the zone of contribution to Graysmarsh identified by AESI are included. Leakage from these canals would enter ground water in the area likely to affect the wetland and creeks, though the actual amount of ground water reaching the creeks would be much less than the total leakage calculated. This is particularly the case where there are many withdrawals from upgradient or nearby wells in the shallow aquifer.

Bell Creek is supplemented by tailwater that would be reduced but not eliminated with the installation of re-regulating reservoirs under plan implementation. Under Alternative 6, the reservoir would not be constructed to maintain the supplemental flow in its current amount. There are no planned re-regulating reservoirs that would affect Siebert Creek or Gierin Creek.

Table 3.3-3 shows projects that would not be completed under Alternative 6 to preserve artificial irrigation recharge to Graysmarsh and to Gierin, Bell, and Siebert Creeks.

Table 3.3-4 shows the projects that would be implemented under this alternative and Figure 3.3-3 illustrates their locations. Approximately 35.38 cfs would be saved from diversion in the Dungeness River.

3.3.6 Summary and Comparison of Alternatives

Table 3.3-5 summarizes the main features of each of the alternatives.

Table 3.3-3. Projects Not Completed under Alternative 6

Stream or Wetland	Type	Location	Estimated Leakage (cfs)	Subtotal Type of Contribution (cfs)	Savings for Stream or Wetland (cfs)
Gierin Creek and Graysmarsh Wetland	Ditch	SP-5	0.39		
	Ditch	SP-6	0.14		
	Ditch	SP-7	0.14		
	Ditch	SP-M1 1/	1.05	Ditch: 1.73 2/	1.73
Siebert Creek	Canal	A-M1	0.12		
	Canal	A-M2	0.12		
	Canal	A-M3	NA		
	Ditch	A-24	0.03		
	Ditch	A-25	0.03		
	Ditch	A-26	NA		
	Ditch	A-27	0.02		
	Ditch	A-29	0.02		
	Ditch	A-31	0.09		
	Ditch	A-34	0.01		
	Ditch	A-35	0.01		
	Ditch	A-37	0.05	Ditch: 0.50	0.5
Bell Creek	Ditch	H-15	0.24		
	Ditch	H-14	0.02	Ditch: 0.26	
	Re-reg	HW1	0.60	Re-reg: 0.5	0.76
Total					**2.99**

1/ Because only the upper half of SP-M1 is in Gierin Creek watershed, not all leakage listed could reach Gierin Creek.
2/ The savings associated with ditch lining in the WUA Conservation Plan do not agree with estimates in AESI (see p. 3-12). The discrepancy may be due to a difference in the way ditches were included in the calculations.
Re-reg = Tailwater reduction due to re-regulating reservoir
Ditch/Canal = Leakage from ditch or canal

Table 3.3-4. Projects to be Implemented Under Alternative 6 (Small Streams and Wetlands Maintenance)

	WUA Member Irrigation Entity (1996 structure, now altered)																		Total
	Agnew District		Dungeness Company		Cline District		Clallam Company		Dungeness District		Independent Company		Highland District		Sequim Prarie Company		Eureka Company		
Type of Project	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**ID**	**Water Savings (cfs)**	**Water Savings (cfs)**
Re-Use Treated Water														1					**1**
Abandon Canal, Replace with GW						2.5													**2.5**
Regulated Reservoirs	A-RR	1	DC-RR	0.5	CL-RR	0.5	C-RR	0.5	DD-RR	0.5			H-RR	0	SP-RR	1.2			**4.2**
Pipe[1/]	A-1	n/a	DC-1	0.57	CL-3	0.12	C-1	0.31	DD-1	0.62	I-1	0.5	H-1	1.48	SP-1	0.09	E-1	0.09	
	A-4	0.32	DC-2	0.14	CL-4	0.06	C-2	0.05	DD-2	0.05	I-2	0.5	H-2	0.03	SP-2	0.37	E-M1	1.54	
	A-5	n/a	DC-4	0.05	CL-11	0.07	C-3	0.4	DD-3	n/a	I-3	0.4	H-3	n/a	SP-3	–			
	A-6	0.05	DC-5	–	CL-12	0.02	C-4	0.17	DD-4	0.05	I-4	0.08	H-4	0.01	SP-4	0.02			
	A-7	0.2	DC-7	–	CL-13	0.14	C-5	0.04	DD-5	0.03	I-M1	0.82	H-5	0.01	SP-8	0.4			
	A-8	0.21	DC-8	–	CL-14	0.05	C-M1	0.17	DD-M1	0.46	I-M2	0.57	H-6	0.02	SP-9	0.05			
	A-11	0.36	DC-11	–	CL-M1	0.19	C-M2	0.13	DD-M2	0.59	I-M3	0.79	H-7	0.02	SP-M2	0.19			
	A-12	0.29	DC-M1	–	CL-M2	0.08	C-M3	0.09	DD-M3	2			H-8	n/a	SP-M3	0.77			
	A-13	0.01	DC-M2	–	CL-M3	0.14	C-M4	0.26					H-9	0.03	SP-M4	–			
	A-14	0.21	DC-M3	–	CL-M4	1.1							H-10	1.1					
	A-15	0.11	DC-M4	2.46	CL-M5	0.48							H-11	0.02					
	A-16	0.21			CL-M6	0.36							H-12	0.01					
	A-17	0.32			CL-M7	2.6							H-13	0.02					
	A-18	0.58											H-16	0.02					
	A-20	0.08											H-17	n/a					
	A-21	0.02																	
	A-22	0.19																	
	A-30	0.2																	
	A-36	0.12																	
	A-38	0.19																	
	A-39	0.01																	
Subtotal for Piping Only		3.68		3.22		5.41		1.62		3.8		3.66		2.77		1.89		1.63	**27.68**
Total Water Savings:		**4.68**		**3.72**		**8.41**		**2.12**		**4.30**		**3.66**		**3.77**		**3.09**		**1.63**	**35.38**

1/ A list of ditches that have already been piped can be found in Appendix A.

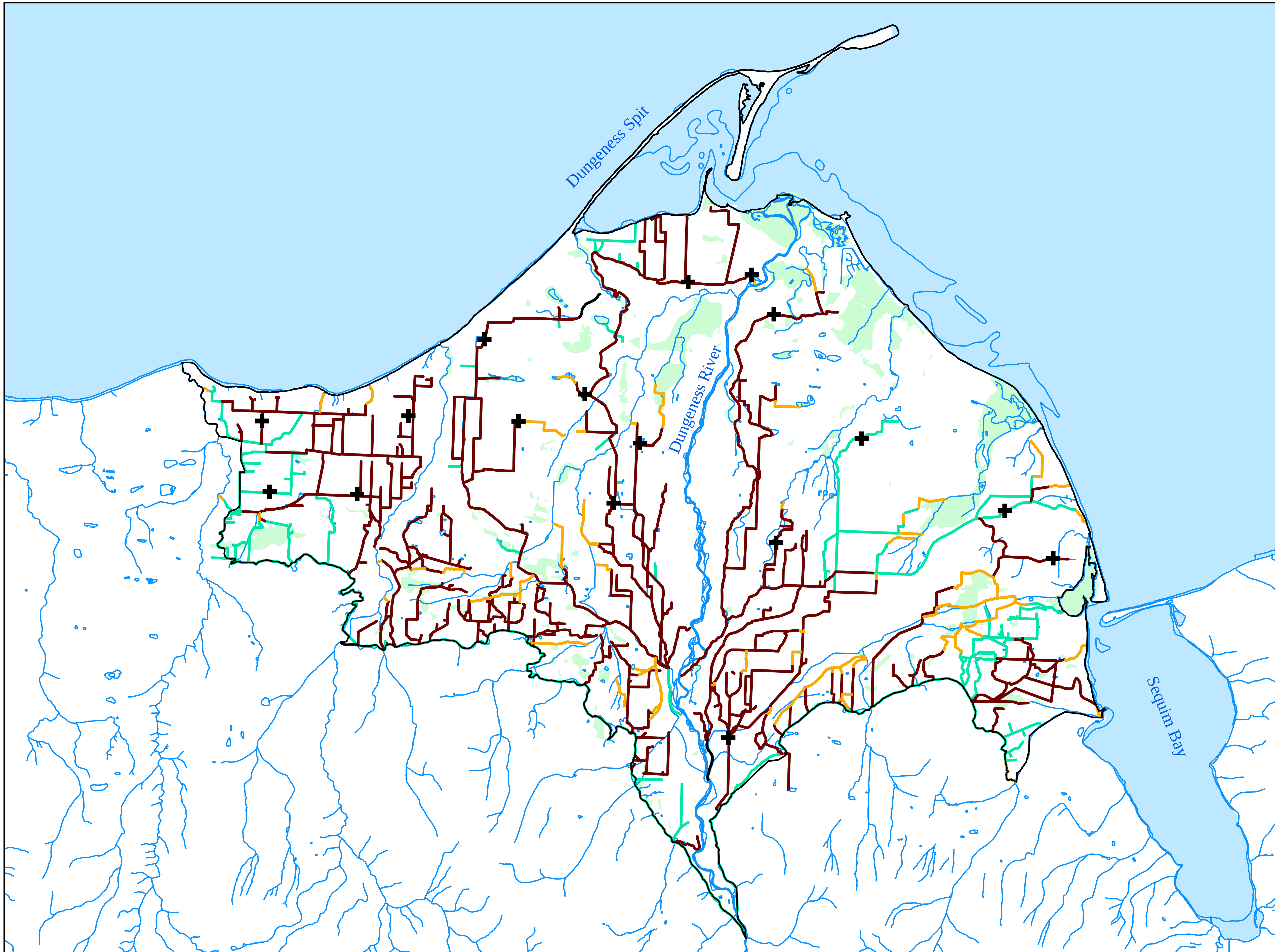

Figure 3.3-3
Location of Projects to be Implemented Under Alternative 6

Map Features
- EIS Boundary
- Wetlands
- Dungeness River
- Irrigation Ditches
- Streams
- Alternative 6
- Abandon / Combine
- Tailwater
- re-regulating reservoirs

Location Map

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Table 3.3-5. Comparison of Alternatives

Alternative	Description	Number of Projects					Comments
		Piping	Canal Combination	Canal Abandonment	Re-Regulating Reservoirs	cfs Saved	
1	Current condition; no action	0	0	0	0	0	See Appendix A for projects completed since 1996
2	Proposed plan	108	3	1	16-20	38.36	
3	Pipe all canals and laterals	110+	3	1	16-20	40.56	Includes piping Agnew and Highland Main Canals
4	Economic efficiency	65	3	1	16-20	33.42	Originally proposed for prioritization only
5	Intra-WUA equity	61	3	1	16-20	35.79	
6	Small streams and wetlands	95	3	1	16-20	35.38	Requested during public scoping

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4. Affected Environment

4.1 Introduction

The purpose of this chapter is to provide background information on elements of the environment that may be affected by the proposed Conservation Plan. Also included are elements like the geology of the area that are important for understanding the crucial topics of ground water and water supply. This is not an exhaustive catalog of all aspects of the natural and built environment in the area but a summary of known information on important elements that the implementation of the Conservation Plan may affect. The majority of the discussion concentrates on water-related resources, including the water itself, fisheries, and wetlands. Brief discussions summarize needed information on other aspects of the environment.

4.2 Geology and Soils

4.2.1 Geology

The bedrock and surficial geology of Western Washington, including the Puget Sound Lowland, has been influenced throughout time by tectonic events and multiple continental glaciations. The bedrock of the Olympic Peninsula consists of both volcanic and marine sedimentary rocks. The volcanic rocks are submarine basalt flows and breccias of the Crescent Formation (Tabor and Cady 1978). The marine sedimentary rocks consist of sandstone, siltstone, mudstone, and conglomerate of the Twin River Group, Aldwell Formation, and the Blue Mountain Unit. Bedrock outcrops in the foothills along the southern boundary of the Sequim-Dungeness peninsula and in the valleys along Canyon, McDonald, Siebert, and Morse Creeks (Thomas et al. 1999).

The present topography and distribution of unconsolidated geologic deposits in the Sequim-Dungeness peninsula are largely a result of the large-scale continental glaciations that occurred during the Pleistocene Epoch (10,000 to 1,600,000 years before present). Cordilleran ice sheets formed in the mountains of British Columbia and advanced southward into the Puget Sound Lowland and the northeast corner of the Olympic Peninsula. Repeated episodes of glacial advance and recession resulted in accumulations of glacial and interglacial deposits up to 2,500 feet thick (Jones 1996).

The last glacial ice sheet, referred to as the Vashon Stade of the Frasier glaciation, began its advance approximately 18,000 years before present. When the climate began to warm, approximately 13,500 years ago, progressive melting of this ice sheet occurred. Stratigraphic deposits of the Vashon Stade include the Everson sand, Everson glaciomarine drift, Vashon recessional deposits, Vashon till, and Vashon advance outwash. These heterogeneous deposits of clay, silt, sand, and gravel form the aquifers and aquitards that comprise the regional ground water flow system in the Sequim-Dungeness area. The volcanic and marine sedimentary rocks that underlie the unconsolidated glacial deposits form the bottom-most unit of the ground water flow system. Aquifers and their characteristics are discussed in Section 4.3.2.

Nonglacial surficial deposits in the area consist of beach deposits; alluvium, peat, and marsh deposits; and older alluvium (Schasse and Logan 1998, Schasse and Wegmann 2000).

4.2.2 Soils

The U.S. Department of Agriculture (USDA) Soil Conservation Service 1979 Soil Survey of Clallam County Area maps 11 soil units for the Sequim-Dungeness area. The soils of the upper Dungeness River basin are typical of the Olympic Peninsula mountainous regions. They tend to be shallow and well-drained, with low to moderate water retention and high infiltration rates (USDA 1979).

Soils in the lower Dungeness basin are alluvial, deposited during episodes of valley flooding. These soils have a high agricultural value due to the fine texture of sediment deposited. Most of the prime farmland identified by the USDA 1979 soil survey (Agnew silt loam, Cassalary fine sandy loam, Dungeness silt loam, and Puget silt loam) occurs extensively along the Dungeness River and the Sequim-Dungeness Valley.

4.3 Water

The Dungeness River watershed is located in the northeastern corner of the Olympic Peninsula (Figure 4.3-1). Within this watershed, surface water and ground water systems interact closely with one another. Surface water consists of the Dungeness River, its tributaries and other independent streams, as well as an extensive system of irrigation ditches that have been constructed over the past 100 years. Leakage from streams and irrigation ditches contributes to the recharge of the ground water flow system. Conversely, ground water discharge and irrigation tailwaters provide much of the flow to the streams in the area (Thomas et al. 1999). Ground water resources also supply the majority of the area's drinking water supply.

This section summarizes surface water and ground water in the affected environment and discusses the interconnection between these two resources.

4.3.1 Surface Water

Dungeness River

The Dungeness River originates in the northeast portion of the Olympic Mountains, draining from Obstruction Peak, Mt. Cameron, Mt. Deception, Mt. Constance, Buckhorn Mountain and Mt. Townsend (Bountry et al. 2002). The Dungeness River descends through the steep mountain canyons of the Olympic Mountains and flows northward to the Strait of Juan de Fuca. After leaving the mountains, the Dungeness passes through an extensive, flatter middle watershed of the foothills before reaching the broad lowland alluvial fan of the Sequim-Dungeness peninsula (Thomas et al. 1999).

The Dungeness River mainstem consists of 31.9 river miles (RM). Those portions of the Dungeness River that are part of the affected environment for this EIS consist of the lower 11 miles of the river, because the first irrigation ditch diversion (the Agnew ditch diversion) is located at RM 11.1 (Figure 4.3-2). This section of the river is also referred to as the lower Dungeness or the study area (Bountry et al. 2002, Thomas et al. 1999).

Kramer, Chin, and Mayo (Kramer et al. 1990) characterize the lower Dungeness River channel as braided from approximately RM 10 to Ward Bridge (RM 3.2) with a shallow, wide (approximately 300-foot) channel, steep bed slope, and non-cohesive bank material consisting of sand and gravel. Below RM 3.2, the bed slope becomes more gradual, following a single channel, with an active width of approximately 100 feet. Tidal influence extends to approximately 0.9 miles up the Dungeness River to about Schoolhouse Bridge (Dames and Moore 2000).

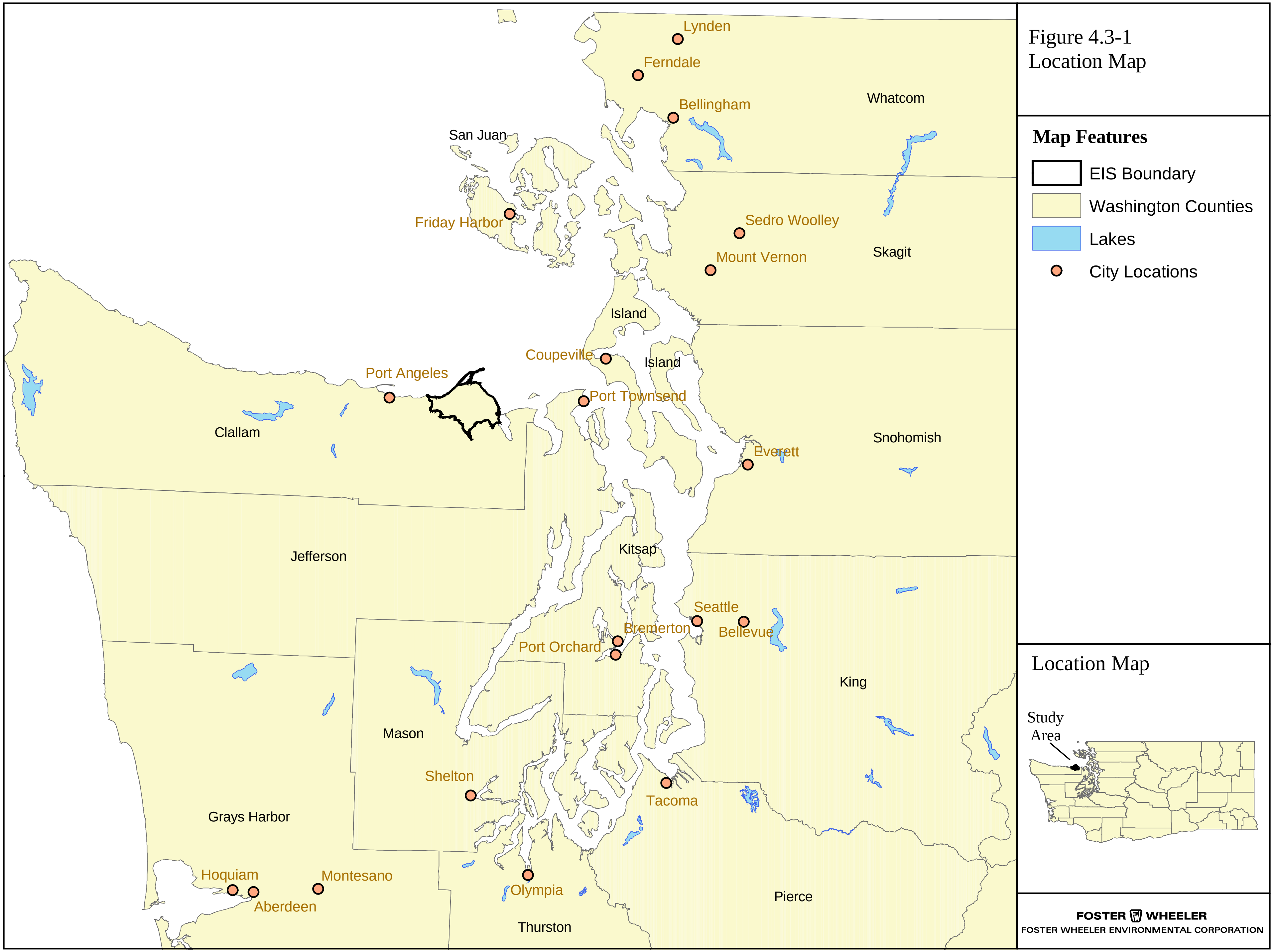

Figure 4.3-1
Location Map

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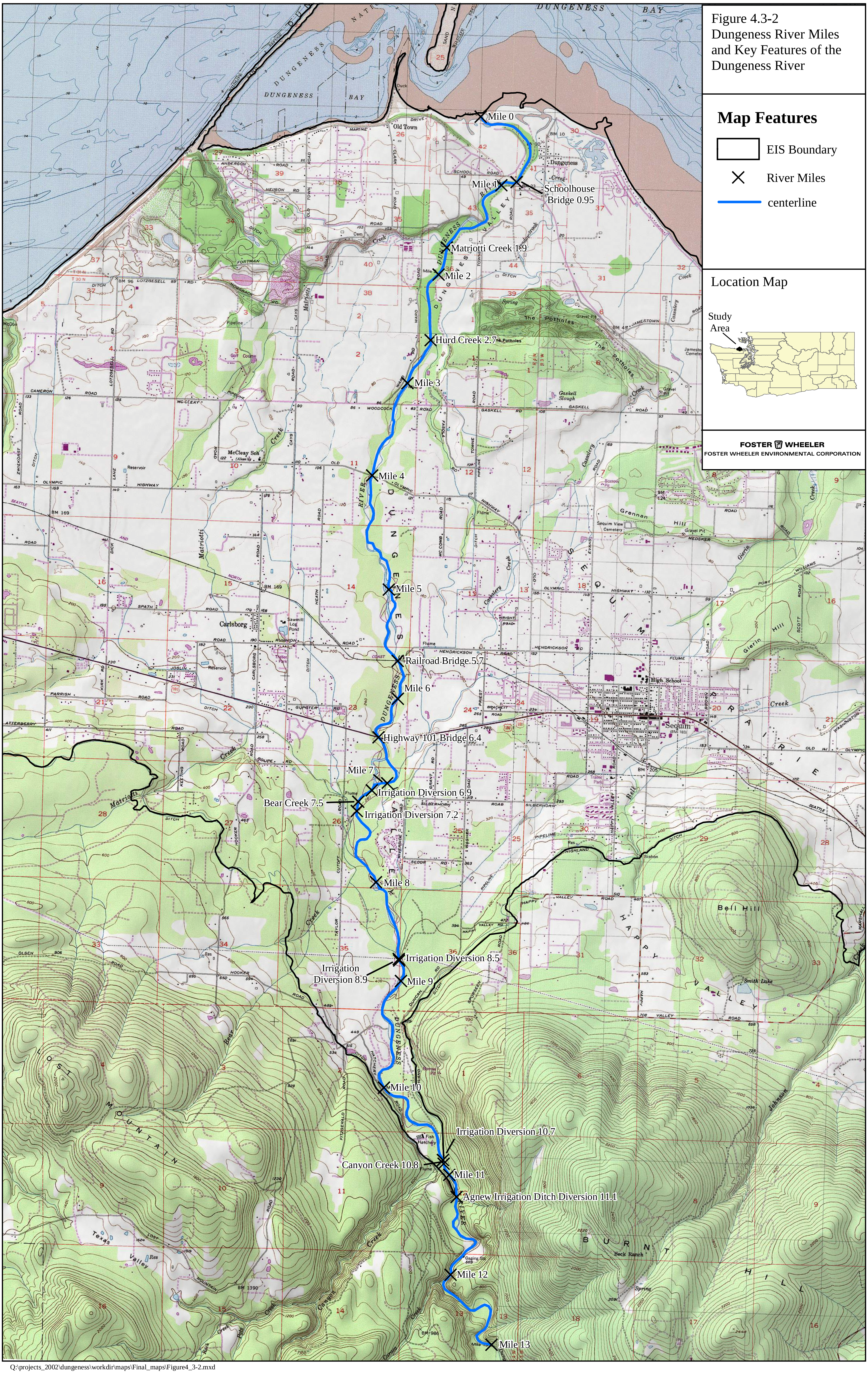
Figure 4.3-2
Dungeness River Miles and Key Features of the Dungeness River



Erosion, slope movement, and sedimentation are key processes in the lower Dungeness River causing the high levels of sediment load in the river (Kramer et al. 1990).

The ongoing migration of the river channel, particularly in the braided river reaches, has led to the construction of levees (also referred to as dikes) for flood protection (Entrix 2003). These levees and other bank protection (riprap) have been constructed along several areas of the lower 10.5 RM since the early 1900s to provide protection to a given area from flooding (Bountry et al. 2002). The main levees on the Dungeness (from upstream to downstream) are as follows (Bountry et al. 2002):

Levee	Location
Kinkade Levee	RM 9.6 to 9.9
Haller Dike	RM 8.57 to 8.87
Dungeness Meadows Levee	RM 7.5 to 8.1
U.S. Army Corps of Engineers (Corps) Levee	RM 2.6 to near the mouth of the Dungeness
Olympic Game Farm Levee	RM 2.1 to 1.0
River's End Levee	RM 0.8 to near the mouth of the Dungeness

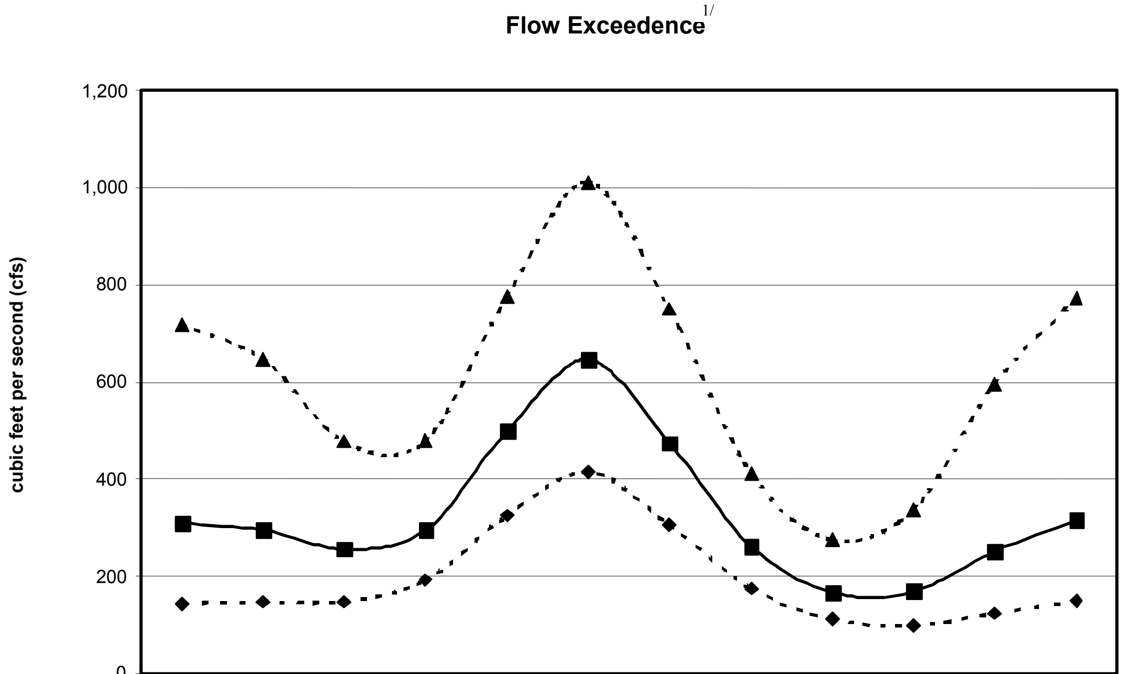
The Dungeness River has two distinct high flow periods (see Figure 2.1-1). Snowmelt in the upper Dungeness watershed causes predictable high flows in late spring and early summer, and precipitation in the upper watershed causes high and more variable flows in the winter (Thomas et al. 1999). The lowest flows are in September and October (Thomas et al. 1999) with a second low flow occurring during some winter months. The variability of flows is a major problem in the Dungeness River (USGS 1994). Because there is relatively little storage in the upper watershed, current-year precipitation directly controls runoff. The location of the Sequim-Dungeness peninsula in the rain shadow of the Olympic Mountains also exacerbates the late-summer, low-flow conditions.

Discharge on the Dungeness River has been continuously recorded since 1937 by the USGS at a gauge site approximately 1 mile upstream from the confluence with Canyon Creek (USGS Gauge 12048000, RM 11.8). The period of record includes June 1923 to September 1930 at RM 11.3 and June 1937 to present at river mile 11.8. Average-year Dungeness flow, including all tributary flows, is 384 cfs (Montgomery Water Group Inc. 1999). The annual instantaneous peak discharges for the river have ranged from 740 cfs (1925) to 7,610 cfs (2002).

Montgomery Water Group Inc. (1999) calculated 10 percent, 50 percent and 90 percent monthly flow exceedences for the Dungeness River (Figure 4.3-3). The Dungeness River flow historically peaks in June, when a flow of 415 cfs is exceeded 90 percent of the time and the median flow is 646 cfs. Flows gradually decrease during the irrigation season from a median flow of 499 cfs in May to 167 cfs in September. Over a period of record from 1924 through 1997, the 7-day and 30-day low flows were 65.6 cfs and 72.6 cfs, respectively (Montgomery Water Group Inc. 1999).

Instream flow reduction from irrigation withdrawals has been a long-standing concern in the Dungeness River (Thomas et al. 1999). Instream river flows have also been affected by water withdrawals for municipal and domestic use (Haring 1999).

Figure 4.3-3. Monthly Flow Exceedences for Dungeness River



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10% exceedence	718	646	478	479	775	1011	750	412	274	338	596	771
50% exceedence	309	296	256	295	499	646	474	262	167	169	251	317
90% exceedence	144	148	148	192	325	415	305	175	112	98	124	149

Months (average, period of record)

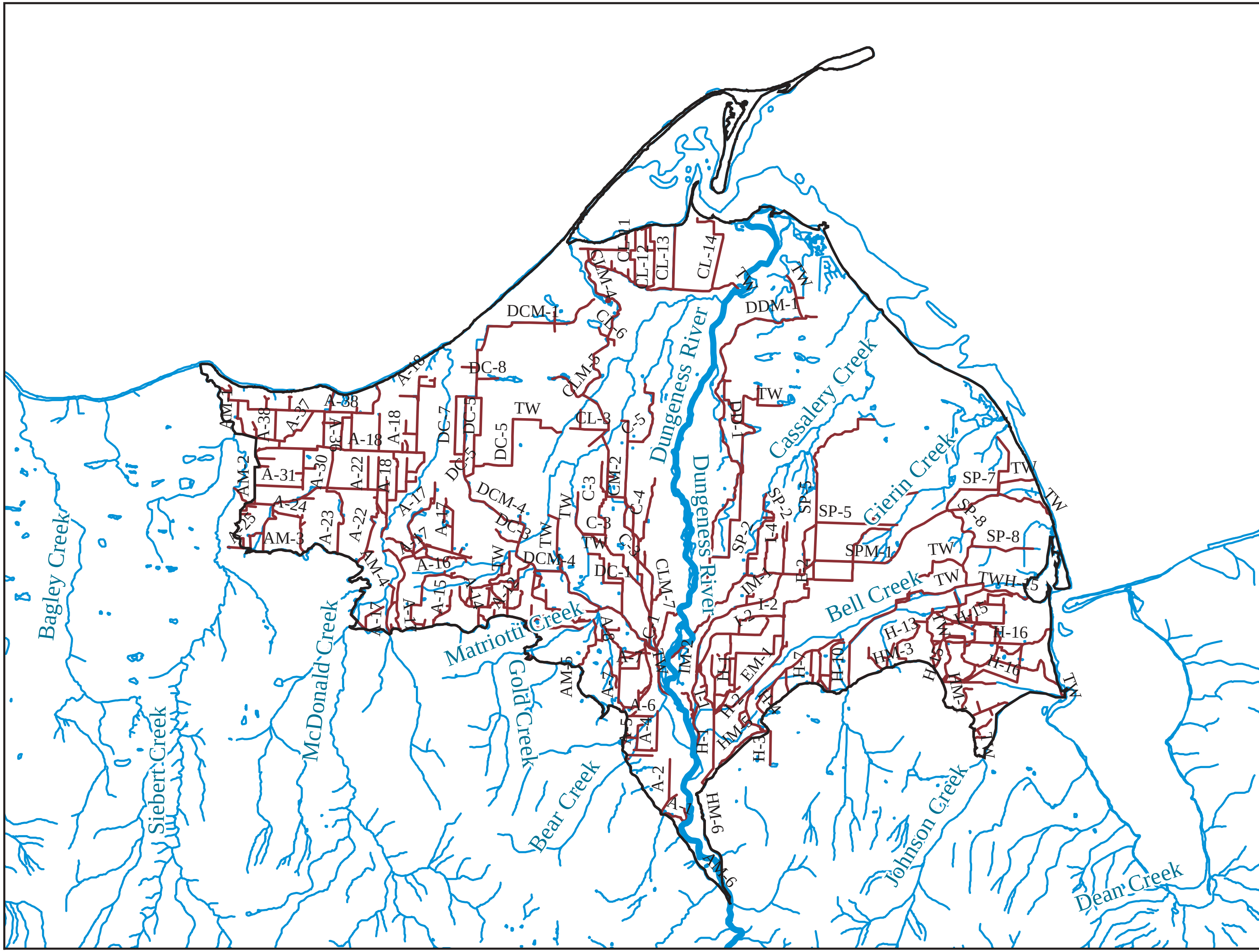
Notes:
[1/] Historic flow exceedences as measured over the period of record from 1923 to 1930 and 1937 to 1994 (Montgomery Water Group Inc. 1999).

The Dungeness River irrigation system was mapped in 1998 as part of the Comprehensive Water Conservation Plan (Montgomery Water Group Inc. 1999). The irrigation system consists of approximately 62 miles of main ditch canal and another 111 miles of secondary ditches and laterals. The irrigation system carries water from the Dungeness River to agricultural and residential lands via gravity flow (Bountry et al. 2002). Figure 4.3-4 shows the "constructed watershed," which effectively comprises the Dungeness River and its tributaries, the irrigation system, and independent creeks within the Sequim-Dungeness area.

With respect to the total water rights listed for diversions from the Dungeness River, the adjudicated water right certificates held by the WUA members have been amended by a trust water rights agreement signed by Ecology and WUA members in 1998 and its implementing orders. This agreement limits the amount of water that can be diverted by the WUA for the Dungeness River to 50 percent of the river flow (Montgomery Water Group Inc. 1999; see also Section 2.2.2).

Irrigation ditches also play an important role in ground water recharge in the lower watershed (Drost 1983, Thomas et al. 1999). During the past 100 years, leakage from ditches and unconsumed irrigation water has created an artificially high water table in the Sequim-Dungeness area (Thomas et al. 1999). Most of the irrigation ditches have been constructed in surficial soils or sediments and leakage from these ditches is controlled by the

Figure 4.3-4
Map of Constructed Watershed



Map Features

EIS Boundary
Irrigation Ditches
Dungeness River
Streams

Location Map

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permeability of these materials, the size of the ditches, and the depth of water in the ditch (Montgomery Water Group, Inc. 1993).

There are currently five diversion locations on the Dungeness River serving the ditch systems of the seven irrigation-provider companies and districts, all between the RM 11.8 USGS gauge and the U.S. Highway 101 bridge (Figure 4.3-2). Currently, all of the diversions are at river surface, located along a bank, with minimal encumbrance of the main river channel (Clark and Clark 1996). Irrigators generally divert Dungeness River water from April 15 through September 15 of each year (Montgomery Water Group Inc. 1999). Irrigation diversions are located on the west bank of the river at RM 11.2 and RM 7.2 and on the east bank at RM 10.7, 8.5, and 6.9 (Bountry et al. 2002) (Figure 4.3-2).

Irrigation company/district outtakes from the Dungeness River are monitored by several agencies (Montgomery Water Group Inc. 1999). Table 4.3-1 summarizes monthly diversions for the period between December 1995 and September 1997 (Thomas et al. 1999). For the 1996 and 1997 summer irrigation season (from May 16 to September 20), the total average irrigation season diversion was estimated at about 74.4 cfs (Thomas et al. 1999). Thomas et al. (1999) estimated conveyance losses along the irrigation ditches to be 23.7 cfs. During this same irrigation season, tailwater was estimated at 15.3 cfs (Thomas et al. 1999).

Tailwater discharge into the Dungeness was measured during the 1997 summer irrigation season. A mean irrigation season tailwater discharge of 0.41 cfs into the Dungeness River was measured in the Cline District.

Because the main canals and most laterals are open, gravity systems, the irrigation canals have also been used as drainage ways for stormwater runoff from areas that were previously farmed, but are now urbanized. The collection and discharge of stormwater is a concern of the WUA because of the associated maintenance, liability issues, and water quality concerns (Montgomery Water Group Inc. 1999).

Dungeness River Tributaries

Dungeness River tributaries within the irrigated portion of the Sequim-Dungeness peninsula, from south to north, are Bear Creek, Hurd Creek, and Matriotti Creek (Figure 4.3-4). These lower Dungeness tributaries are primarily low-gradient streams flowing through agricultural areas and urbanizing areas. All three of these tributaries are influenced by ground water and receive a component of their instream flow from irrigation recharge or the conveyance of irrigation water through natural stream channels (Entrix 2003). Table 4.3-2 summarizes available surface water flow data for Dungeness River tributaries. Table 4.3-3 presents available tailwater discharge data for the 1997 irrigation season (May 18 through September 23, 1997). Each of the tributaries is discussed in detail below.

<u>Bear Creek</u> originates on the slopes of Lost Mountain. The creek is a medium-sized, low-elevation tributary to the lower Dungeness River, entering the river at RM 7.3 (Bountry et al. 2002). Stormwater flows and high fine sediment loads are conveyed to Bear Creek through the Agnew Irrigation Company delivery system. Leakage to ground water of 0.12 cfs was observed on October 7, 1997 (Thomas et al. 1999).

<u>Hurd Creek</u> is a small, low-elevation tributary to the Dungeness River, entering the river at RM 2.7. It is a short, low-gradient stream with its origins in ground water and irrigation tailwater discharge upstream. Clallam County Streamkeepers data are not available for this creek. However, the Thomas et al. (1999) study measured this creek as a gaining creek (i.e., the creek receives flow from ground water) and noted that the fish hatchery near Hurd Creek discharged approximately 2.2 cfs into the creek.

Table 4.3-1. Monthly Diversions from Dungeness River for December 1995 through September 1997

Month	Year	Agnew District	Clallam Company	Cline District	Dungeness Company	Dungeness District	Eureka Company	Highland District	Independent Company	Sequim-Prairie Company	Total
December	1995	5.1	-	-	-	--	0.8	1.3	4.9	--	**>12.1**
January	1996	3.4	-	-	-	--	0.7	2.9	4.0	--	**>11.0**
February		0.5	-	-	-	--	1.1	2.2	3.6	--	**>7.4**
March		3.5	-	-	-	--	1.6	1.8	3.7	--	**>10.6**
April		11.7	1.1	-	0.1		2.2	4.5	3.6	--	**23.2**
May		14.1	3.8	8.6	2.2		3.0	5.6	5.2	--	**42.5**
June		16.5	4.0	9.9	5.6	8.1	4.1	8.0	7.3	7.5	**71.0**
July		19.7	4.9	7.9	6.2	8.9	4.6	7.8	7.6	8.0	**75.6**
August		17.9	4.3	6.6	6.1	8.0	7.1	7.7	6.2	8.5	**72.4**
September		9.4	4.3	7.4	2.6	5.6	4.2	5.6	3.7	6.0	**48.8**
October		5.8	3.8	4.8	0.6	5.2	1.9	4.8	4.5	3.6	**35.0**
November		4.4	3.2	4.0	3.2	1.6	1.5	5.0	6.1	0.8	**29.8**
December		0.7	2.4	5.7	1.6	1.6	0.8	4.0	6.2	0.5	**23.5**
June-September	**1996**	**15.9**	**4.4**	**8.0**	**5.1**	**7.6**	**5.0**	**7.3**	**6.2**	**7.5**	**67.0**
January	1997	-	-	-	-	0.8	0.6	-	3.1	0.8	**5.3**
February		0.5	-	-	-	0.9	0.8	0.4	3.7	0.6	**6.9**
March		2.1	-	-	-	--	0.5	0.7	3.9	--	**>7.2**
April		7.8	2.6	5.0	3.2	6.5	2.8	2.2	6.5	6.5	**43.1**
May		12.7	4.9	9.7	8.0	8.8	5.4	4.7	8.6	8.9	**71.7**
June		15.3	5.0	9.2	7.9	7.6	4.8	6.9	10.2	6.8	**73.7**
July		16.7	5.6	8.2	6.4	7.6	4.7	7.8	9.4	8.0	**74.4**
August		19.6	5.9	9.1	6.5	10.8	5.7	7.0	12.0	9.7	**86.3**
September		9.6	4.8	5.9	3.4	7.0	4.4	4.0	4.7	6.3	**50.1**
June-September	**1997**	**15.3**	**5.3**	**8.1**	**6.0**	**8.2**	**4.9**	**6.4**	**9.1**	**7.7**	**71.0**

Source: Thomas et al. 1999 (Table 6)

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Table 4.3-2. Surface Water Flow, Data Summary

	Discharge (cfs)																
	Streamkeepers Data[1/2/]					USGS Data[3/]		DRAFT WRIA 18 Data[4/]		Caldwell Data 1997[7/] Data 1997		Department of Ecology Gauged Flow Data					
	Range of All Available Measurements for Fall 1999 – Spring 2002	Fall (Sept, Oct) Ranges 1999 – 2001	Spring (April, May) Ranges 2000 – 2002	Average of Spring and Fall Measurements 2000	Average of Spring and Fall Measurements 2001	Range: Various Gauging Stations 10/7/97	Measurement at Furthest Downstream Location 10/7/97	Fall Range Prior to 1997	Spring Range Prior to 1997	Measurement Location	Fall Range (Sept and Oct)	Measurement Location	Spring Range 2000 (April and May)	Sept 2000	Oct. 2001	Fall Range 2002 (Sept and Oct)	Spring Range 2003 (April and May)
Bear	Not measured	Not measured	Not measured	Not measured	Not measured	0.02 – 0.09	0.02[5/]	No data	No data	**N/D**	N/D	**N/D**		N/D	N/D	N/D	N/D
Bell						0.04 – 2.39	2.39	2.0 – 5.7	2.4 – 7.3	**Schmuck Road**	2.0 - 2.9	**N/D**	N/D	N/D	N/D	N/D	N/D
Bell 0.1	0.6 – 6.7	0.8 – 2.6	1.9 – 4.2	2.2	1.5												
Bell 0.8	0.1 – 1.2		0.5 – 1.0														
Bell 1.8	0.1 – 3.8	0.1	0.9 – 1.0	0.5													
Cassalary						0.2 – 3.57	3.57	2.2 – 5.2	3.4 – 5.8	**Woodcock Road**	2.5 - 3.7	**N/D**	N/D	N/D	N/D	N/D	N/D
Cassalary 0.5	0.6 – 2.4	1.2 – 1.7	1.5 – 1.6	1.7	1.4												
Cassalary 0.6	1.8		1.8														
Cassalary 1.1	0.2 – 4.2	0.7 – 4.2	0.2 – 2.6	0.9													
Cassalary 1.6	1.4 – 4.1	1.6 – 2.3	1.9 – 2.8	2.1	1.8												
Gierin[6/]	Not measured	Not measured	Not measured	Not measured	Not measured	0.32 – 1.16	1.16	1.0 – 1.7	ND	**Holland Road**	0.1 - 1.7	**N/D**	N/D	N/D	N/D	N/D	N/D
Hurd	Not measured	Not measured	Not measured	Not measured	Not measured	0.23 – 5.91	5.91	1.1 – 6.7	1.7 – 6.9	**ND**	ND	**ND**	ND	ND	ND	ND	ND
Johnson Creek								0.3 – 4.9	1.4 – 3.6	**W. Sequim Road**	0.3 - 3.0	**N/D**	N/D	N/D	N/D	N/D	N/D
Johnson 0.0	1.7 – 6.3	1.7	Not measured	Not measured	Not measured	Not measured	Not measured										
Johnson 0.6	1.3 – 4.9	1.3	Not measured	Not measured	Not measured	Not measured	Not measured										
Matriotti	Not measured	Not measured	Not measured	Not measured	Not measured	0.05 – 8.10	8.10	1.8 – 14.9	5.7 – 11	**Lamar Lane**	2.5 - 4.5	**Olympic Game Farm**	12.8 - 13.9	11.8	12.3	N/D	N/D
McDonald	Not measured	Not measured	Not measured	Not measured	Not measured	0.06 – 13.9	13.9	0.1 – 11.0	8.1 – 20	**Old Olympic Hwy**	0.4 - 11.0	**HWY 101**	N/D	N/D	N/D	N/D	0.54 - 1.22
Meadowbrook	Not Measured	Not Measured	Not Measured	Not Measured	Not Measured	2.89 – 4.26	4.26	1.1 – 5.2	3.6 – 6.8	**Sequim-Dungeness Way**	3.6 - 4.3	**N/D**	N/D	N/D	N/D	N/D	N/D
Siebert						9.06 – 11.3	11.3	2.6 – 8.6	5.6 – 14	**Old Olympic Hwy**	6.0 - 8.6	**Old Olympic Hwy**	N/D	N/D	N/D	2.5 - 4.3	9.1 - 16.1
Siebert 0.6	0.8 – 41.4	2.7 – 3.3	7.2 – 41.4	4.9	6.8												
Siebert 3.0	1.0 – 39.1	2.4. – 2.9	6.1 – 39.1	4.3	7.4												
Siebert 3.8	1.8 – 35.5	2.1	3.4 – 35.5		7.1												
Siebert 9.3	0 – 1.3	0.0	1.0														

Notes:

1/ Data for Clallam County streams monitored by Streamkeepers organization. Generally, data measurements were taken once per season for 1 to 4 measurements per reach per year.
2/ Streamkeepers data for 1997 in the area of interest is limited to two measurements on Bell Creek and three measurements on Siebert Creek. The locations of these measurements are not available and therefore have not been included in this table.
3/ Data from Thomas et al. 1999, Table 10. Measurement locations are shown on Figure 12.
4/ Data from WRIA 18 Synthesis Report (Entrix 2003).
5/ Value is highlighted to indicate that Bear Creek has lost flow along study area (Thomas et al. 1999).
6/ Surface water flows were measured by AESI (1999). Flows for Gierin Creek at Station 3 (located at the culvert where Gierin Creek passes beneath Holland Road) ranged from 0.83 cfs (10/28/97) to 3.2 cfs (4/29/98), (AESI 1999).
7/ Caldwell, Brad. Flow measurements were taken by B. Caldwell of DOE.

Table 4.3-2, page 2

Table 4.3-3. Tailwater Discharge Summary (Data from 1997 and 1998)

Tailwater	Gauge	Location	Mean Annual Tailwater (cfs)	Recipient Area or Creek
Highland District	HW1	1888 3rd S. [1/]	0.60	Bell Creek
	HW2	Happy Valley/Huffman Road	1.27	Johnson Creek
	HW3	John Wayne Marina	0.09	Johnson Creek
	HW4	1794 West Sequim Bay Road	0.01	Wetland/Sequim Bay
	HW5	Sun Meadows [2/]	0.06	Salt water
	HW6	920 W. Sequim Bay	0.07	Salt water
Sequim-Prairie Trial Company (SPTC)	SW7	Port Williams	0.58	Salt water
	SW8	Grays Marsh	0.36	Unnamed creek SE of Gierin
	SW9	301 Port Williams Road	0.17	Gierin Creek
	SW10	Sequim Dungeness Highway [3/]		
	SW10	Sequim Dungeness Highway (adjusted) [3/,4/]	0.38	To ground
Eureka Company	EW11	981 Gierin Creek Lane	0.55	Gierin Creek
Dungeness District	DDW12	4041 Dungeness Highway	0.11	Wetland
	DDW13	4382 Dungeness Highway	0.54	Meadowbrook Creek
Cline District	CLW14	Lotzgesell/Dungeness River	0.41	Dungeness River
	CLW15	Cline Spit	0.02	Salt water
	CLW16	520 Marine Drive	0.35	Salt water
	CLW17	80 Marine Drive	0.09	Salt water
	CLW18	Marine Drive/Cays Road	0.03	Salt water
	CLW19	134 W. Anderson Road	0.22	Salt water
Dungeness Company	DW20	515 Lotzgesell	0.17	Woods Creek
		Dungeness Wildlife Refuge	0.02	Salt water
		185 Olstead Road	0.11	Wetland
		Kitchen Road/Adolphsen	0.61	Matriotti Creek
Agnew District	AW24	856 Gerke Road	0.11	Siebert Creek
	AW25	1079 Finn Hall Road	2.11	Salt water
Clallam Company	CW26	Cays Road/Timothy Lane	0.55	Matriotti Creek
	CW27	6793 Olympic Highway	0.37	Wetland
TOTALS			**9.96**	

Notes:

[1/] No flow to Bell Creek after 6/28/97.

[2/] Gauge listed as 572 Wash. Hbr. for 1998.

[3/] in 1998, 0.3 cfs pumped downstream, no surface flow to Cassalary Creek.

[4/] Note for 8/2/97 states: 0.65 cfs withdrawn downstream at Taylor Ranch Road, 8/12/97; no tailwater due to ditch leakage.

Note: Staff gauges or weirs are not present at all sites. Some sites at inflows to small streams have downstream pump stations. When downstream pumps are operating, indicated flow is site reading minus pump output.

Matriotti Creek is the largest tributary of the lower Dungeness River. The creek parallels the Dungeness until it joins the river on the west bank at RM 1.9, at the Olympic Game Farm.

Stormwater flows and high sediment loads are conveyed to Matriotti Creek through irrigation delivery systems (Bountry et al. 2002). Tailwater discharge to Matriotti Creek was measured for the 1997 irrigation season (Table 4.3-3). A mean annual tailwater discharge of 0.55 cfs was observed in the Clallam Company system (Gauge CW-26, approximately 2.88 RM up Matriotti Creek). A mean annual tailwater discharge of 0.61 cfs was measured in Dungeness Company (Gauge DW23, approximately 3.41 RM up Matriotti Creek). A ground water discharge to Matriotti Creek of 7.98 cfs was measured on October 7, 1997 (Thomas et al. 1999).

Independent Creeks

West of the Dungeness River, Siebert Creek and McDonald Creek are the principal independent streams within the planning area, beginning from headwaters in the northern front of the mountains and foothills and flowing north to drain into the Strait of Juan de Fuca

(Figure 4.3-4). Because snowmelt and rainfall runoff produce most of the flow in these creeks, Siebert and McDonald Creeks have high flows in the winter and spring, and low flows during the remainder of the year (Dames and Moore 2000).

East of the Dungeness River, independent creeks include Meadowbrook Creek, Cooper Creek, Cassalary Creek, Gierin Creek, and farther south, Bell Creek and Johnson Creek (Figure 4.3-4). These streams are, in a sense, distributaries of the Dungeness; part of their flow is due to irrigation-enhanced ground water discharge and irrigation tailwater, both originally diverted from the Dungeness River (Clark and Clark 1996). Because ground water and irrigation tailwater comprise a significant portion of their flow, these smaller streams have relatively constant flows throughout the year (summer flows are higher than they otherwise would be) (Thomas et al. 1999).

Each of the independent creeks is discussed below. Table 4.3-2 summarizes surface water flow data for independent creeks. Table 4.3-3 presents tailwater discharge data for the 1997 irrigation season (May 18 through September 23, 1997). Section 5.3-1 explains the use of the Ecology 2003 ground water model to predict ground water recharge to these creeks.

<u>Siebert Creek</u> is 12.4 miles long and drains approximately 19.5 square miles of the northwest flank of the Blue Mountain (Bountry et al. 2002) to the Straits of Juan de Fuca. Its upper watershed lies at 3,800 feet and the stream is incised. Annual flows from 16 years of gauging (1953 to 1969) averaged 17 cfs with a peak instantaneous flow of 1,620 cfs recorded in November 1955 (USGS 1994). Surface water flow data obtained for 1999 through 2001 at the 0.6 RM gauge on Siebert Creek measured flows in September and October of between 2.7 to 3.3 cfs. Spring (April and May) flows for 1999 through 2001 were 7.2 to 41.4 cfs (Streamkeepers, Unpublished Data, 1999 to 2001). Ecology installed a flow monitoring station in Siebert Creek at Old Olympic Highway in September 2002. Mean flow during October was 4.33 cfs. Mean flow during April 2003 was 8.9 cfs. A ground water discharge to Siebert Creek of 2.27 cfs was measured on October 7, 1997 (Thomas et al. 1999).

A seasonal 1997 tailwater discharge of 0.11 cfs into Siebert Creek was measured in the Agnew District at 0.5 RM up Siebert Creek (Table 4.3-4).

<u>McDonald Creek</u> is 13.6 miles in length. Its headwaters are at 4,700 feet and it flows through a deeply incised coastal upland and marine bluff to the Strait of Juan de Fuca (Bountry et al. 2002). The stream is confined and channelized from Agnew ditch to U.S. Highway 101. Irrigation practices affect McDonald Creek because RM 5.0 to 2.0 is used for conveyance of irrigation water by the Agnew Irrigation District (Bountry et al. 2002). Historic recorded flows range from less than 1 cfs in late summer and early fall to 25 cfs in June (Dames and Moore 2000, Caldwell 1997). Significant erosion and storm damage has been reported in association with winter storms.

<u>Meadowbrook Creek</u> is a small, low-elevation stream that was once a mouth of the Dungeness River and now flows into Dungeness Bay. The creek is located immediately east of the mouth of the Dungeness River (Figure 4.3-4). Fall (September and October) flows for 1997 were 3.56 to 4.29 cfs (measured at Sequim-Dungeness Way; Caldwell 1997). A ground water discharge to Meadowbrook Creek of 1.37 cfs was observed on October 7, 1997 (Thomas et al. 1999).

An average seasonal 1997 tailwater discharge into Meadowbrook Creek of 0.54 cfs was measured at Gauge DDW13, located approximately 0.85 RM up Meadowbrook Creek (in Dungeness District).

Cooper Creek, about 1 mile long, drains low-lying areas irrigated with water diverted from the Dungeness River (Bountry et al. 2002) directly to salt water. The majority of Cooper Creek has been channelized. Streamkeepers flow data and USGS surface water-ground water data are not available for Cooper Creek.

Cassalary Creek is a small, independent drainage that discharges to salt water between Sequim Bay and the Dungeness River. Cassalary Creek is approximately 4 miles long, draining low-elevation land on the east side of the lower Dungeness Valley. The stream is low-gradient with low velocity flows (Dames and Moore 2000). Most of Cassalary Creek has been artificially straightened and confined (Bountry et al. 2002). The creek is predominantly ground water-fed with limited inputs from the irrigation system. Surface water flow data obtained for 1999 through 2001 at the 0.5 RM gauge on Cassalary Creek measured flows in September and October of between 1.2 to 1.7 cfs. Spring (April and May) flows for 1999 through 2001 were 1.5 to 1.6 cfs (Streamkeepers, Unpublished Data, 1999 to 2001). A ground water discharge to Cassalary Creek of 3.55 cfs was measured on October 7, 1997 (Thomas et al. 1999).

Gierin Creek is a small, independent drainage to salt water on the east side of the Dungeness plateau just north of Sequim Bay. There are 8.3 miles of streams and tributaries in the Gierin Creek watershed. The lower mile of Gierin Creek was shortened and channelized at the time of installation of a tide gate at the mouth of the relocated creek in about 1910. Flows in Gierin Creek are believed to be heavily influenced by ground water contribution from irrigation diversions from the Dungeness River (Haring 1999). A ground water discharge to Gierin Creek of 0.84 cfs was measured on October 7, 1997 (Thomas et al. 1999).

Gierin Creek flows were also measured by AESI from April 1, 1997 through March 24, 1998. At Station 3, located at the culvert where Gierin Creek passes beneath Holland Road, surface water flows in Gierin Creek ranged from 0.83 cfs (October 28, 1997) to 3.2 cfs (April 29, 1997) (AESI 1999). AESI (1999) estimated the base flow as measured at Station 3 to be approximately 1 cfs in Gierin Creek (based upon measurement from November through January 1997).

In 1997, the average seasonal tailwater contribution as measured by the Sequim-Prairie and Eureka Companies, respectively, at Gauges SW9 and EW11 (located 2.55 and 2.62 RM up Gierin Creek) were 0.17 and 0.55 cfs.

Bell Creek is 3.8 miles long and flows eastward through the town of Sequim to the Washington Harbor Lagoon, a small bay or wetland just north of Sequim Bay. Probably originally an ephemeral stream fed by precipitation runoff, it has historically served as a conveyance channel for irrigation water (Bountry et al. 2002). During low-flow periods, the instream flow in Bell Creek is compromised by an irrigation diversion just upstream of Carrie Blake Park in the City of Sequim, which diverts up to 50 percent of the creek's water. The City of Sequim began augmenting streamflow in Bell Creek with 0.1 cfs of reclaimed water in December 2001 (Pacific Groundwater Group 2002a).

Surface water flow data obtained for 1999 through 2001 at the 0.1 RM gauge on Bell Creek measured flows in September and October of between 0.8 to 2.6 cfs. Spring (April and May) flows for 1999 through 2001 were 1.9 to 4.2 cfs (Streamkeepers, Unpublished Data, 1999 to 2001). A ground water discharge to Bell Creek of 2.35 cfs was measured on October 7, 1997 (Thomas et al. 1999).

Tailwater discharge into Bell Creek was measured in 1997 at Gauge HW1, located approximately 2.62 RM up Bell Creek. An average seasonal tailwater discharge of 0.60 cfs was reported at this location.

Johnson Creek is 7.4 miles long and begins near the top of Burnt Hill, flowing north-northeast into Sequim Bay at Pitship Point. The creek drains approximately 4.72 square miles (Ecology 1994). Historic flow measurements noted in the DQ Plan (Ecology 1994) indicate that surface water flows have peaked at approximately 10 cfs, but generally range between 2 to 6 cfs. Streamkeepers data for Johnson Creek at RM 0.0 for 1999 through 2002 generally fall within the historic range of surface water flows noted in the DQ Plan (Ecology 1994). Streamkeepers flows at RM 0.0 were reported from 1.7 to 6.3 cfs for 1999 through 2002 (Table 4.3-2). Johnson Creek was closed to new appropriations in 1983.

An average seasonal 1997 tailwater discharge into Johnson Creek of 1.36 cfs was measured in the Highland District (at Gauges HW2 and HW3) (Table 4.3-3).

4.3.2 Ground Water

Thick accumulations of glacial and interglacial deposits across the Sequim-Dungeness peninsula have resulted in a complex, heterogeneous, stratified system of confined and unconfined aquifers. Thomas et al. (1999) delineated three aquifers (shallow, middle, and lower) and two confining units within these unconsolidated glacial sediments. Beneath the lower aquifer, undifferentiated, unconsolidated deposits were noted to overlie bedrock.

In general, the aquifers described by Thomas et al. (1999) are composed of coarse-grained unconsolidated sediments. The confining beds consist of clays, silts, and fine-grained sands. However, within the aquifers, lenses of fine-grained clays or silts affect local permeability and flow patterns. Within the confining beds, local lenses of coarse-grained sands or gravels are present and yield moderate amounts of water to individual wells (Thomas et al. 1999). Because the confining beds are not impermeable, some ground water moves vertically across them. Water also moves through fractures in the bedrock and into the ground water system as subsurface flow (Thomas et al. 1999).

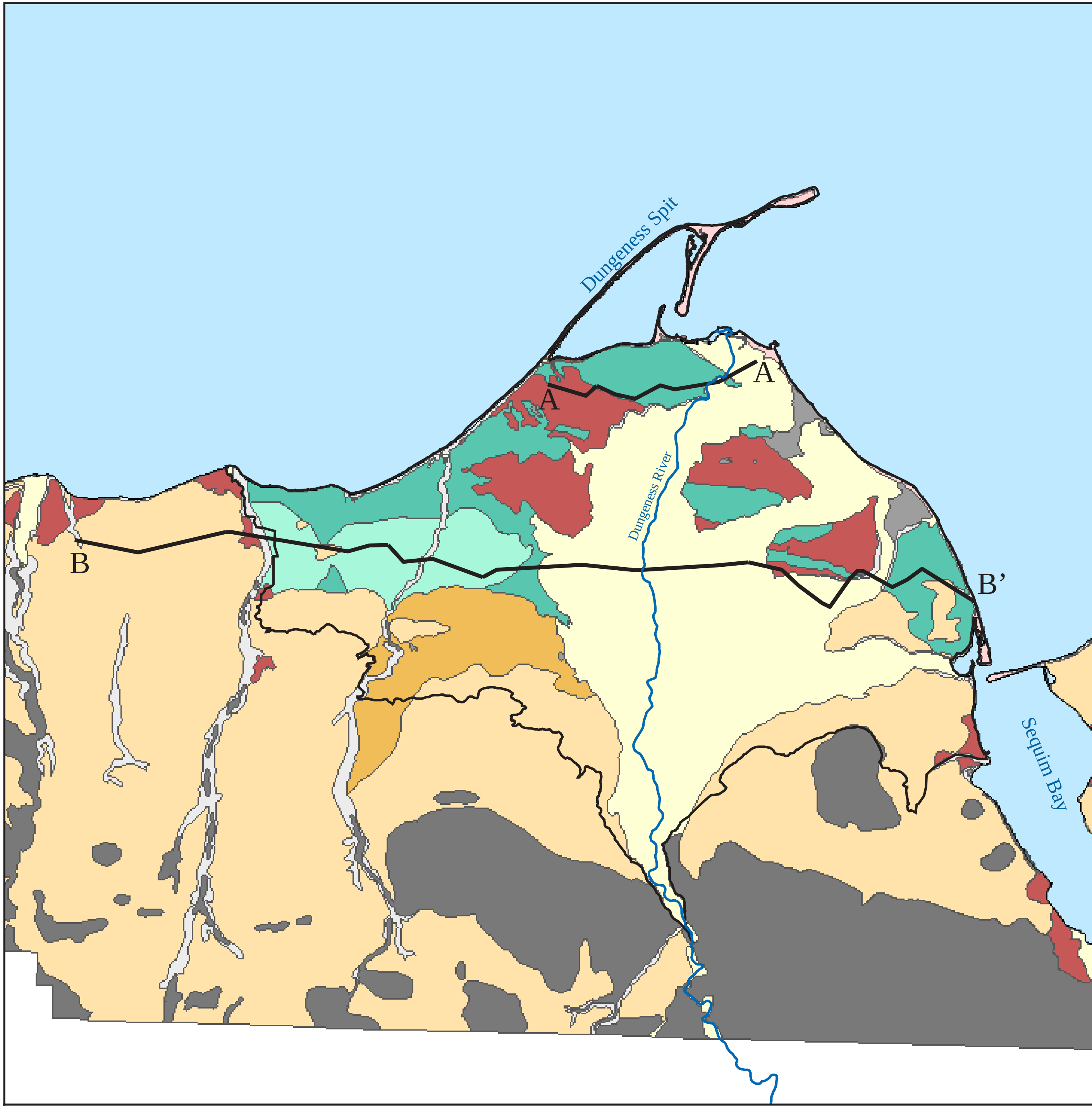
Ground water across the Sequim-Dungeness peninsula may be perched, confined, or unconfined. The aquifers and confining beds have variable hydraulic properties and boundaries. The upper boundary of the regional ground water flow system is the water table in the upper shallow aquifer and the lower boundary of the flow system is considered the top of the bedrock due to its low permeability as compared with the unconsolidated deposits (Thomas et al. 1999).

In their 1999 study, Thomas et al. prepared several hydrogeologic cross-sections. Two of these cross-sections are presented in this document. The location of the Thomas et al. (1999) hydrogeologic sections is shown in Figure 4.3-5, and the cross-sections themselves are presented in Figures 4.3-6 and 4.3-7.

Regionally, ground water enters the Sequim-Dungeness area as subsurface flow from bedrock from the south. Ground water flows from south to north, discharging into the Strait of Juan de Fuca and Sequim Bay.

These aquifers, their composition, and the characteristics of ground water flow are described below.

Figure 4.3-5
Hydrogeologic Cross
Section Location Map
for A-A’ and B-B’



Map Features

- EIS Boundary
- Hydrogeologic Cross-Sections A and B
- Bedrock
- Alluvium and older alluvial deposits
- Beach deposits
- Everson glaciomarine drift
- Everson sand
- Peat and marsh deposits
- Undifferentiated Quaternary deposits
- Vashon outwash
- Vashon till
- Vashon reworked till
- Dungeness River

Source:
Thomas et al. 1999

Location Map

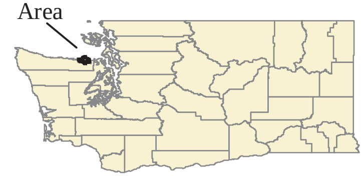


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Figure 4.3-6. Cross-section A-A' (Thomas et al. 1999)

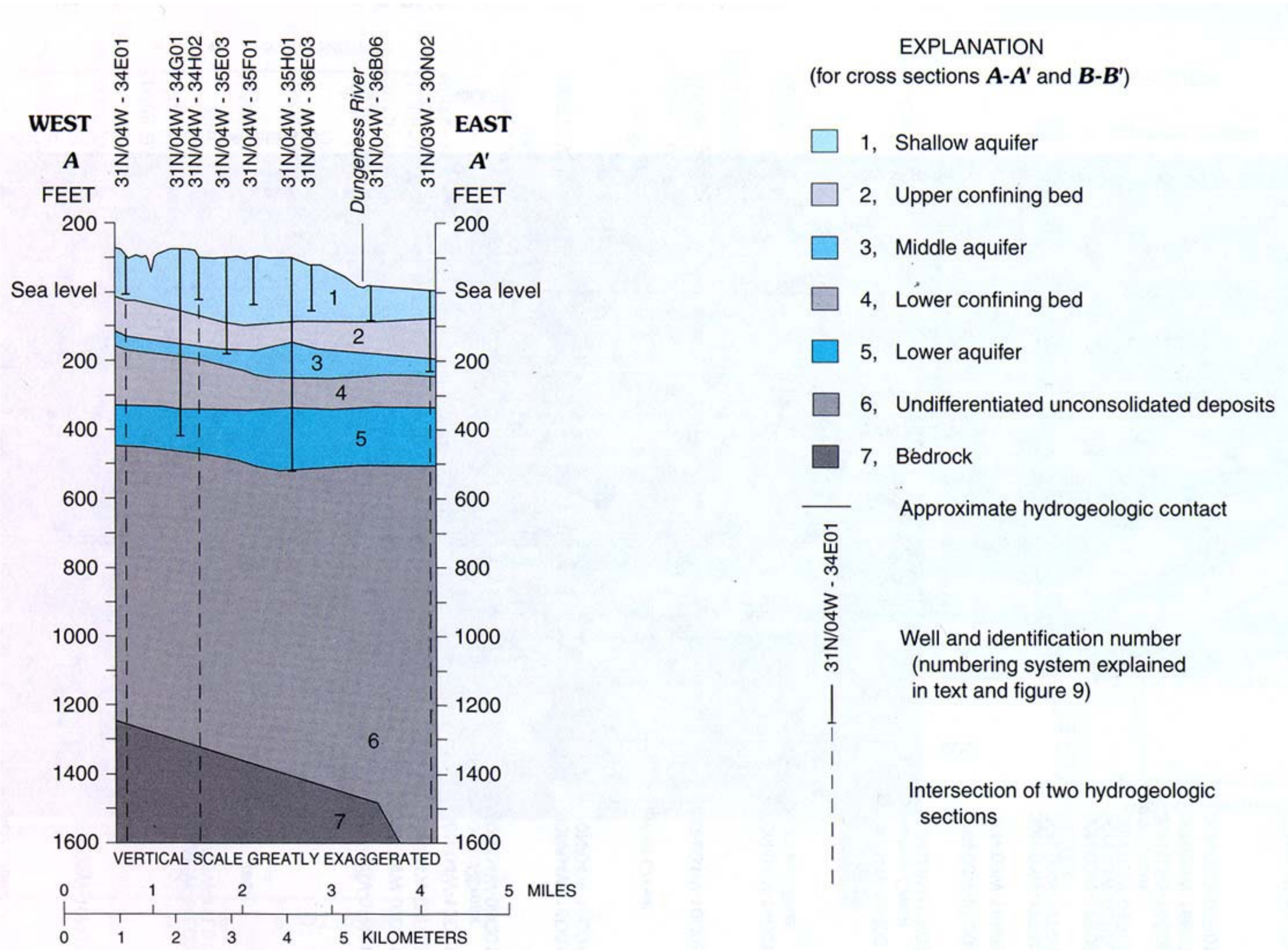
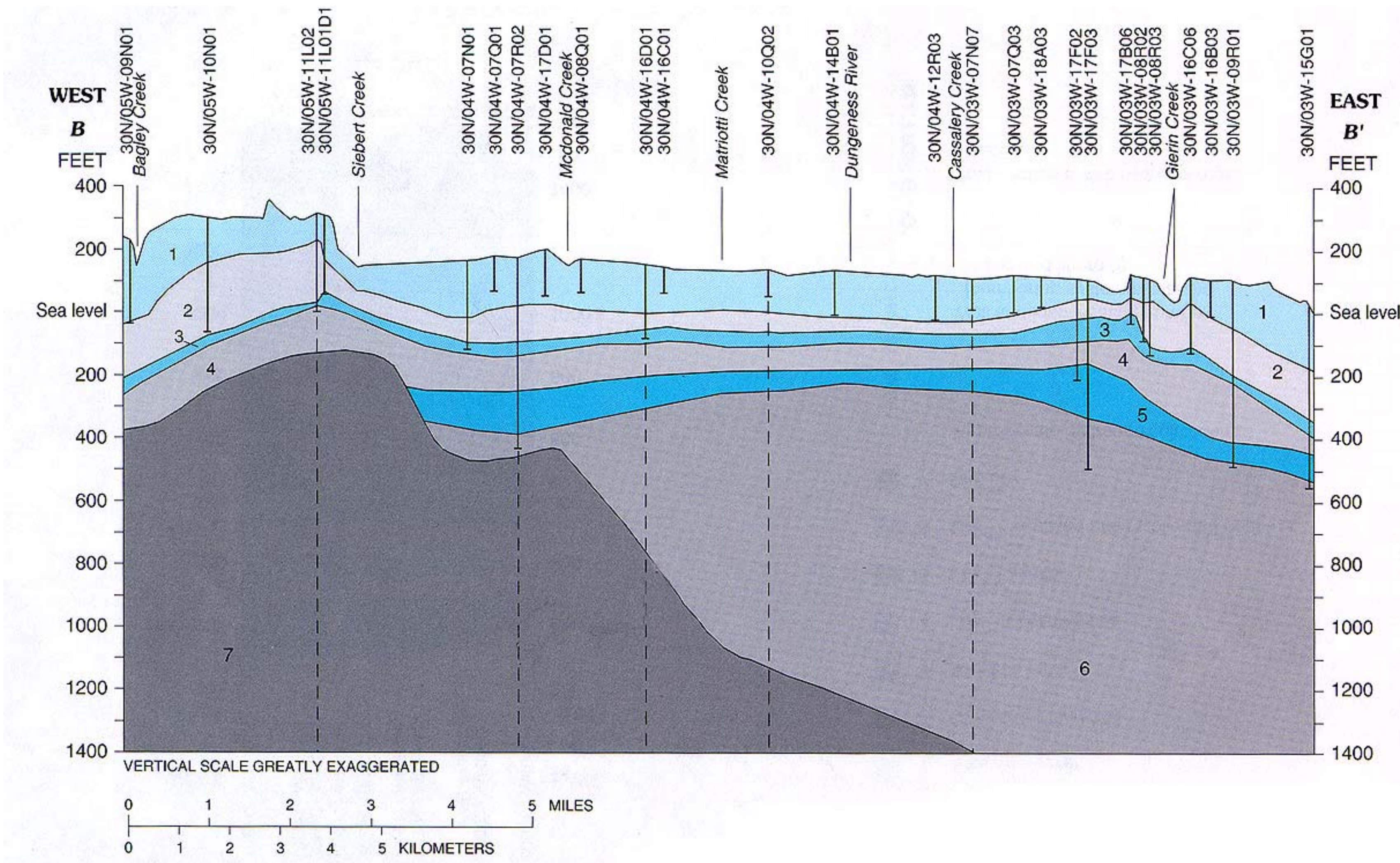


Figure 4.3-7. Cross-section B-B' (Thomas et al. 1999)



Shallow Aquifer

The shallow aquifer covers almost the entire study area. The majority of the shallow aquifer is unconfined; however, small sections of the aquifer are locally confined by shallow clay deposits (Thomas et al. 1999). Sources of recharge to the shallow aquifer are precipitation; unconsumed irrigation water; septic recharge; land application of treated wastewater; and leakage from irrigation ditches, the Dungeness River, its tributaries, and independent streams.

There is a considerable range in the measured depth to water in the shallow aquifer (about 20 feet above land surface (artesian) where locally confined to over 200 feet below land surface). However, on average, the water table is encountered in most areas at depths of less than 100 feet, with an average depth to water of approximately 40 feet (Thomas et al. 1999).

Ground water in the shallow aquifer generally moves from recharge areas in the south to discharge areas in the north (Figure 4.3-8). The hydraulic gradient ranges from approximately 250 feet per mile in the south to 40 feet per mile in the north (Thomas et al. 1999). Average ground water velocities were calculated by Thomas et al. (1999) and ranged from 1 foot per day in the southern hills to 4 feet per day near Sequim and in the north. In the Dungeness River valley, average ground water velocities were estimated to be 8 feet per day (Thomas et al. 1999). Zones of horizontal hydraulic conductivity were estimated for the shallow aquifer using available specific-capacity well data. A median conductivity of 75 feet per day was calculated for the shallow aquifer (Thomas et al. 1999).[1]

Middle Aquifer

The middle aquifer covers the central, northern, and eastern sections of the study area (Figure 4.3-9). The middle aquifer is confined; depth to water in the middle aquifer ranges from about 30 feet above land surface (indicating flowing artesian conditions) to more than 300 feet below land surface (Thomas et al. 1999). The average depth to water in the middle aquifer was 90 feet (Thomas et al. 1999). Ground water in the middle aquifer generally moves from south to north with a hydraulic gradient of 30 feet per mile and an average ground water velocity of 1 foot per day (Thomas et al. 1999). Recharge to the middle aquifer occurs primarily via leakage from the upper shallow unconfined aquifer and from upward flow from units below the middle aquifer. There is much less information available on the middle aquifer than on the shallow aquifer.

Lower Aquifer

The lower aquifer, present in the northern and eastern parts of the project area, is typically about 90 feet thick and is composed of sand with thin lenses of other materials. Depth to water ranges from about 20 feet above land surface (artesian) to about 400 feet below land surface (Thomas et al. 1999). Compared to the shallow aquifer, there is very little data available on the lower aquifer.

4.3.3 Connectivity and Continuity

Research has shown a substantial degree of hydraulic continuity between surface water and ground water within the Dungeness system. Direct exchanges of water between streams (or irrigation ditches) and ground water occur in three ways. Streams gain water from

[1] Note that hydraulic conductivity is a parameter that describes the conductance of a given medium based upon the properties of both the media and the fluid passing through it. Hydraulic conductivity (along with porosity and hydraulic gradient) is used to calculate ground water flow velocities.

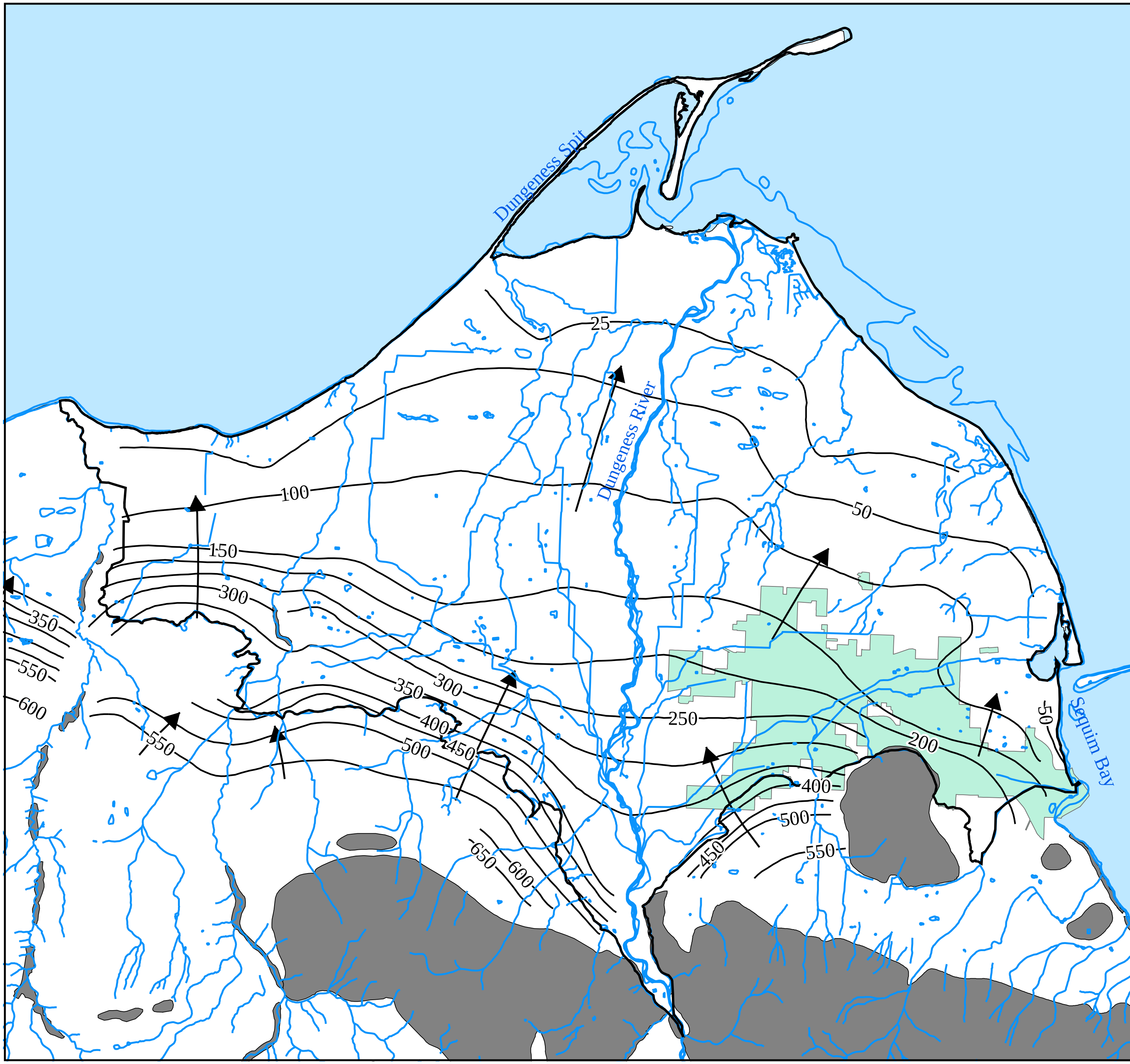


Figure 4.3-8
Potentiometric Surface and Inferred Groundwater flow in the Shallow Aquifer

Map Features

- EIS Boundary
- City of Sequim
- Area where aquifer is absent
- Dungeness River
- Potentiometric Contours
- Streams
- Direction of Groundwater flow

Contours show approximate altitude of potentiometric surface in feet above sea level. Contour interval 50 feet, with a supplementary contour of 25 feet.

Ref: Thomas et al., 1999
(Figure 24)

Location Map

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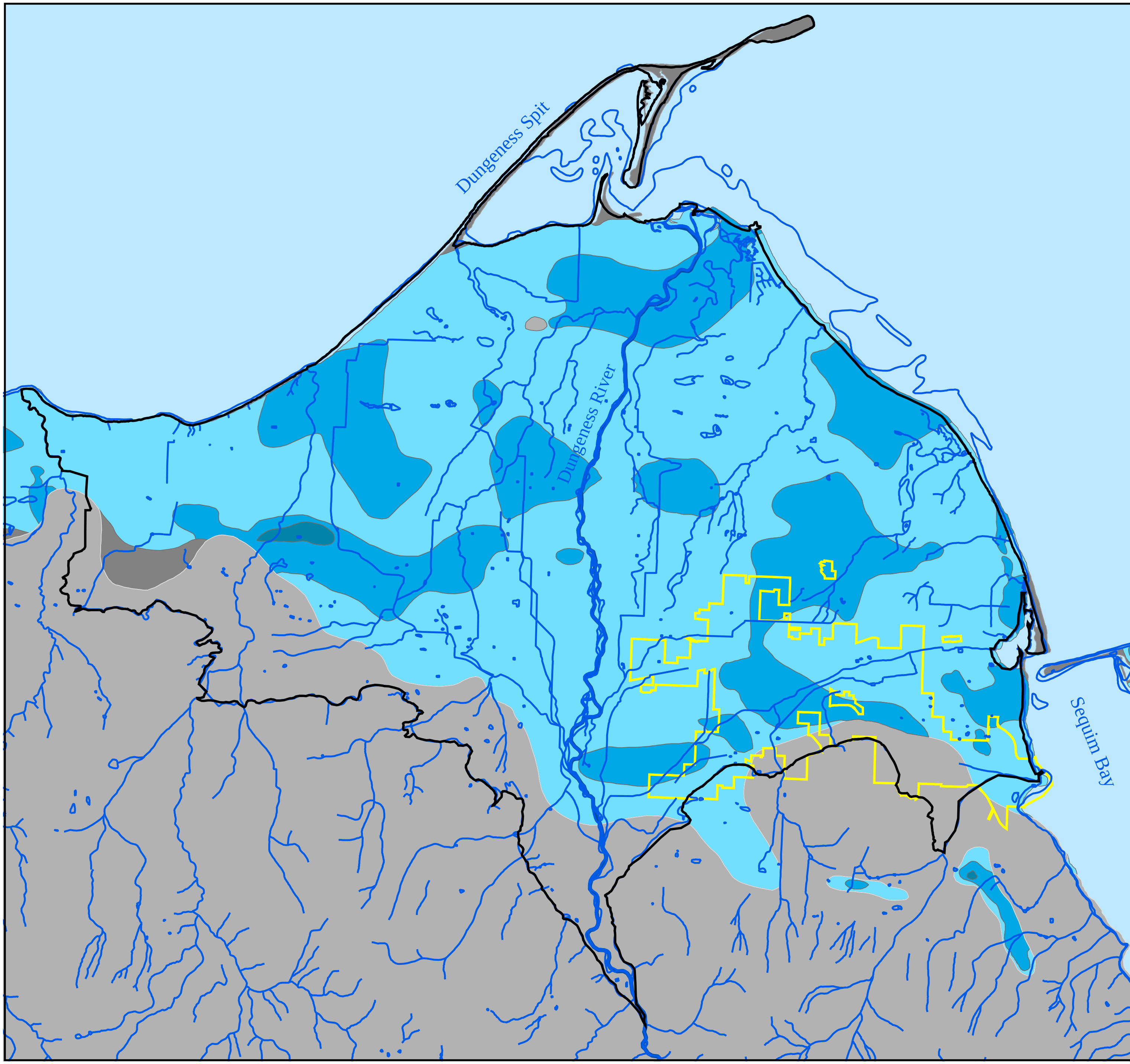
Figure 4.3-9
Extent and Thickness
of the Middle Aquifer



Map Features

EIS Boundary
Streams
Dungeness River
City of Sequim

Thickness in feet

0-50
51-100
101-150
151-200
Area where Unit is absent
Area not defined due to insufficient data

Thomas et al., 1999
(Figure 21)

Location Map

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ground water seepage into their streambed, lose water through their streambed to ground water, or both gain water in some reaches and lose it in others.

The irrigation ditches and canals within the Sequim-Dungeness peninsula lose a portion of their water to ground water, thereby providing recharge to the shallow aquifer (Montgomery Water Group, Inc. 1993, Thomas et al. 1999). Recharge to ground water along irrigation ditches and canals was estimated by Montgomery Water Group Inc. (1999). Table 4.3-4 summarizes estimated irrigation recharge by irrigation company/district averaged over the May to September 1996 and 1997 irrigation seasons. Recharge to ground water varies from an estimated 1.63 cfs (Eureka Company) to 5.41 cfs (Cline District).

The Dungeness River has both losing and gaining reaches (Simonds and Sinclair 2002, Thomas et al. 1999, Drost 1983) (see Figure 4.3-10). River seepage to and from the adjacent and underlying shallow aquifer varies by river reach and by time of year (Montgomery Water Group Inc. 1999).

Table 4.3-4. 1996 Estimated Ground Water Recharge via Irrigation Ditches and Canals Proposed for Piping

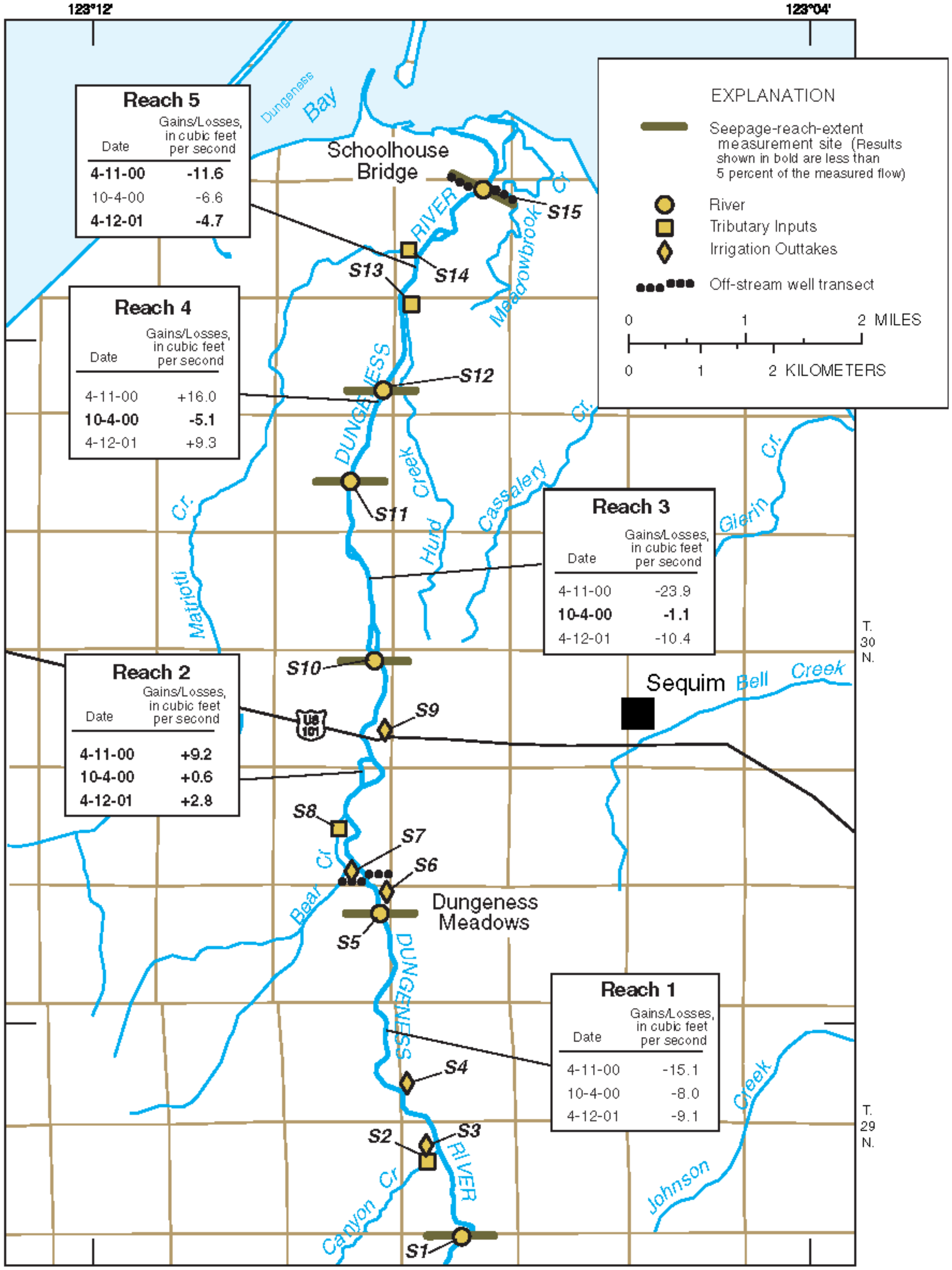
Irrigation Company	Estimated 1996 Ground Water Recharge (cfs)
Agnew District	4.18
Dungeness Company	3.22
Cline District	5.41
Clallam Company	1.62
Dungeness District	3.80
Independent Company	3.66
Highland District	3.03
Sequim-Prairie Company	3.61
Eureka Company	1.63
Total Estimated Ground Water Recharge	**30.16**

cfs = cubic feet per second

The Drost (1983) steady-state model ground water budget estimated 19 cfs of leakage from the Dungeness to the shallow aquifer for March 1979. For their period of study from December 1995 through September 1997, Thomas et al. (1999) estimated the average annual ground water discharge to the Dungeness River to be approximately 27 cfs and the estimated average annual leakage from the river to the shallow aquifer to be 28 cfs. This equates to an approximate 1 cfs leakage from the Dungeness River to the shallow aquifer. USGS (2002) also measured seepage into and out of the Dungeness River. For the months of April 2000, October 2000, and April 2001, USGS (2002) reported a net leakage from the Dungeness River into the shallow aquifer of 25.4, 20.2, and 12.1 cfs, respectively (Figure 4.3-10).

The tributaries of the lower Dungeness River and independent creeks are also interconnected with the ground water flow regime (Drost 1983, Thomas et al. 1999). Gains and losses resulting from discharge of ground water into the streams or loss of water to the shallow aquifer were measured on October 7, 1997 by the USGS (Thomas et al. 1999). Based upon these instream measurements and field observations, the total estimated average annual discharge to the small tributaries and independent streams included in the EIS study area was 25 cfs. With the exception of Bear Creek, in which a loss to ground water was measured, all other creeks received ground water discharge during the period of measurement.

Figure 4.3-10. Results of the Seepage Runs on the Five Study Reaches of the Lower Dungeness River, Clallam County, Washington, September 1999 to July 2001



Reach 5

Date	Gains/Losses, in cubic feet per second
4-11-00	**-11.6**
10-4-00	-6.6
4-12-01	**-4.7**

Reach 4

Date	Gains/Losses, in cubic feet per second
4-11-00	+16.0
10-4-00	**-5.1**
4-12-01	+9.3

Reach 3

Date	Gains/Losses, in cubic feet per second
4-11-00	-23.9
10-4-00	**-1.1**
4-12-01	-10.4

Reach 2

Date	Gains/Losses, in cubic feet per second
4-11-00	**+9.2**
10-4-00	**+0.6**
4-12-01	**+2.8**

Reach 1

Date	Gains/Losses, in cubic feet per second
4-11-00	-15.1
10-4-00	-8.0
4-12-01	-9.1

Used by permission, Department of Ecology from Simonds and Sinclair 2002.

In addition to ground water seepage into rivers and creeks, ground water discharges from the shallow aquifer into the middle via downward leakage through the confining bed, that separates the two aquifers, and by outflow to salt water bodies (Drost 1983).

4.3.4 Water Supplies

Surface Water

Surface water diversions from the Dungeness River during the 1996 and 1997 summer irrigation seasons (May 16 through September 20) averaged 74.4 cfs (Thomas et al. 1999). Figure 4.3-4 shows the location of irrigation canals and ditches and Table 4.3-1 summarizes monthly diversions by irrigation company/district from December 1995 to September 1997 (Thomas et al. 1999).

The City of Sequim currently uses three sources of water supply, two of which are ground water supply sources and are discussed in the Ground Water Supply Section, below. The third source of supply for the City of Sequim is the infiltration gallery. The infiltration gallery consists of perforated pipe buried in a gravel filter pack under the stream bank of the Dungeness River (City of Sequim 2000). The perforated pipe feeds a central collection well. The reported installed capacity of the infiltration gallery is 628 gallons per minute (gpm); however, gravity flows are currently taken on-demand at rates of approximately 200 gpm (0.45 cfs) (Pacific Groundwater Group 2002a).

Ground Water Supply

As the population increases in the Sequim-Dungeness peninsula, water use needs have changed (Montgomery Water Group Inc. 1999). Whereas agricultural water needs dominated water use before the late 1970s, residential needs are now important (Thomas et al. 1999). Consequently, withdrawals directly from the Dungeness River for irrigation have been decreasing and withdrawals from ground water supply wells have been increasing.

Ground water withdrawals during 1996 were estimated by Thomas et al. (1999) using the following water-use categories: domestic self-supplied, public supply, irrigated agriculture, golf courses, dairy operations, fish hatcheries, and commercial or industrial. Using these categories, total ground water withdrawals were estimated to be 5,212 acre-feet. This volume represents gross withdrawals and does not reflect returns to the ground water system via septic recharge. If septic recharge is considered, the total net withdrawal from the ground water system was approximately 3,344 acre-feet in 1996 (Thomas et al. 1999).

Most of the water supply withdrawals are from the shallow aquifer. The distribution of gross water withdrawals is approximately 67 percent from the shallow aquifer, 13 percent from the middle and lower aquifer, and 7 percent from the lower aquifer (Thomas et al. 1999). (The remaining 13 percent of ground water withdrawals come from the upper and lower confining beds, the undifferentiated deposits, and the underlying bedrock.)

Exempt Water Supply Wells

Exempt wells are those wells that do not require a water right permit or certificate because they use 5,000 gallons per day or less for 1) stock watering, 2) single or group domestic purposes, 3) industrial purposes, or 4) watering a lawn or non-commercial garden that is not larger than one-half acre. With respect to the long-term management of ground water resources, the proliferation of exempt wells and the continuing high rate of new well drilling are sources of concern (Dames and Moore 2000).

There are now more than 4,000 wells in the Sequim-Dungeness area and ground water extraction from exempt wells in the vicinity of Sequim is estimated to have increased by approximately 0.58 million gallons per day (mgd) between 1990 and 2001 (Pacific

Groundwater Group 2002a). Approximately 55 percent of this volume (0.32 mgd) is estimated to have been used consumptively (i.e., it did not return as recharge to the shallow aquifer via septic discharge or irrigation return flow).

Current total ground water withdrawals from exempt wells are estimated to be equivalent to approximately 5 percent of the total certificated ground water withdrawals (Dames and Moore 2000).

Non-Exempt Water Supply Systems

Key non-exempt water supply systems on the Dungeness-Sequim peninsula that rely on ground water include the City of Sequim, Public Utility District Number 1 (PUD #1) of Clallam County, and the Sunland Water District. The City of Sequim relies on two wellfields: the Silberhorn Wellfield and the Port Williams Wellfield. Each of these wellfields currently has two production wells.

PUD #1 operates the Loma Vista Wellfield (consisting of three production wells), the Smithfield Drive Wells (two active wells), the Carlsborg Well, and the Mains Farm Property Association Wellfield (three wells, but only one is active). The Sunland Water District operates two domestic wells and two irrigation wells north of the Port Williams Wellfield. The location of these water supply systems is shown on Figure 4.3-11.

Production wells in the City of Sequim Silberhorn Wellfield are completed in the shallow aquifer at depths of 132 to 220 feet below land surface (bls). The Port Williams Wellfield currently consists of two wells with well completions in the lower aquifer at depths of 284 and 411 feet bls. The Port Williams production wells supply 50 percent of the City of Sequim's water supply (City of Sequim 2000).

The PUD #1 Loma Vista Wellfield, the Smithfield Drive Well #1, and the Carlsborg Well are all completed in the shallow aquifer at depths ranging from 130 feet bls (Loma Vista Wells #2 and #3) to 177 feet bls (Carlsborg Well). Of the remaining PUD #1 wells, the Smithfield Drive Well #2 is completed in the middle aquifer and the Mains Farm Property Association Well #2 (the active well) is completed in the lower aquifer at a depth of 537 feet bls.

Sunland Water District's two domestic wells are constructed in the shallow aquifer (Domestic Well #2) at a depth of 124 feet bls and the middle aquifer (Domestic Well #1) at a depth of 250 feet bls.

As an approximate measure of comparison of ground water withdrawals, in 1996, the City of Sequim had 1,086 total connections to its water supply system. The Loma Vista Wellfield, operated by PUD #1, had 280 connections and the Sunland Water District had 630 connections. Other ground water users, such as the Parkwood Mobile Home Community and Dungeness Meadows Homeowner's Association had 210 and 200 total connections, respectively (Pacific Groundwater Group 2002a). Table 4.3-5 summarizes 1996 reported water use values for these and other ground water users.

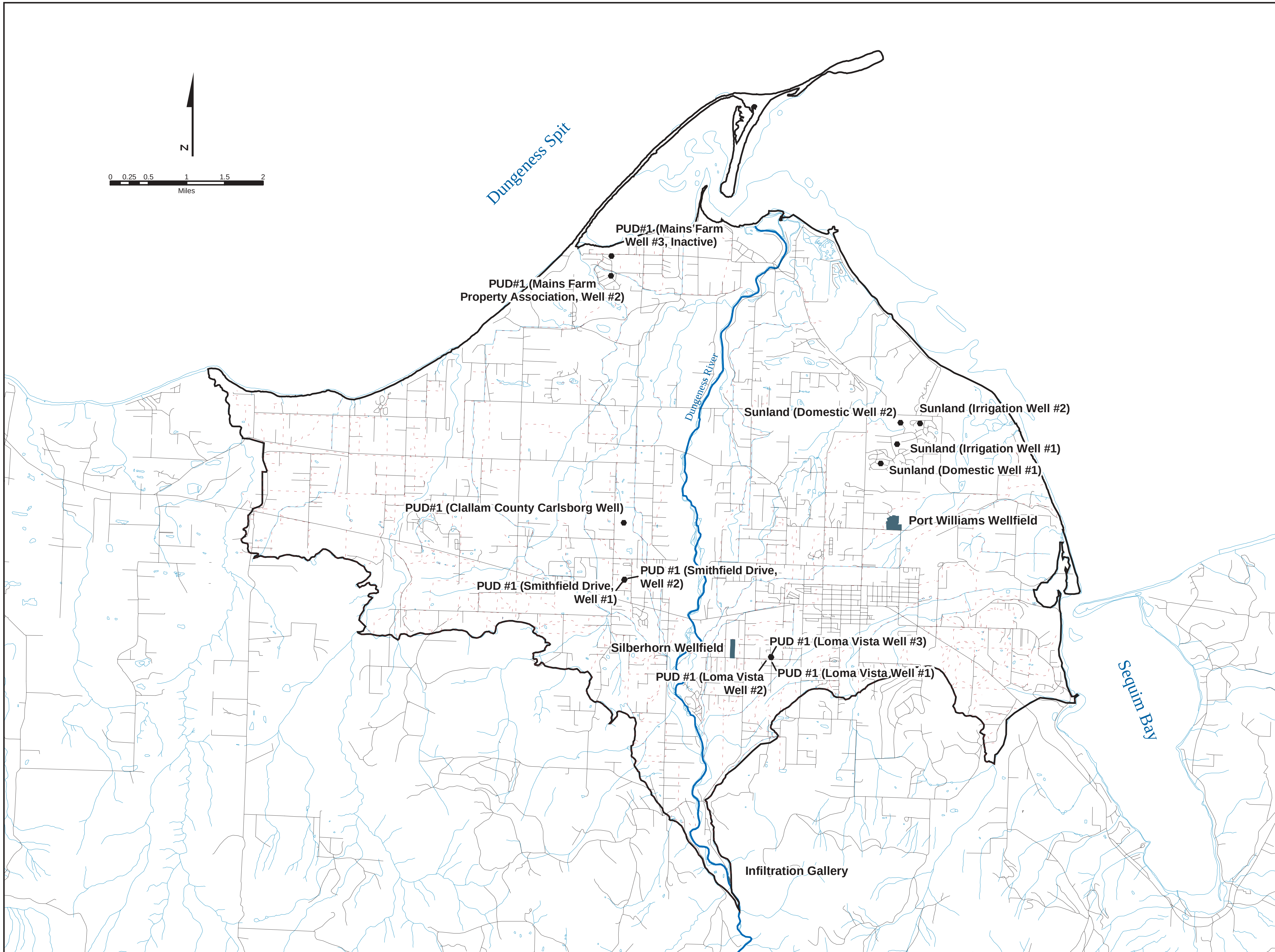


Figure 4.3-11
Selected Public Water Supply Wellfield Locations

Map Features

- EIS Boundary
- Dungeness River
- Streams
- Irrigation Ditches
- Roads
- Public Water Supply Well
- City of Sequim Wellfield Locations

Location Map

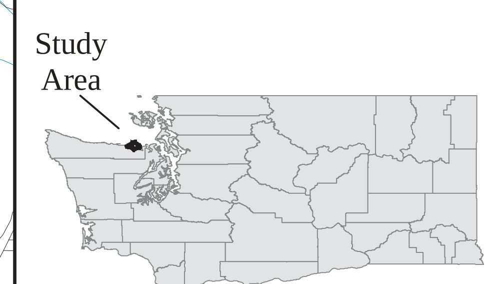


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Table 4.3-5. Reported Ground Water Use for Public Supply, Industrial, Agricultural, and Recreational Facilities (1996)

Water Use	User	Location	Hydrogeologic Unit[1/]	Use in gpm	Use in AF/YR
Crop farms	Weyerhaeuser Seed Orchard	30N/04W-09E	1	0.27	0.43
Crop farms	Weyerhaeuser Seed Orchard	30N/04W-09F	1	2.65	4.29
Crop farms	Graysmarsh	30N/03W-05R	1	61.26	99.25
Crop farms	Knapman	30N/04W-12M	1	1.32	2.13
Crop farms	Graysmarsh	30N/03W-09R	5	26.26	42.53
Crop farms	Weyerhaeuser Seed Orchard	30N/04W-09L	6	6.18	10.02
Dairy	Smith - Gary, Ben	30N/03W-21H	1	19.40	31.43
Dairy	Jeff Brown	31N/04W-36G	1	3.30	5.35
Dairy	Dan Smith	30N/04W-15G	1	4.70	7.61
Dairy	Smith - Gary, Ben	30N/03W-08J	5	17.26	27.96
Dairy	Smith - Gary, Ben	30N/03W-08P	3	8.42	13.63
Dairy	Jerry Schmidt	30N/04W-18C	1	6.80	11.02
Dairy	Lonnie Booth	30N/03W-17G	1	1.90	3.08
Fisheries	WDFW Hurd Creek Hatchery	30N/04W-01M	1	1,000.00	1,620.00
Golf courses	Dungeness Golf and Country Club	30N/04W-03Q	1	4.11	6.66
Golf courses	Sunland Golf Course	30N/03W-08B	1	50.51	81.82
Industrial	Blake Sand and Gravel	30N/04W-03A	1	1.43	2.31
Industrial	Primo Construction	30N/04W-01A	1	1.20	1.94
Crop farms	Dungeness Turf Farm	30N/04W-02R	1	21.60	34.99
Public supply	Sequim Silberhorn Wellfield	30N/04W-25C	1	84.87	137.49
Public supply	Loma Vista Wellfield	30N/04W-25A	1	71.19	115.33
Public supply	Sunland Water System (No. 2)	30N/03W-08C	1	55.45	89.83
Public supply	Carlsborg LUD#10	30N/04W-15R	3	29.79	48.25
Public supply	Sunland Water System (No. 1)	30N/03W-08L	3	104.89	169.92
Public supply	Sequim Port Williams	30N/03W-17F	5	138.14	223.78
Public supply	Mains Farm Property Association	31N/04W-34G	6	16.78	27.18

[1/] Hydrogeologic Units from which ground water is being withdrawn: 1- shallow aquifer, 3 – middle aquifer, 5 – lower aquifer, 6 – undifferentiated, unconsolidated deposits
gpm = gallons per minute, AF/YR = acre-feet per year, WDFW = Washington Department of Fish and Wildlife, LUD = Land Use District
Source: Pacific Groundwater Group 2002a

4.3.5 Water Quality

Surface Water Quality

Water quality problems in the project area have been recognized since results of sampling by Clallam County in the late 1980s indicated that fecal coliform standards were not met in the tailwaters of 4 out of 5 irrigation ditches and 8 out of 10 streams in the eastern portion of WRIA 18 (Dames and Moore 2000). Monitoring since then has revealed additional problems with nutrients, temperature, dissolved oxygen, pH, instream flows, and sediment in some sections of the mainstem Dungeness, tributaries, and irrigation ditches. Several areas have been closed to commercial shellfish harvest due to elevated fecal coliform levels in Dungeness Bay.

The State of Washington classifies the Dungeness River and its tributaries from the mouth to its confluence with Canyon Creek as Class A (Excellent) under WAC 1733-201-045(1). All portions of the river above Canyon Creek (RM 10.8) are classified as Class AA (extra-ordinary). Dungeness Bay is classified as Class AA marine water, and as a result all streams and irrigation ditches that drain directly into the bay are also classified as Class AA (Table 4.3-6). There are several stream segments within the project area that are listed on Washington State's 303(d) list of water quality impaired waterbodies, which requires the preparation of a TMDL for water quality parameters of concern (Table 4.3-6). A TMDL for fecal coliform is being prepared for Dungeness Bay and one has been completed on the Lower Dungeness Watershed (Sargeant 2002).

Table 4.3-6. Water Quality Concerns

Waterbody	Segment	Class	Concern (Source)	303(d) Listed
Dungeness River	RM 3.2	A	Instream flow – Listed Fecal coliform – Exceeded pH – Exceeded	
Dungeness River	RM 3.2, mouth	A	Fecal coliform – Exceeded during irrigation season at one site, exceeds shellfish growing area standards pH – Exceeded standard in three samples (Sargeant 2002)	Yes – Instream flows
Meadowbrook Creek	Mouth to CM 2.0	AA	Fecal coliform – Most samples did not meet standards Temperature – Five exceedences pH – Five readings below standards DO – Five readings below standards (Sargeant 2002)	No
Meadowbrook Creek irrigation ditch		AA	Fecal coliform – No locations met standards Temperature- 2 exceedences (Sargeant 2002)	No
Meadowbrook Slough	Near Abernathy Road	AA	Fecal coliform – About half of the sampling locations met standards Temperature – Five exceedences pH – Five readings below standards DO – Three readings below standards (Sargeant 2002)	No
Cooper Creek		AA (marine-except FC)	Fecal coliform – Did not meet standards Temperature – Two samples did not meet standards pH – One sample was below standard (Sargeant 2002)	No
Golden Sands Slough		AA (marine)	Temperature – Seven exceedences (Sargeant 2002)	No
Irrigation Ditches	Just west of Cline Spit	A	Fecal coliform – Did not meet standards Temperature – Ditch 1 did not meet standards (Sargeant 2002)	No
Matriotti Creek, tributaries, and ditches	CM 0-6	A	Fecal coliform – Major source of fecal coliform to Dungeness, only 12 out of 46 sampling locations/periods met standards pH – Two samples exceeded the standard, one sample was below DO – Two samples were below standard (Sargeant 2002)	Yes – Fecal coliform
Hurd Creek		A	Fecal coliform – Standards met during wet season and annually, exceeded during irrigation season (Sargeant 2002)	No
Bell Creek	Lower portion	AA	Fecal coliform – Numerous samples, all exceeding standards, collected between 1985 and 1991 (Ecology 2000) DO – Standards exceeded during summer months Ammonia – One sample exceeded the acute standard out of 25 measurements (City of Sequim 2001)	Yes – Fecal coliform
Cassalary Creek	At the mouth	AA	Fecal coliform – Three samples collected in 1991 exceeded the standard (Ecology 2000)	Yes – Fecal coliform
Gierin Creek		AA	Potentially affected by animal waste (Haring 1999)	No
Bear Creek		A	Sediment – At high flows, water and sediment can flow through Agnes Irrigation System channels into Bear Creek (Haring 1999)	No
McDonald Creek	RM 2.0	AA	Fecal coliform – Potentially elevated levels Temperatures – Exceeded at one location (Haring 1999)	No
Siebert Creek		AA	Low levels of fecal coliform with fair to good temperature conditions (Haring 1999)	No

DO = dissolved oxygen

Elevated fecal coliform levels are the most widespread pollution problem in the project area and are a particular concern due to commercial shellfish harvest area closures in Dungeness Bay for fecal coliform exceedences. Fecal coliform is an indicator of the presence of possible harmful pathogens (e.g., bacteria and viruses) associated with human and animal waste. There are no point sources or regulated stormwater discharges to surface water in the study area, indicating that nonpoint pollution is the source of fecal coliform problems in the basin (Sargeant 2002). Monitoring indicates that most of the sites upstream from the mouth of the Dungeness have higher fecal coliform concentrations during the irrigation season. The mouth of the Dungeness had more consistent levels year-round, with a slight increase during the wet season. In order to meet strict AA marine standards for fecal coliform and protect shellfish harvesting in Dungeness Bay, the TMDL study recommended reductions in fecal coliform loading in the Dungeness and tributaries by up to 82 percent. Lower Matriotti Creek and the lower Dungeness were noted as having the highest loads during the irrigation season and the wet season, respectively (Hempleman and Sargeant 2002).

Other water quality concerns are not as ubiquitous in the project area. Stormwater management and related water quality impacts are increasing in importance as the area develops and the amount of impervious surface increases. The specific effects have not been determined. Table 4.3-6 lists streams within the project area and their water quality concerns.

Ground Water Quality

There are comparatively few data available on ground water quality within the project area. In general, most of the ground water quality samples collected met state and federal standards as defined in WAC 246-290-310 and 40 CFR 141.61(a), respectively. The main ground water quality concerns in the project area are above-natural levels of nitrates, potential fecal coliform contamination, and salt water intrusion.

In samples collected recently around Agnew, on the west side of the project area, 13 of 32 wells were found to exceed safe-drinking-water standards for coliform bacteria or nitrates (Hempleman and Sargeant 2002).

Existing water quality and nitrate data were reviewed and samples collected for a recent USGS study (Thomas et al. 1999) in the project area. The report concluded that there were above-natural concentrations of nitrates in some areas of the shallow aquifer because of its proximity to sources at the surface. Areas of elevated concentrations were noted in a large area east of the Dungeness River and north of Bell Creek, and scattered higher-concentration samples were noted in the area west of the Dungeness River and east of McDonald Creek. Although the sources for the increased levels of nitrate were uncertain, the report speculated that septic systems, residential fertilizers, nitrogen stored in the soil from past agricultural practices, commercial agricultural fertilizers, dairies, and less dilution of nitrate from reduced ground water recharge could be contributing to the change in nitrate levels.

The study noted that nitrate levels significantly increased over the past 15 years, and that residential areas contribute higher levels of nitrogen to the shallow aquifer than other land uses (Thomas et al. 1999). The nitrate levels were well below drinking water standards in 1997, but were higher than natural background levels, and appear to be increasing. Ecology completed a water quality study of the Agnew and Carlsborg area in 2003 (Sinclair 2003). This study concluded that nitrate levels are increasing, though they are still well below drinking water standards. Other water quality constituents studied, including dissolved chloride, iron, specific conductance, temperature, pH, and dissolved oxygen, were within expected ranges.

A smaller-scaled study of water quality in the Agnew and Carlsborg area was completed in 2003 by Ecology. This study found that out of eight wells tested, three showed statistically significant increases in nitrate-N concentration between 1980 and 2002. Of the remaining wells, four showed no significant trend and one showed a statistically significant decline in nitrate-N concentration. The wells that displayed an increase in nitrate concentration are located east of Matriotti Creek and west of McDonald Creek. Though some of these wells show an increasing trend, the highest nitrate detection (4.58 mg/L) is well below the drinking water standards (10.0 mg/L).

Other water quality constituents were studied, including total persulfate nitrogen, total iron, total manganese, total and fecal coliform bacteria, and chloride in area ground water. Total coliform bacteria were detected in approximately 16 percent of samples and were found on one or more occasions in five of the eight wells sampled during this study. While coliform bacteria generally pose no direct health risk to humans, their presence in well water indicates possible contamination by sewage or other fecal matter. Numerous wells exceeded secondary (aesthetic) drinking water quality criteria for pH, total iron, and total manganese during one or more sampling events.

The City of Sequim Department of Public Works monitors ground water quality in samples collected from its three sources: an infiltration gallery adjacent to the Dungeness River below Canyon Creek, the Silberhorn Wellfield just north of U.S. Highway 101 and east of the Dungeness River (draws from the shallow aquifer), and the Port Williams Wellfield, which lies about a mile northeast of the City of Sequim (draws from the middle aquifer). Monitoring results indicate elevated levels (but below water quality standards) of nitrate, and one sample from the Dungeness River location taken in 1994 had detectable levels of fecal coliform. The City's five-times-per-month sampling within the distribution system has otherwise shown levels to be within drinking water standards. For inorganic chemicals, including sodium, trace metals, lead, nitrate, turbidity, and hardness, concentrations for most of the measurements were very low, and none exceeded standards. Soluble organic compounds and volatile organic compounds, typically pesticides, herbicides, petroleum products, or solvents, were not detected in any of the four samples analyzed.

Seawater intrusion has been described as a potential problem along the shorelines of Sequim Bay, Dungeness Bay, and the Fairview area. Sampling in 1993 confirmed that Diamond Point and the east, west, and south shores of Sequim Bay continue to be vulnerable to seawater intrusion; severe, but localized cases were noted from the past (Dames and Moore 2000). However, the 1993 data did not indicate a pervasive problem in eastern Clallam County at the time. Other studies (Drost 1983, 1986 [as cited in Dames and Moore 2000]; Thomas et al. 1999) corroborate this.

4.4 Vegetation and Land Cover

4.4.1 General

The land cover of the study area has been dramatically altered since Euroamericans began populating the area in 1852. The dominant vegetation at that time across the project area was hemlock-fir forest, punctuated by prairies maintained by burning. As settlements grew, the hemlock and fir forests were cleared for agricultural land use. Land use in the project area has changed over the last 50 years from predominantly commercial agriculture to rural residential, with some agricultural areas remaining.

Currently, approximately 22 percent of the land remains forested. Persisting forested areas can be found along the south and southwest boundary of the study area, Gierin Hill, Graysmarsh, the Potholes, Dungeness Recreational Area, and within the riparian zones of McDonald Creek and Dungeness River. Dominant tree species include Douglas-fir, hemlock, cedar, and red alder (Dungeness Area Watershed Analysis Cooperative Team 1995). Field, pasture, berries, and orchard cover approximately 46 percent of the study area and are dispersed throughout the area with denser concentrations to the north. Built cover, including paved impervious surfaces, covers approximately 13 percent of the project area. Residential lawns cover approximately 8 percent of the study area and are concentrated around the communities of Sequim, Carlsborg, Dungeness, and Sunland. Grass/brushy areas also cover 8 percent of the study area and can be found in Graysmarsh, north of Gierin Hill, near the mouth of the Dungeness River, and east of Carlsborg. One percent cover each is attributed to bare areas and water (Montgomery Water Group Inc. 1999).

4.4.2 Wetlands

This section is intended to provide a basis for understanding the evaluation of environmental impacts on wetlands. The first part defines wetlands and the second part describes the wetlands in the project area. The third part describes wetland functions, how they are assessed, and how wetlands in the project area are assessed.

Wetlands are "those areas that are inundated or saturated by surface water or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas" (Environmental Laboratory 1987). Wetlands are ecologically important because of their beneficial effect on water quality, moderation of flow regimes by retaining and gradually releasing water, and value as wildlife habitat and as areas of botanical diversity. Major sources of water to many wetlands in the project area are direct discharges from irrigation systems (tailwaters) and increased shallow aquifer recharge from leaking irrigation ditches (CCDCD 1995, PSCRBT 1991).

Wetland Identification and Regulation

A wetland is an ecosystem that relies on either constant or recurring saturation of the substrate to create unique physical, chemical, and biological conditions. Three major features characterize these conditions: presence of water in the substrate, physical and chemical features of the substrate, and vegetation (Committee on Characterization of Wetlands 1995).

To comply with federal, state and local regulations, wetlands are delineated according to the U.S. Army Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987), and the Washington State Wetlands Identification and Delineation Manual (Ecology 1997). Both manuals define wetlands as areas where vegetation, soils, and hydrology combined determine wetland conditions. Specifically, it is land that: 1) has a predominance of hydric soils; 2) is inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions; and 3) under normal circumstances does support a prevalence of this vegetation.

All three criteria must exist for an area to be identified as a regulated wetland. An area may be wet at times and may provide some functions of a wetland but not be regulated. The manuals have specific methods and indicators that are used to delineate a wetland for regulatory purposes.

Generally, the wetlands in the project area are subject to regulation regardless of water source. For example, Clallam County regulates a wetland whether it was historically natural or artificially created (or enlarged) due to irrigation in the region. An important exception is that wetlands that were intentionally created, such as the irrigation ditches, are not subject to County regulation. This section addresses areas that are classified in the Clallam County database as wetlands (Clallam County Wetland Database).

Wetlands in the Project Area

The Clallam County wetland database has been revised since its creation in 1995 and updated with new information by the Clallam County Planning Division. It is the primary source of information for the following general description of wetlands in the project area.

Size

There are 265 wetlands or wetland complexes, covering a total of 2,732 acres, within the project area (Figure 4.4-1). Approximately 8 percent of the study area is mapped as wetland. The location and estimated size of each wetland is from the Clallam County database. This county evaluation of wetlands was based on aerial photo interpretation, the National Wetland Inventory, and local knowledge (CCDCD 1995). Although some wetlands have been professionally delineated, most have not, and the size indicated in the database may represent an over or underestimate of the actual wetlands. For example, it is possible that a wetland in the database is actually a complex of several smaller wetlands with upland separations. The wetlands in the planning area range from 0.1 acre to 405 acres. Figure 4.4-2 shows size class distribution of wetlands as recorded in the Clallam County database. Eight wetlands (less than 5 percent of the total number) are larger than 100 acres and account for approximately 1,686 acres or more than 60 percent of the wetland acreage in the project area. They will be discussed individually. Forty-five percent of the wetlands in the project area are less than one acre in size.

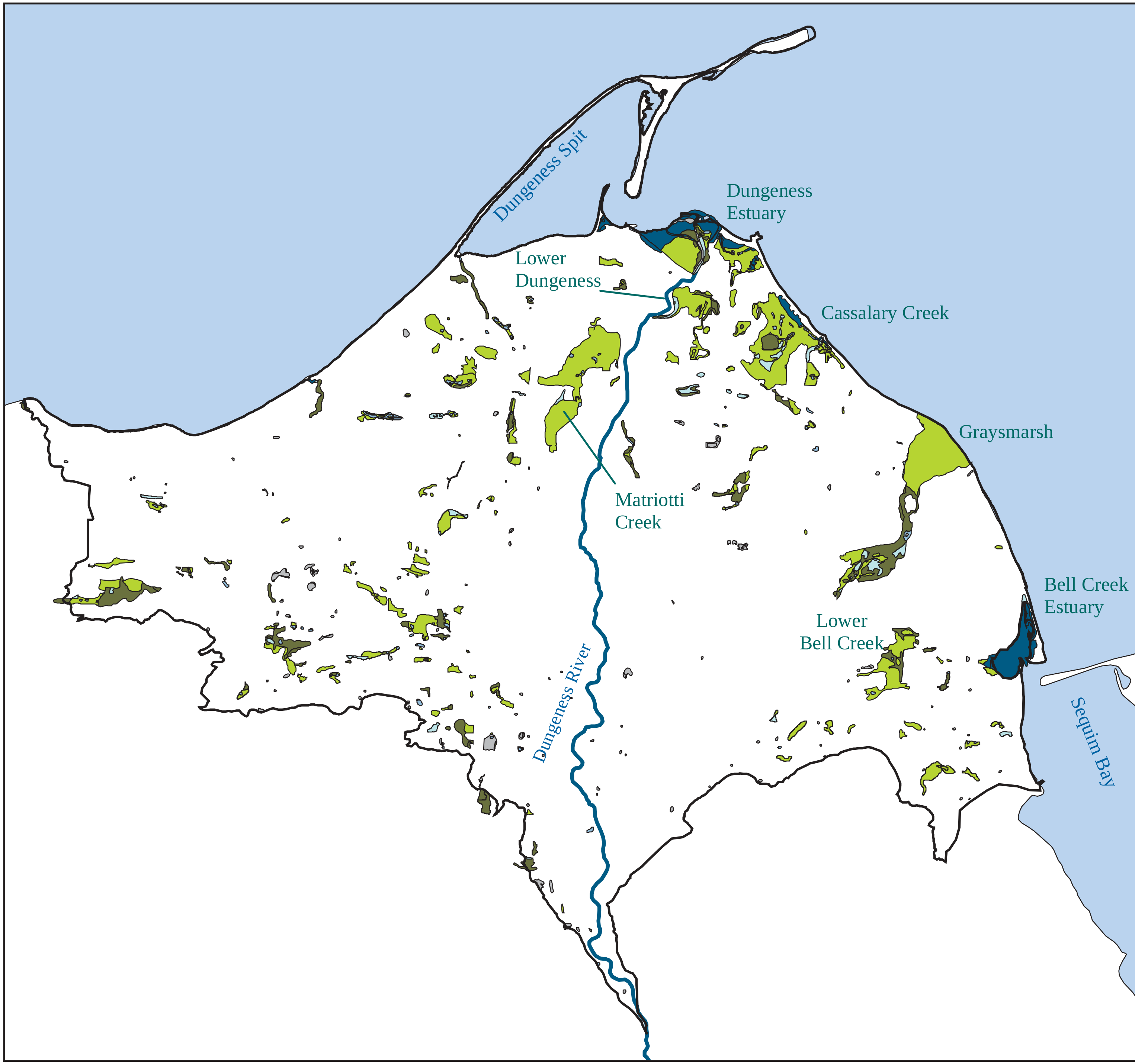
Vegetation Type

This category was based on the USFWS classification system used for the National Wetland Inventory Database (NWI). Wetlands are broadly classified as riverine, lacustrine, estuarine, or palustrine, (Cowardin et al. 1979). The project area includes estuarine and palustrine wetlands. Estuarine systems occur along salt water and in the intertidal or subtidal zones. Palustrine systems are those that are not classified as riverine, lacustrine, or estuarine and are dominated by trees, shrubs, persistent emergents, and emergent mosses or lichens. While there are many vegetation types in the database, there are six that account for 93 percent of the acreage in the project area. Figure 4.4-3 shows wetland acreage by class. Because the dominant vegetation defines wetland classes, the classes and vegetation types are used interchangeably.

Many of the wetlands in the project area are complexes of several types of vegetation types. The largest wetlands have many vegetation types and strata that increase habitat complexity. The interspersion of classes provides edges that increase the habitat suitability for some wildlife species (Hruby et al. 1999). For example, General Habitat Suitability, defined as being suitable habitat for many species of plants and animals, is partially dependent on having several types of vegetation. Open water within other vegetative types, such as forested or emergent, makes wetlands more attractive to amphibians.

Fifty-eight percent of the wetland area, or 1,597 acres, is palustrine emergent wetland (PEM) dominated by herbaceous vegetative cover (Figure 4.4-3). This type of wetland may provide habitat for small mammals, invertebrates, amphibians, and some birds. If it contains small

Figure 4.4-1
Wetland Locations and Classes



Map Features

- EIS Boundary
- Dungeness River
- Aquatic Bed
- Estuarine
- Open Water
- Palustrine Emergent
- Palustrine Forested
- Palustrine Scrub Shrub
- Uncoded

Location Map

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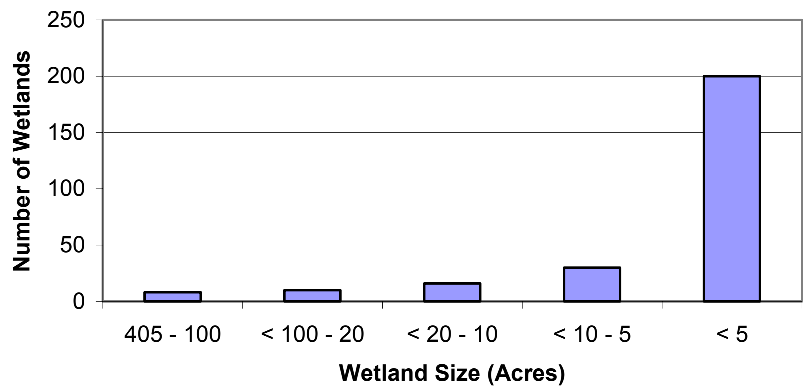
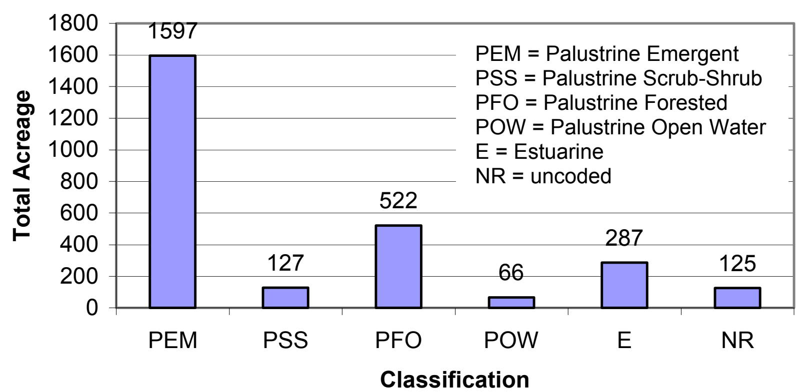


Source: Clallam County Wetland Database (2002)

Figure 4.4-2. Number of Wetlands in the Planning Area by Size Class



Source: Clallam County Wetland Database (2002)

Figure 4.4-3. Acreage of Wetlands in the Planning Area by Wetland Class

ponds or is adjacent to open water, it would be improved habitat for amphibians and birds (Hruby et al. 1999). An emergent wetland may also provide other functions such as sediment, nutrient, or toxic removal.

The next largest acreage cover is palustrine forested wetland (PFO), accounting for 522 acres or 19 percent of the wetland acres. A forested wetland provides habitat for birds and mammals, particularly if it is a partially open canopy. A forested wetland adjacent to other types of vegetative units would provide better habitat. Open water adjacent to a forest could improve suitability of the habitat for bird species or provide habitat for additional species of birds or mammals (Hruby et al. 1999). Palustrine scrub-shrub (PSS) accounts for 127 acres, or 5 percent of the total wetland acres, and 66 acres or 2 percent of total wetlands are open water within palustrine wetland (POW).

Water cover is important to bird species richness. Depth, duration, and frequency of water cover influences bird species composition (Richter et al. 1996). The open-water areas within the wetlands are mostly very small. They range from 0.1 acre to less than 5 acres, but only 3 are larger than 2 acres and 16 are between 1 and 2 acres. Eighty percent, or 81 of the open-water areas, are less than 1 acre and many are ditches or ponds. These smaller open-water areas would enhance bird habitat but may not be large enough to include large numbers of waterfowl.

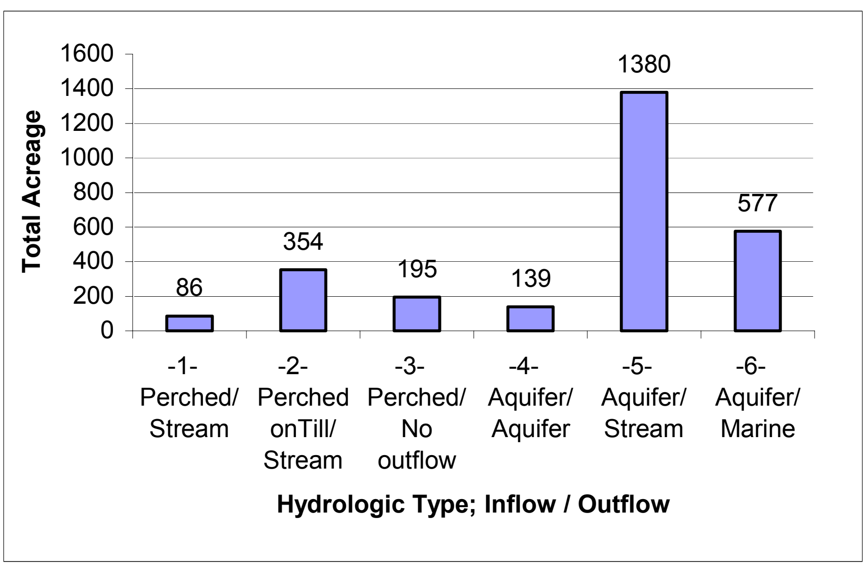
Estuarine (E) wetlands, influenced by tides and fresh water, account for 125 acres or 5 percent of the total. Estuarine wetlands are considered one of the most productive types of wetland and may provide excellent habitat for birds and fish. Figure 4.4-1 shows the vegetation type in each wetland.

Hydrologic Types

While there are 11 hydrologic types in the Clallam County database, the wetlands in the project area are classified into 6 of the types. The hydrologic type, which categorizes the source and outflow of water, has implications for the hydrologic, biologic, and biogeochemical functions. For example, a wetland with a perched water table and no outlet may be good habitat for waterfowl, depending on the length of the saturation at or above the surface, but would not provide much flow to streams to support fish. A perched wetland that is fed by runoff and subsurface water (not from the aquifer) that is on a hill would not provide much detention/retention, while a wetland with the same sources but in a depression could provide significant detention/retention and water quality functions. The hydrology types were determined for each wetland depending on the source of the water and on the position in the area landscape for the Clallam County wetland analysis (CCDCD 1995) and can be found in Appendix C.

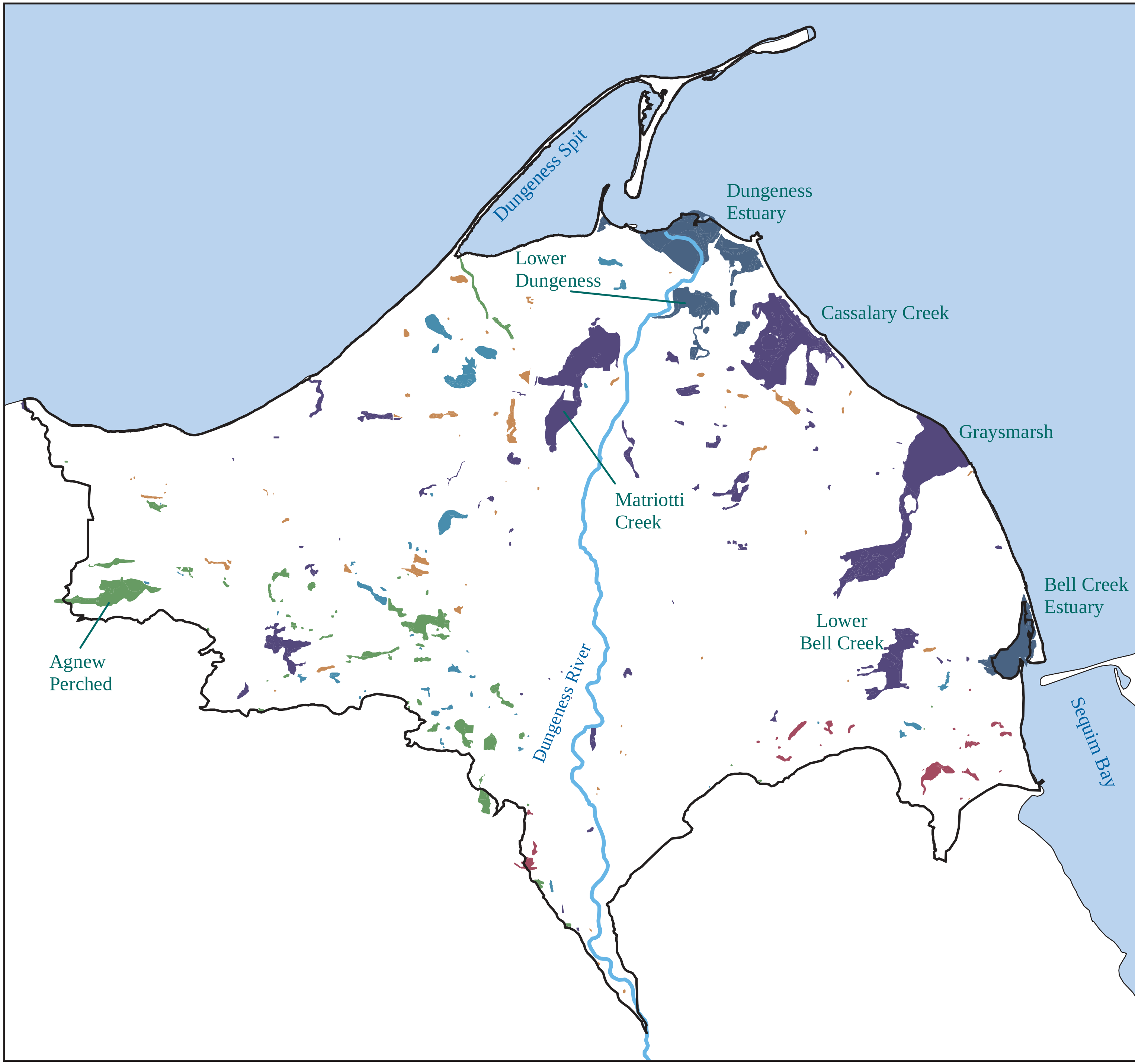
Figure 4.4-4 shows the acreage of each hydrologic type in the project area and Figure 4.4-5 depicts the hydrologic type for each wetland. Seventy-five percent of the wetland acreage is primarily fed by the shallow aquifer. The hydrologic function of these wetlands would be affected by changes in the ground water level. The remaining 25 percent of the wetland acreage is primarily fed by runoff and water close to the surface, often a perched water table. These would not be expected to be affected by ground water level changes but could be affected by changes in amounts of runoff from rain, irrigation tailwater, or irrigation leakage in the local area.

Figure 4.4-4. Source of Inflow and Outflow for Wetlands in the Project Area



Source: Clallam County Wetland Database

Figure 4.4-5
Wetland Hydrology Types

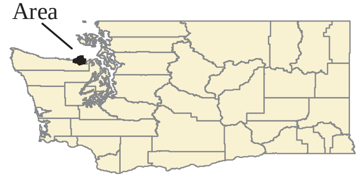


Map Features

- EIS Boundary
- Dungeness River
- Perched water table / stream
- Perched water table / can initiate stream when full
- Perched water table/ none
- Aquifer / groundwater
- Aquifer / stream
- Aquifer / stream; tidally influenced

Source:
CCDCD Wetland Database

Location Map



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Wetlands Larger than 100 Acres

The following is a description of the eight wetlands larger than 100 acres ranked by size in the Clallam County database. For these wetlands, the Clallam County wetland database has been supplemented by additional published resources, aerial photograph interpretation, and communications with local wetlands experts. Information is available to assess each wetland's size, classification, hydrologic function, general vegetation, and management.

Graysmarsh/Gierin Creek

The largest of the wetland complexes is along Gierin Creek and includes Graysmarsh. The entire complex is listed as 405 acres in the Clallam County database. In an 1859 survey of the area, it was noted as a salt marsh and grass swamp in the northern portion and a tree swamp in the southern portion of the same area as exists today. In a 1914 survey, it was noted as a salt marsh (Eckert 1998). In approximately 1910, a tidegate was installed, and the marsh was changed from a saltwater, estuarine wetland to a freshwater and brackish palustrine wetland. The tide gate reduced salt content and eliminated tidal and wave energy that existed in the estuarine wetlands. In addition, Gierin Creek was channeled and confined to a much shorter course that empties directly through the tide gate into the ocean instead of meandering through a salt marsh (personal communication, R. Johnson, Wildlife Biologist for WDFW, memorandum to B. Banard, Environmental Engineering Division, November 23, 1998, Appendix H.1).

The source of water today for the wetland is primarily the shallow aquifer and secondarily Gierin Creek, fed in part by tailwater from irrigation and ground water from irrigation discharge and other sources. There is an artesian well on the Graysmarsh property that also contributes to the wetland from the lower aquifer. Leakage from irrigation canals in the local area is believed to affect local recharge to the shallow aquifer (AESI 1999, Montgomery Water Group Inc. 1999). Associated Earth Sciences, Inc. (AESI) was retained by Graysmarsh, LLC, to study and report on the hydrogeologic conditions of the Graysmarsh area (AESI 1999). They defined an "approximate ground water zone of contribution to Graysmarsh". This report estimated 9.2 cfs of inflow to the shallow aquifer within the Gierin Creek basin, which includes 1.5 cfs from recharge from outside of the basin, 1.5 cfs from Dungeness River loss flowing through an ancestral channel, 0.7 cfs from Graysmarsh Farms Hi-Line Ditch, 3.0 cfs from irrigation ditch leakage, 0.6 cfs from upwelling from the lower aquifer, 0.1 cfs from direct precipitation, and 1.8 cfs from unknown sources. An estimated 1.5 cfs from the shallow aquifer discharges into Gierin Creek in addition to the 0.5 cfs that Gieren receives from tailwater. Both Gierin Creek and the shallow aquifer feed Graysmarsh wetland. The AESI report indicates these two sources contribute 1.4 cfs and 7.9 cfs, respectively to the wetland. A figure showing the estimate schematic water balance for Graysmarsh wetland can be found attached to the comment letter from Pamela Krueger of Perkins Coie in Appendix G.

There is also salt water input from the Strait of Juan de Fuca that is controlled with the tidegate. Prior to the alteration of Gierin Creek and the installation of the tidegate, the lower marsh was substantially supplied with salt water. Subsequent to these modifications, the owners have had to periodically dredge sediments from Gierin Creek to maintain desired open-water components (personal communication, Robin Berry, Biologist, Graysmarsh LLC, to Penny Eckert, Foster Wheeler Environmental, Field Tour of Graysmarsh, July 18, 2002).

The outflow of the wetland is to the stream and the Strait of Juan de Fuca. The soils are mapped as a combination of Beach, Mukilteo Muck, and Sequim Series. Mukilteo Muck is a hydric and organic soil that is not likely to have been created recently. Sequim soil is very gravelly sandy loam that is somewhat excessively drained and is not a hydric soil. Beach is generally gravely and sandy, subject to wave action, and may have tidal marshland (USDA 1987). Beach soil is the soil mapped for the area of Graysmarsh that is closest to the Strait of Juan de Fuca. It is probably the original soil before the tidegate was installed when the area was estuarine and heavily influenced by tides. The soils have probably been changing since the early 1910s when the tidegate was installed.

The wetland includes approximately 260 acres of emergent wetland, 115 acres of forested, 26 acres of scrub-shrub wetland, and 5 acres of open water in four separate areas (the largest is 3.6 acres) (Clallam County wetland database). The northernmost part of the wetland, including what remains of the Gierin Creek estuary and saltmarsh, is brackish. There is a gradient of salt marsh to freshwater plants going inland. The salt marsh is approximately 30 acres. The area mapped as wetland includes upland interspersed in the wetland (Clallam County database).

The current private owners actively alter the vegetation in Graysmarsh to improve waterfowl habitat. Livestock are not allowed, and commercial agriculture does not occur in the marsh, though both ranching and commercial agriculture are conducted on adjacent parcels of Graysmarsh property. Waterfowl habitat is maintained through growing barley both in the wetland and in adjacent agricultural fields, growing berry crops in adjacent fields, mowing large areas of reed canary grass and cattails in the marsh area, and also dredging the marsh channels (personal communication, Robin Berry, Biologist, Graysmarsh LLC, to Penny Eckert, Foster Wheeler Environmental, Field Tour of Graysmarsh, July 18, 2002).

Because Graysmarsh has several vegetation types (forest, shrub, emergent, open water) and is adjacent to the Strait of Juan de Fuca, it provides diverse habitat for waterfowl, eagles, osprey, mammals, anadromous fish, and resident fish. The tidegate may create some blockage to anadromous fish entry. There is an osprey nest in the pond and eagle nesting territories near the wetland (WDFW 2002). Section 4.5.2 presents a more detailed discussion of wildlife in this wetland as part of the larger project area.

In 1995, Chris Chappell, plant ecologist with the Washington Department of Natural Resources, surveyed Graysmarsh for plant community types. He found three significant plant communities that are largely restricted in range to the Olympic rainshadow area (Moriarty 1997). The communities noted are communities that are tolerant of dry conditions and may be upland sites.

Cassalary Creek

The second largest wetland complex includes the mouth of Cassalary Creek and is close to the Strait of Juan de Fuca. It was noted as a salt marsh and grass swamp in the 1859 survey of the area, and the portion closest to the Strait was noted as a salt marsh in 1914 (Eckert 1998). The wetland is Clallam County hydrology type 5, indicating that the source is primarily ground water and the outflow is to a stream. There are now residences and a road between the majority of the wetland and the Strait of Juan de Fuca. The soils are mapped as the Lummi Series and Mukilteo Muck Series. Both are poorly drained soils and are classified as hydric.

The wetland is mapped at 329 acres and is likely to have some upland inclusions. Seventy-seven percent (256 acres) is emergent, 9 percent is scrub shrub, 2 percent is forested (a 7-acre grove of large trees), 6 percent is open water, and 5 percent is estuarine. At least half of the water areas are ditches at the edge of the wetland adjacent to the residential area along the Strait of Juan de Fuca. Cooper Creek bisects the wetland and leaves the wetland at the coast. Cassalary Creek runs through the eastern portion of the wetland and has a small estuary at its mouth. Because this wetland has a small creek, moderately interspersed vegetation types, and is adjacent to the Strait of Juan de Fuca, it provides habitat for birds, eagles, anadromous fish, and resident fish. Some of the land is grazed and farmed and other parts have been developed for residences. The wetland is surrounded by residences, roads, and other farmed or grazed areas.

Matriotti Creek Complex

The third largest wetland complex is about a mile from the Strait of Juan de Fuca, south of Matriotti Creek, and close to Matriotti Creek confluence with the Dungeness River. It is listed in the Clallam County database as covering 267 acres. The wetland is Clallam County hydrology type 5, indicating that it is fed by the aquifer and discharges to a stream. There are two small unnamed streams flowing through the wetland that are tributaries to Matriotti Creek, which in turn provides habitat for both resident and anadromous fish. The unnamed streams may provide habitat, at least seasonally. The streambanks are partially farmed and only partially vegetated with shrubs or trees, reducing the quality of the stream habitat for fish. Although only a small amount of acreage is in ponds, the area is also listed as providing habitat for waterfowl, possibly because crops provide a food source. The soils are mapped as Bellingham, Mukilteo, and Puget. All three are poorly drained, hydric soils that are either organic or formed in alluvium that are unlikely to have developed wetland characters recently (USDA 1987). This wetland is 97 percent palustrine emergent wetland and a large portion is used for pasture or farmland, including a wildlife exhibit farm. Because there are several buildings (including residences) within the 267 acres, inclusions of upland areas are likely within the overall mapped wetland acreage. To the east is a developed upland area separating the wetland from the Dungeness River. Matriotti Creek is to the north. The other surrounding land is farmed, grazed, or developed. Some recent restoration work has been completed along Matriotti Creek (personal communication, Cynthia Nelson, Washington State Department of Ecology, 2002).

Dungeness Estuary

The next largest wetland is at the mouth of the Dungeness. This was mapped as a salt marsh in 1914 (Eckert 1998). It is mapped as containing approximately 227 acres and is of hydrologic class 6, indicating that it is fed by the aquifer and discharges to marine water. The soils are mapped as Beach and Lummi Series. The Beach Series is gravelly sand with some tidal marshland and the Lummi Series is a poorly drained, hydric soil formed in marine sediment and alluvium (USDA 1987). Half of this wetland is estuarine with tidal influence that provides excellent habitat for birds and fish. A third of the area is farmed with emergent vegetation, 10 percent is the forested riparian area adjacent to the Dungeness River and the remainder includes the river, a small pond, and scrub-shrub areas. A residential road bisects the wetland along the western side of the Dungeness. The wetland is adjacent to the Dungeness National Wildlife Refuge and otherwise surrounded by roads, housing, and farms. Habitat for eagles, waterfowl, and peregrine falcons is present (WDFW 2002).

The Dungeness estuarine wetland is connected to the 89-acre wetland formed where Meadowbrook Creek had served as a distributary of the Dungeness. They are separated by a road but are hydrologically connected. The habitat for birds and fish is effectively connected and that greatly enhances the quality of the potential wildlife habitat in the area.

Bell Creek Estuary

At the mouth of Bell Creek is a wetland of approximately 115 acres known as Washington Harbor Lagoon. It is almost entirely open to salt water and primarily affected by tidal and wave action. A small portion of the wetland is at the mouth of Bell Creek and is affected by the freshwater creek and the salt water. The wetland is hydrologic class 6, indicating that it is fed by the aquifer and discharges to marine. The vegetation is largely marine algae. There are small emergent plant areas where Bell Creek flows into the wetland. There are eagle nesting territories, peregrine falcon, shorebird, and waterfowl habitat (WDFW 2002). The habitat quality is primarily due to the open water. Adjacent to the wetland is a forested area that runs along the coast and enhances the bird habitat. More than 50 percent of the wetland is surrounded by farm or roads. The rest is adjacent to the Strait of Juan de Fuca.

Lower Bell

Another wetland of approximately 115 acres is upstream from the estuary of Bell Creek. The wetland is hydrologic class 5, indicating that it is fed by the aquifer and supplements streamflow in its discharge. Three-quarters of the wetland is emergent vegetation, farmed or grazed, and one-quarter is forested. It is also adjacent to a large forested area that provides a continuation of habitat. There are two small open-water areas in the wetland, one in the forested area and one in the emergent area. The majority of the buffer is farmed, grazed, or roaded. Bell Creek and a tributary of Bell Creek bisect the wetland and provide anadromous and resident fish habitat. Bell Creek and the tributary in this area (above the fork) do not have the potential to perform as many wetland functions as the lower section due to lower flows and poorer riparian habitat quality.

Lower Dungeness

Just south of the Dungeness estuary wetland is a smaller, 102-acre wetland associated with the lower Dungeness River. The wetland is mapped as having Lummi Series soils that are poorly drained and hydric. The eastern edge includes Meadowbrook Creek and its forested riparian zone. Meadowbrook Creek feeds directly into the Strait of Juan de Fuca near the mouth of the Dungeness River. More than half of the wetland is farmed or grazed with emergent vegetation. The rest is forested or scrub-shrub, primarily in the Meadowbrook riparian zone. Meadowbrook provides habitat for anadromous and resident fish. The wetland is aquifer-fed and discharges to Meadowbrook Creek and the Dungeness River.

Agnew Perched

Only one wetland larger than 100 acres is a perched wetland not fed by the shallow aquifer. It is just south of U.S. Highway 101, between McDonald and Siebert Creeks, and is mapped with approximately 103 acres. Sixty percent of the wetland is emergent with a few small ponds, and is farmed or grazed. The remaining 40 percent is forested with a small scrub-shrub component. It is Clallam County hydrologic class 2, indicating that it is perched on till and flows to a stream when the wetland fills in winter. This wetland type may support a stream until June or July. Three Agnew irrigation ditches traverse small parts of the wetland. The trees and the irrigation ditches may provide bird habitat but the area is not recorded as having any notable animal habitat.

Wetland Functions

Wetlands perform significant functions in a watershed. Functions are processes that occur in wetlands and are generally of value to humanity. There are many lists of functions attributed to wetlands and in general they fall into three broad categories: hydrologic, biogeochemical, and habitat (Mitsch and Gosselink 1993, Committee on Characterization of Wetlands 1995). The hydrologic function is the regulation of water flow, including timing and duration, across the landscape. The biogeochemical function includes the maintenance and improvement of water quality. Habitat includes all species of animals and plants. These functions can be performed by the wetlands in the project area whether they are historically natural wetlands or whether they have been created or enhanced by irrigation water.

An assessment methodology is used to determine how well an individual wetland and its buffer function against several characteristics. Wetland functions are complex and interrelated processes; determining the presence and importance of functions within any specific wetland is difficult and requires site-specific knowledge.

In 1995, Clallam County developed a geographic information system (GIS)-based procedure to inventory and characterize functions of wetlands in the County. The County assessment took future possibilities into account and provided an indicator of long-term potential and value to the region. The County assessment is described in Appendix C.

After discussion with Clallam County personnel (Steven Gray, Clallam County Senior Planner, personal communication with Mary-Clare Schroeder, Foster Wheeler Environmental, October 11, 2002) and Ecology staff (Ann Boeholt, Department of Ecology Wetlands Biologist, personal communication with Mary-Clare Schroeder, Foster Wheeler Environmental, October 11, 2002), a modification of the system proposed by Hruby et al. (1999) was used. Hruby et al (1999) uses an evaluation of quantitative measurements and qualitative observations to calculate wetland functional indices for individual wetlands. For this analysis, information from the Clallam County wetland database, National Wetland Inventory (NWI) maps, aerial photography, and site drive-by assessments were used to perform a qualitative analysis. Thirteen functions from Hruby et al. were identified for qualitative evaluation of wetland functions on an individual and landscape basis. Several of these functions were combined in this analysis because the input variables used were similar. Nutrient removal and toxin removal were combined, as were invertebrate and amphibian habitat and anadromous and resident fish. The variables used and how they apply to the identified functions are found in Hruby et al. Table C-3, Appendix C, shows the functions evaluated and the variables used to assess the wetland functions. The table also shows which variables apply to which functions.

The Clallam County database was used to develop the following parameters for the wetlands: hydrologic type, total size, size of each vegetation class (e.g., forested, open water), the relationship to any adjacent stream, and position in the landscape. A summary of the Clallam County hydrologic functional assessment is in Appendix C. Some on-site information and aerial photo interpretation were used to determine current vegetation and to augment County database information on landscape position and habitat quality for wildlife and for fish.

Each of the following functions was assessed on a qualitative basis, using available information.

Sediment Removal: Sediments are removed when water velocity is reduced and the particles settle out of the water column. This is generally performed by filtration or physical blockage by the vegetation.

Nutrient and Toxin Removal: Wetlands primarily remove nutrients and toxics through physical entrapment on plant tissue and chemical binding on soil particles and by nitrification and denitrification in alternating oxic and anoxic conditions (Mitsch and Gosselink 1993).

Peak Flow Reduction: Wetlands slow and store water by holding back runoff from the watershed during high water events that could flow downstream and cause floods. The potential to perform this function is considered to be affected by the shape of the wetland (a bowl holds more than a plate), the constriction of the outflow (something to hold the flow back), the size of the area not already inundated, and the density of woody vegetation.

Production and Export: Wetlands are generally thought to have high primary production and can then export the organic material to adjacent waters. This provides a food source for the aquatic system (Mitch and Gosselink 1993). To have the potential to perform this function, a wetland needs vegetative cover and a mechanism to move the organic matter to adjacent water systems.

Recharging Ground Water: Wetlands can provide a source of recharge to ground water. This is influenced by the ability to retain water and the ability of the soil type to transport water.

General Habitat: General habitat is the suitability for a broad range of animal species. It incorporates the habitat needs for invertebrates as well as macro-fauna. Therefore, it benefits by complexity in vegetation in the wetland, interspersal of upland and wetland, and interspersal of open water within the wetland.

Invertebrates and Amphibian Habitat: This function is benefited by a lack of development in the wetland or its buffer, the availability of plant litter, the amount of open water, and the interspersal of open water within the wetland. Most of the amphibians found in the project area (Table 4.5-4) require ponds or wetlands for breeding and rearing of young (Leonard et al. 1993).

Fish Habitat: This function requires surface water connection to the ocean for anadromous fish but not for residents, and is influenced by the type, quality, and variety of open water. This is discussed in detail in the fisheries section (Section 4.5.1).

Wetland Birds: Wetland-associated birds rely on the wetland ecosystems for their habitat. The factors that influence bird habitat are a wetland's proximity to a stream or the Strait of Juan de Fuca, development in the wetland or its buffer, open water in the wetland, vegetation structure, and food sources. This is also discussed in the wildlife section (Section 4.5.2).

Wetland Mammals: The factors that contribute to this function are the quantity of open water, interspersal of the water within the wetland, development in the wetland and its buffers, and connectivity to other wetlands and natural areas.

Each function was assessed on a qualitative basis using available information. Table C-3, Appendix C, shows the variables used to assess each of the functions for the wetlands.

Wetlands Larger than 100 Acres

Table 4.4-1 shows the functional assessment for the eight wetlands in the project area greater than 100 acres in size, and Figure 4.4-1 shows the location of each. These eight wetlands were given ratings of high, medium, or low for their potential to perform functions based on the factors listed above. This assessment does not account for a wetland's opportunity to perform a function. For example, a wetland may have the shape, constricted outflow, and size to perform the function of peak flow reduction to a high degree. If that wetland does not have enough concentrated rainfall or snowmelt to create high flows, the opportunity does not exist to perform the function. Opportunity is discussed further in the analysis of project effects in Section 5.4.

Table 4.4-1. Functional Assessments for Wetlands Over 100 acres

Wetland	Size (acres)	Potential for[1/]					Habitat Suitability					
		Sediment Removal	Nutrient, Toxic Removal	Peak Flows and Erosion Reduction	Production and Export	Recharging Ground Water	General	Invertebrates and Amphibians	Anadromous Fish	Resident Fish	Birds	Wetland Mammals
Graysmarsh	405	M	M	L	M	L	H	H	M	M	H	H
Cassalary Creek	329	M	M	L	M	L	L	L	M	M	M	M
Matriotti Creek Complex	267	M	M	M	M	L	L	L	M	M	L	L
Dungeness Estuary	227	L	L	L	M	L	H	H	H	H	H	H
Bell Creek Estuary	115	L	L	L	L	L	M	M	M	M	H	L
Lower Bell	115	M	M	M	M	L	M	M	L	L	M	M
Lower Dungeness	105	M	M	L	M	L	M	L	M	M	L	L
Agnew Perched	100	H	H	M	L	H	L	L	L	L	L	L

H: High, M: Moderate, L: Low

[1/] This assessment used size, location, vegetation, and hydrology type input from the Clallam County wetland database. See Appendix C for a discussion of the county functional assessment.

Wetlands Less Than 100 Acres

There are 257 wetlands in the project area that are less than 100 acres. In total, they cover approximately 1,050 acres, less than 40 percent of the wetland acres.

Table 4.4-2 shows the distribution of acreage by hydrologic type for the wetlands less than 100 acres. These wetlands smaller than 100 acres have been grouped together to facilitate discussion of the project alternatives. They were not reviewed for current vegetation or habitat quality, and their assessment is based only on data from the Clallam County database (Appendix C). The grouping is based on hydrologic type as identified by Clallam County because the project has the potential to affect the source of wetland hydrology. There are two primary groups: those wetlands fed by the aquifer and those that are perched and fed with surface or subsurface runoff.

Table 4.4-2. Hydrologic Functions of Small Wetlands in the Area by Hydrologic Type

Hydrologic Type		Percent of Acreage	Sediment Removal	Nutrient and Toxin Removal	Peak Flows	Production and Export	Recharging Ground Water
1	Perched Wetlands: 51%	8	Low	Low	Low	High	None
2		24	High	High	High	Low	None
3		19	High	Low	Low	Low	Low
4	Ground Water Fed: 49%	13	Low	High	Low	Low	High
5		25	High	High	High	High	None
6		11	Low	High	Low	High	Low

Source: Adapted from Clallam County Critical Area Code C.C.C. 27.12.210 (see Appendix C for discussion).

Approximately half of the acreage is ground water-fed (shallow aquifer). These wetlands could be affected by changes in the ground water level. The remaining half of the wetland acreage is primarily fed by runoff and water close to the surface over a dense subsurface layer, creating a perched water table. These wetlands are unlikely to be affected by ground water level changes but could be affected by changes in amounts of runoff from rain or irrigation leakage in the local area.

Although each specific wetland will potentially perform the biogeochemical and hydrologic functions to a higher or lower level, the effects for these two groups will be assessed on the potential performance of the hydrologic type shown in Table 4.4-2.

4.5 Wildlife

4.5.1 Fish

The variety of salmonids (salmon and trout) that inhabit the project area are described in Appendix D with information about their life histories, stock status, and known limiting factors. Each species tends to utilize the project area at specific times of the year at some stage of their life cycle (Table 4.5-1) and tends to utilize particular types of habitat (Table 4.5-2). Salmonid habitat in the project area can be broadly categorized into five types of watercourses: 1) mainstem Dungeness River, 2) side channels of the Dungeness, 3) tributaries to the mainstem, 4) the irrigation system, and 5) independent streams that flow to marine waters. Such a categorization is useful because it groups watercourses with similar characteristics; ideally, each segment of each watercourse would be surveyed and catalogued to assist in the assessment of cumulative effects, but such an effort would be prohibitively expensive.

The Dungeness project area has some anadromous species whose populations are considered healthy. However, other populations are less healthy, with three of them (chinook salmon, summer chum salmon, and bull trout) listed under the ESA (Table 4.5-2). In addition to those species listed under the ESA, Haring (1999) states that fall chum, both summer and winter steelhead, and Lower Dungeness pink salmon stocks are critically depressed. A measure of the condition of the various species is indicated by the historical number escaping to spawn in the system (Table 4.5-3).

Current Status

Chinook Salmon

Chinook salmon in the Dungeness River are termed spring/summer chinook because the adults migrate into the Dungeness River in May to rest and hold until they are ready to spawn from mid-August into October. Chinook salmon have been observed throughout the river to the impassable falls at river mile (RM) 18.7, although in more recent years they have spawned in the river mainstem up to the Dungeness hatchery (RM 10.5) which impedes but does not necessarily totally restrict upstream passage (Haring 1999). They have also been observed in the Gray Wolf River up to RM 2.5, although the latter river is thought to be passable up to RM 8.0 (Haring 1999). Adult chinook salmon have also been observed in the lower reaches of Canyon Creek.

Table 4.5-1. Life Stages of Anadromous Salmonids on the Dungeness River[1/]

									Approx. Low Flow Period				
Species	**Life Stage**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Chinook[2/]	Upstream Migration												
	Spawning												
	Emergence												
	Rearing												
Pink – Odd Years Only (Both Upper and Lower Stocks)	Upstream Migration and Spawning												
	Emergence and Downstream Migration												
Coho	Upstream Migration and Spawning												
	Emergence[3/]												
	Rearing												
Chum	Upstream Migration and Spawning												
	Emergence and Downstream Migration												
Steelhead	Migration												
	Spawning												
	Rearing												
Char[4/] (Bull trout/Dolly Varden)	Spawning												
	Emergence												
	Rearing												

[1/]. The degree of shading indicates the relative intensity of each life history stage, with the darkest shades indicating the highest levels of intensity.
[2/] Lichatowich, J. 1992.
[3/] Sandercock, F.K. 1991.
[4/] Timing and stock status of char in the Dungeness watershed are unknown. Sources: Haring (1999) and WDFW (1998). However, general information about this species is available from Scott and Crossman (1973).

Table 4.5-2. Distribution of Anadromous Fish Species in the Dungeness River, Tributaries, and Independent Streams in the Project Area

					Dungeness River						Independent Creeks (from west to east)							
							Tributaries											
Species / Stock	**ESA listing** (T= threatened)	**Stock status** [1/] (Crit = critical; Dep = depressed; D/C = both)	**Stock origin:** W = Wild; M = Mixed; N = Native	**Production:** W = Wild; M = Mixed; N = Native	**Mainstem**	**Side Channels**	**Matriotti**	**Hurd**	**Bear**	**Canyon**	**Siebert**	**McDonald**	**Meadowbrook**	**Cooper**	**Cassalary**	**Gierin**	**Bell**	**Johnson**
Chinook Spring/Summer	T	Crit	N	W	X [1/]													
Chum Summer	T	D/C			X [1/]		X [1/]	X [1/]										
Fall		Crit	N	W	X [1/]		X [2/]		X [1/]		X [2/]	X [2, 3/]	? [2/]	X [2/]	X [4/]	X [4/]	X [4/]	X [2/]
Coho Dungeness		Dep	M	M	X [2/]	X [5/]	X [1/]	X [1/]	X [1/]	X [2/]			X [1/]	X [1/]	X [1/]	X [1/]		
Sequim Bay		Dep	M	W													X [1/]	X [2/]
Morse Creek		Dep	M	W							X [2/]	X [1/]						
Pink (odd-years only) Upper Dungeness River		Dep	N	W	X [1/]			X [2/]										
Lower Dungeness River		Crit	N	W	X [1]	X [6/]	X [2/]	X [1/]										
Steelhead Summer		Crit	[7/]	[7/]	X [2/]													
Winter (Dungeness River)		Crit	[7/]	[7/]	X [2/]		X [2/]	X [1/]	X [1/]	X [2/]								
Winter (Independent Streams)		Dep	[7/]	[7/]							X [1/]	X [1/]	X [1/]	X [1/]	X [1/]	X [1/]	X [1/]	X [5/]
Bull Trout/Dolly Varden	T	(unk) [8/]	W	N	X [2/]												X	
Coastal Cutthroat		(unk) [8/]	W	N	X [2/]		X [2/]				X [2/]	X [2/]	X [2/]	X [2/]	X [2/]	X [2/]	X [2/]	X [2/]

Notes:
Unk = status unknown
X= may be found in this location
[1/] Haring (1999), which updated WDF (1993)
[2/] Unpublished
[3/] Perhaps strays
[4/] DQ Plan (Ecology 1994); Haring (1999)
[5/] Salmon and Steelhead Stock Inventory by WDFW and Western Washington Treaty Indian Tribes, 1992
[6/] Hirschi and Reed (1998)
[7/] Stock status and production unresolved by WDFW and the Tribes
[8/] WDFW and Western Washington Treaty Indian Tribes 1998 (Unk = status unknown)

Table 4.5-3. Recorded Spawning Escapement of Anadromous Salmonids in the Dungeness River

Species	Years	Escapement
Chinook (spring)	1986 – 2001	88 – 453
Pink (odd-year only)	1959 – 2001	1,695 – 400,000
Coho[1/]		
Chum (Fall)	1968 – 2000	20 – 1,726
Steelhead (Winter)	1988 – 2001	0 – 438
(Summer)[2/]		

Source: Personal communication from Ann Blakley, WDFW to Don Beyer, Tetra Tech FW, May 20, 2003.
1/ Coho numbers are not available for the Dungeness River.
2/ Indices are counts only, not escapement estimates.

Before settlement by Europeans, the runs of adult chinook salmon in the Dungeness may have ranged from around 19,500 to 26,000 fish (Lichatowich 1992). However, Dungeness River spring/summer chinook salmon runs only ranged from 88 to 335 between 1986 and 1991 (Table 4.5 3). Between 1991 and 2001, run size numbered less than 200 fish, with less than 100 fish in 3 of those years. The Dungeness chinook run, as a component of the Puget Sound Evolutionarily Significant Unit (ESU), was listed on March 24, 1999, as a threatened species under the ESA. Severe depletions in the Dungeness spring/summer run were noted as early as 1909 (Lichatowich [1993] as quoted in Dames and Moore 2000).

Chum Salmon

Dungeness Summer Run: Summer run chum salmon are usually larger and older than fall chum, and spawn in the mainstem of streams. The Dungeness run is thought to enter the River in August to spawn in the main channel from September into October. Their population numbers are very low; they are listed as threatened under the ESA. The summer run chum in the Dungeness River are a component of the Hood Canal Summer Run ESU and were listed as threatened under the ESA on March 24, 1999. Adult summer run chum salmon have been observed in the Dungeness River up to RM 10.8, and up to RM 0.5 in both Matriotti and Hurd Creeks (Haring 1999).

Dungeness River/East Strait Tributary Fall Chum: Fall run chum salmon typically spawn later and often use smaller spring-fed waters higher in the watershed because of the moderated (lower) temperatures. This run is more abundant than the summer run (Table 4.5-3) and is not listed under ESA. Fall run chum salmon enter the Dungeness River in September and spawn in the side channels into November and December (Jamestown S'Klallam Tribe as quoted in Dames and Moore 2000).

Spawning of fall run chum salmon occurs in the Dungeness River to upstream of RM 11.8, in Bear Creek (below Taylor Cutoff Road), Matriotti Creek (documented only to RM 0.9, but perhaps as far upstream as U.S. Highway 101), Beebe Creek to its upper reaches, McDonald Creek, Siebert and Bagley Creeks, and Lees Creek (in the 1940s, up to RM 0.8). The presence of chum in Cassalary, Bell, and Gierin Creeks may have occurred historically before these streams were altered (Haring 1999).

Fall run chum salmon were anecdotally noted as once being "incredibly numerous" in most streams in the project area, although the Dungeness River Technical Advisory Group (Haring 1999) noted that the stock status should now be considered as "critical" because of the few adults that return to spawn.

Char: Bull Trout and Dolly Varden

Bull trout are emphasized in this discussion because they were listed in 1999 as a threatened species under the ESA.

The Dungeness/Gray Wolf stock is thought to consist of anadromous, fluvial, and resident life history forms. The status of this stock is unknown. Anecdotal information provided in the Salmon and Steelhead Stock Inventory (SASSI) document (WDFW and Western Washington Treaty Indian Tribes 1993) indicates that char were once very common and widespread; anglers are reported to say that now they are still widespread, but not very common. WDFW biologists captured and identified char that they identified as bull trout at the Dungeness hatchery (RM 10.5) in 1996, at RM 16 in the Dungeness River in 1994, and at RM 1 in the Gray Wolf River in 1994.

Other anecdotal notes in Haring (1999) include observations of adult char in Canyon Creek near the Agnew ditch in 1998, and in upper Bell Creek. Haring (1999) also considers Cassalary and Gierin Creeks to be potential char habitat because the fish have been observed in Bell Creek, though none has been observed in either creek.

Coho Salmon

Dungeness River coho salmon populations are dominated by Dungeness hatchery production. Natural coho production has been documented in Bell Creek in the lower 3.0 miles including the tributaries to that creek; in Gierin Creek to mile 2.7 and its tributaries; in Cassalary Creek to mile 2.9; in the Dungeness River to mile 18.7 and side channels to the river at miles 7.0 and 9.3; in Matriotti Creek to the Agnew ditch at RM 6.8; in Beebe Creek for the first 0.6 mile; and in Bear Creak for 1.0 mile. Coho salmon are known to spawn in McDonald Creek up to RM 5.1 and are presumed to spawn in Siebert Creek to RM 8.5, and in West Fork Siebert Creek to RM 2.0 (Haring 1999).

The lower Dungeness River contains some of the most productive coho salmon habitats in the region. Spring Creek, a tributary of Dawley side channel, is especially important (WDFW unpublished, cited in Hirschi and Reed 1998). Coho use overflow channels not connected to the Dungeness River, and have been observed in small isolated pools in the watershed (Hirschi and Reed 1998). Juvenile coho salmon were present throughout the year in all side channels sampled by Hirschi and Reed (1998).

Haring (1999) speculates that the higher than expected coho returns to McDonald Creek may be the result of their attraction to the Dungeness River water that is diverted into that creek through the irrigation system.

Pink Salmon

An estimate of the historical Dungeness pink salmon runs before European settlement ranges from 299,566 to 599,133 (Lichatowich 1992). An estimated 400,000 pink salmon returned to the Dungeness River in 1963 (Lichatowich 1992). However, this run is currently considered either depressed (upper Dungeness) or critical (lower Dungeness) because of recent low numbers of returning adults.

Pink salmon return to the Dungeness River during the summer low flow and are found in the tributaries and accessible side channels. Lower Dungeness River pink salmon spawn primarily in the river up to RM 3.0, although some spawn up to RM 6.0. They also use Matriotti Creek to RM 0.2 and Beebe Creek to RM 0.6. Only recently have they begun to also use the central portion of the mainstem Dungeness (personal communication with R. Johnson, cited in Haring 1999). Meadow Creek, a stable side channel in the vicinity of the

Sequim Prairie irrigation intake and bypass, tends to be a productive area for pink salmon (Haring 1999).

Coastal Cutthroat Trout

Cutthroat trout in all watercourses in the project area are considered to be members of the Eastern Strait stock (WDFW and Western Washington Treaty Indian Tribes 2000). These fish have been documented in the Dungeness and Gray Wolf Rivers; in Johnson, Bell, Gierin, Cassalary, McDonald, Siebert, and Bagley Creeks; as well as in several unnamed independent streams.

The anadromous coastal cutthroat trout in the Eastern Strait complex are mostly late-entry, but early-entry cutthroat may also be present in the Dungeness River system. The time when spawning occurs is largely unknown, but is thought to be from January to April for both forms. Resident cutthroat may be present throughout the basin.

Steelhead and Rainbow Trout

O. mykiss has both a resident form (rainbow trout) that does not migrate to salt water and a sea-run form, which are known as steelhead. Rainbow trout may be found throughout the Dungeness drainage. Both summer and winter run steelhead are present in the Dungeness River.

Dungeness summer steelhead use the main river up to RM 18.7, where there is an impassable falls. Winter steelhead also use the main river to RM 18.7. Spawning times for summer and winter steelhead may occur between February through June (Table 4.5-1). In addition, they are presumed to have the same distribution as coho salmon in Bell, Gierin and tributaries, Cassalary, Meadowbrook, Matriotti, Beebe, and Bear Creeks (Haring 1999).

Affected Habitat Conditions

Dungeness River

A variety of changes to the Dungeness River have occurred over the past 150 years. Changes to the river channel have been extensive since World War II and the river has been diked, constrained with armoring, and even bulldozed to "clean" the channel and provide flood control. Partly because of these activities, the river began to aggrade in the lower sections (Haring 1999).

Salmonid production in the Dungeness River has been profoundly affected by water withdrawals for irrigation and commercial or domestic use. Removal of water either directly from stream channels or from wells that are hydraulically connected to streamflows reduces the amount of instream flow available for salmonid spawning and rearing habitat (Haring 1999). In other instances, streamflows may actually increase due to direct or indirect water transfers from other basins (such as irrigation ground water returns or storm water flows) (Haring 1999).

Access to spawning and rearing areas is considered one of the major limiting factors to salmonid production in the Dungeness River. The primary concern is that low flows during the late summer-early fall both decrease useable juvenile habitat in more than 9 miles of the river and impede adult salmon migration [Puget Sound Cooperative River Basin Team (PSCRBT) 1991, Lichatowich 1992, Orsborn and Ralph 1994, Haring 1999]. As the flow rates decrease in August and September, the potential for fish passage barriers to develop in shallow riffles increases, preventing adult pink and chinook salmon from reaching preferred spawning areas (Wampler and Hiss 1991). Under certain low-flow conditions, side channels that are utilized for spawning or rearing may become disconnected from the main channel

(Bountry et al. 2002). The extent and quality of spawning habitat in reaches subject to water withdrawals is substantially reduced compared to pre-withdrawal conditions (Haring 1999). Surveys of the lower river indicate a number of locations where juvenile salmonids were trapped in pools or other low spots along the margin of the wetted channel (Haring 1999). Some mortality was noted as water levels decreased and temperatures exceeded 68°F (20ºC; Haring 1999). In addition, during very low flows, salmon may have to utilize spawning sites in the main channel that are later subject to scour during high or flood flow conditions during the winter. If eggs are flushed from the gravel during these conditions, they likely will not survive.

Large woody debris was historically removed from the Dungeness River for flood control and, as a consequence, stable logjams are very scarce in the lower 10.8 miles of the river (Orsborn and Ralph 1994). In addition, removal of the wood resulted in increased velocities, erosion, and channel instability, as well as a reduction in pool frequency, sediment storage capacity, and side channel habitat.

The PSCRBT (1991) and Orsborn and Ralph (1994) identified bank erosion, aggradation, braiding of the channel, and lack of off-channel habitat as major concerns throughout the Dungeness River. Anadromous fish access in the Dungeness River has been affected by bedload aggradation in some portions of the lower river between the mouth and the railroad trestle (Haring 1999). Aggradation requires higher flows to achieve depths for fish passage and to provide access to side channels (Haring 1999).

The floodplain of the Dungeness River is constrained by dikes, bridges, and road crossings from its mouth up to RM 10.8. These changes in the river have restricted the export of sediment from the channel. Frequent flooding of the floodplain historically allowed sediment to exit the system through the watersheds of Meadowbrook, Cassalary, and Cooper Creeks, whereas now, all sediment in the system is routed through the mainstem Dungeness River into Dungeness Bay.

Dungeness River Side Channels

Five side channels of the mainstem Dungeness River have been identified as important fish habitat in the project area.

Side channels in the lower Dungeness include Gagnon (RM 3.25 to 4.0), West Railroad Bridge (RM 5.6 to 4.0), Campsite (near the West Railroad Bridge), East Railroad Bridge (RM 5.65 to 6.4), and Dawley (RM 6.4 to 7.5). The most productive side channels can provide valuable spawning and rearing habitat for salmon and steelhead because of greater food abundance, reduced velocities, and a relatively greater supply of ground water. Side channels that are stable and have mature vegetation are often the most productive (Haring 1999). Pink salmon have been documented using side channels successfully for spawning, while mainstem pink salmon redds have lower survival rates. The side channels have a high contribution from ground water and also are somewhat protected from the harmful effects of high flows (Haring 1999). However, they do change in structure over time. In 2002, Bountry et al. (2002) extensively studied the geomorphological structure of the lower river, including the side channels.

The following descriptions of these important side channels are modified from Hirschi and Reed (1998).

Gagnon Side Channel (RM 3.25 to RM 4.0): This channel is about 3,100 feet long. Fish are present in the channel even at low flow when the channel is not connected to the river for extended periods. This side channel is isolated from the mainstem when the river falls below 200 cfs and the upper reaches of the channel can become dry during the intermittent flows of both the summer and winter. Much of this side channel is pool habitat formed by imbedded wood (Hirschi and Reed 1998).

Alcove pools in the mainstem also seem to have great importance for both chinook and coho salmon rearing during low-flow periods (Hirschi and Reed 1998). These pools provide refuge all year and remain connected to the mainstem in low flows (Hirschi and Reed 1998). Alcove pools provide off-channel habitat on the opposite streambank of the Dungeness just downstream from Gagnon side channel.

West Railroad Bridge Side Channel (RM 5.6 to RM 6.4): This side channel flows for about 4,100 feet before connecting with the mainstem just below the railroad bridge. The lower reaches have pools providing significant coho salmon habitat. In addition, overflow channels connected to this side channel provide limited habitat for chinook salmon as well as for coho salmon and trout. Twenty-six percent of the channel length is pool habitat (Hirschi and Reed 1998).

Campsite Side Channel: This side channel is located near the West Railroad Bridge side channel. It provides some habitat for chinook and coho salmon. The channel has flow all year, even though it is connected to the Dungeness via one of the braids of the main channel (Hirschi and Reed 1998).

East Railroad Bridge Side Channel (RM 5.7 to RM 6.4): This channel is about 1,950 feet long. The top entrance of this side channel is open at least part of the year, but the channel goes dry for half its length during both winter and summer low-flow periods (Hirschi and Reed 1998). Chum salmon were observed spawning in riffle habitat in this side channel. The lower reaches provide juvenile coho habitat during low flows. Juvenile chinook salmon may also use pools in the lower reaches of this side channel (Hirschi and Reed 1998).

Dawley Side Channel (RM 6.4 to RM 7.5): This side channel is about 3,800 feet long, and was the only side channel noted by Hirschi and Reed (1998) to have flow during most of the year. The Sequim Prairie Ditch Company maintains an open connection to the mainstem that brings water into the Dawley side channel. Maintaining flow in the side channel, even in times of extreme low flow, is important for its use by chinook salmon (Hirschi and Reed 1998).

Spring Creek (which is actually another side channel near the Dawley side channel) has been noted as highly productive coho habitat (Randy Johnson, WDFW Fisheries Biologist, personal communication with Kenneth Carrasco, Foster Wheeler Environmental, September 2002) and may also support a few juvenile chinook salmon. The upper end of Spring Creek is not connected to the river due to a blocking structure (Hirschi and Reed 1998).

Lower Dungeness River Tributaries

Several tributaries enter the Lower Dungeness River, including Bear Creek, Matriotti Creek, Hurd Creek, and Canyon Creek.

Bear Creek: This medium-sized stream enters the Dungeness River at RM 7.3. A low dam used for irrigation pumping just above the confluence of this stream with the Dungeness River barred upstream fish passage until the late 1990s when aggradation of the river and at the mouth of Bear Creek eliminated the barrier. Stormwater flows and sediment, augmented by irrigation ditch deliveries, are conveyed via Bear Creek to the Dungeness during peak flow events.

Hurd Creek: Hurd Creek is a short, low-gradient tributary entering the Dungeness River at RM 2.7. It provides high-quality rearing and refuge habitat for fish (Haring 1999). The majority of spawning and rearing habitat in the creek is in the lower 0.25 mile downstream from Woodcock Road. Prior to 1999, adult salmonids were blocked at RM 0.5 by an artificial impassable barrier operated by Washington State's Hurd Creek Hatchery. Both adult and juvenile access was restored in 1999. The Dungeness River Technical Advisory Group (TAG) for Limiting Factors Analysis indicates that there is little spawning habitat upstream from Woodcock Road, but some juveniles have been noted upstream of the road (Haring 1999). No effects from irrigation operations were noted by Haring (1999).

Matriotti Creek: This tributary enters the Dungeness River at RM 1.9 and is the largest low-elevation tributary. There are several tributaries to Matriotti including Bear Creek (entering at RM 3.6), which is not to be confused with the larger Bear Creek described previously. This creek and two other tributaries are currently used as conveyance for Dungeness irrigation water by the Dungeness Irrigation Company system. Storm water flows are also transferred into this creek by the same irrigation system (Haring 1999).

Culverts in Bear Creek and a 3-foot drop in Matriotti Creek may both act as partial barriers to upstream fish passage. The latter, created by the Agnew ditch, bars fish from the uppermost 0.25 to 0.5 mile of Matriotti Creek (Haring 1999).

Independent Streams

Several streams, independent of the Dungeness River, drain directly into the Strait of Juan de Fuca. streamflows in these creeks have increased due to direct or indirect water inputs from the Dungeness River (such as irrigation ground water recharge, tailwaters, or storm water flows) (Haring 1999). Although these situations may increase the streamflow and habitat for fish in the small streams, the increased flow levels may cause bedload movement, bank erosion, loss of large woody debris, and other adverse habitat changes in these drainages (Haring 1999).

Siebert Creek: Siebert Creek has 31 miles of mainstem stream and tributaries. Juvenile fish populations in Siebert Creek have been documented at low densities, which is a consequence of degraded habitat and channel conditions (Haring 1999). The majority of fish observed in this creek are riffle-dependent species, (e.g., steelhead). Coho, which prefer pools, constitute an unusually small proportion (personal communication with McHenry et al. 1996, cited in Haring 1999).

However, several restoration activities have been conducted recently in Siebert Creek, including the installation of a bridge to replace a box culvert that served as a fish barrier at the Old Olympic Highway, and other projects that serve to enhance salmonid presence in this stream (personal communication with Ms. Mary Peck of the organization Pacific Woodrush 2003).

A seasonal tributary to Siebert Creek, Emery Creek, is not known to directly support anadromous fish due to a barrier upstream of its mouth.

McDonald Creek: Irrigation practices likely indirectly affect salmon presence and abundance in McDonald Creek. The reach from RM 2.0 to RM 5.0 is used for conveyance of irrigation water withdrawn from the Dungeness River by the Agnew Irrigation District. This practice may cause fish intending to enter the Dungeness River to home instead into McDonald Creek, and conversely to reduce the homing ability of the native McDonald Creek fish (McHenry et al., 1996, cited in Haring 1999).

Meadowbrook Creek: This relatively short and low-gradient creek historically was a distributary of the Dungeness River. Prior to construction of levees along the Dungeness, Meadowbrook Creek was influenced by the flooding of the Dungeness River. In 1999, shoreline erosion moved its mouth 1,400 feet east (Haring 1999) so that, instead of emptying into the Dungeness River, it now drains directly into Dungeness Bay. Water temperature in this creek often exceeds optimal levels for salmon spawning and rearing (personal communication with Freudenthal, cited in Haring 1999). Haring (1999) stated that streamflows are increased by irrigation via ground water. He assumed that this watercourse is used by spawning coho and is used for steelhead spawning and rearing. He also assumed that there are no fish access problems.

Cooper Creek: Cooper Creek flows for about 1 mile directly into salt water. This creek may be affected by irrigation water from the Dungeness River that has been delivered as ground water recharge. It supports juvenile coho and adult cutthroat trout in the lower reaches (personal communication with R. Johnson, cited in Haring 1999). A tide gate at the mouth of the creek was opened in 1995 to allow fish passage. The creek is associated with about 10 acres of tidal marsh (part of the larger Cassalary wetland).

Cassalary Creek: Cassalary Creek is about 4 miles long, has a low gradient, and drains agricultural land to salt water. It is predominantly spring fed with limited ground water recharge from irrigation and tailwaters. Flow is fairly uniform throughout the year. Effects to instream flow from increased use of water from the creek by landowners for irrigation and pond maintenance have been noted, but have not been measured (Haring 1999).

A culvert at the mouth of this creek limits the interaction of the creek with salt water. Flooding of the creek due to frequent blockage of this culvert also may affect juvenile fish rearing in the lower reaches of the creek (Haring 1999).

Gierin Creek: Gierin Creek is about 8.3 miles long, including tributaries. The majority of this distance is within Graysmarsh, a privately owned freshwater and brackish marsh managed for wildlife and fish habitat. A tidegate at the mouth of the creek can impair fish passage at certain tidal stages. Tidal connection with the marsh has been significantly reduced by this tidegate. In addition, the relocation and shortening of the stream channel that historically meandered through the marsh has reduced fish habitat quality (Haring 1999). A fish ladder at RM 1.3 provides passage for adult fish, but it is unknown if juvenile fish can successfully migrate upstream past this structure. Haring (1999) recommended the removal of the tidegate to improve fish habitat.

Flows in Gierin Creek are influenced by ground water return flows, including those from irrigation percolation to the aquifer as well as irrigation conveyance losses. Ground water is also influenced by upgradient withdrawals from public and private wells and upwelling from deeper aquifers.

A narrative description of Gierin Creek was provided by an environmental consultant who is familiar with this stream (Hadley 2002). The first mile upstream from the mouth is reported to be a multi-channeled area flowing through a freshwater marsh, and upstream from that point the streamflows through an alluvial fan (450 feet), a forested and gently sloped ravine (900 feet), a man-made lake and adjacent river reaches (1,000 feet), a relatively undisturbed forested area (1,800 feet), and a very channelized and linear feature in the upstream mile. Hadley (2002) reports that Gierin Creek has "... significant potential for use as salmonid rearing habitat ... year-round fish use for rearing is likely to consist primarily of smaller resident trout species ... and juvenile coho salmon." He also describes "... isolated patches of gravels potentially suitable for use as resident trout and coho spawning habitat ..." and states that it is "... possible that chum and pink salmon make occasional use of the stream for spawning ..." though none have been directly observed.

Bell Creek: This small stream is almost 4 miles long. Historically, it was probably an ephemeral stream fed by rain. DeLorm (1999) considered that the streamflow was "totally determined" by irrigation needs during low-flow summer and fall periods, but the recent addition of 0.1 cfs of treated wastewater from the City of Sequim has changed that assessment somewhat. The Highland Ditch Irrigation Company provides most of the water to this creek in the summer and fall (DeLorm 1999). Stormwater runoff from developed areas is a growing concern in Bell Creek, with increased incidence of flood events in Sequim in recent years (Haring 1999). Recent reductions of both irrigated acreage and irrigation system conveyance losses have decreased ground water infiltration to Bell Creek, especially during low flow, causing decreased flow and increased water temperatures (Haring 1999).

A waterfall at RM 3.0 blocks access to upstream areas by anadromous fish. Fish passage is also affected by low flow (Haring 1999). Coho salmon use Bell Creek to spawn in October through January and for rearing in February through September (Hiss 1993).

Johnson Creek: This small stream is the easternmost to be affected by irrigation and is actually in WRIA 17, the Sequim Bay Watershed. It has intermittent flows in the 2 to 5 cfs range, with peaks and lows generally in the 10 to 1 cfs range, respectively (Ecology 1994).

4.5.2 Other Wildlife

The project area encompasses a variety of habitat types from coniferous forests to marine shoreline. More than 305 species of terrestrial wildlife (250 birds, 41 mammals, 8 amphibians, and 5 reptiles) have been documented at Dungeness National Wildlife Refuge (Refuge) located immediately north of the project area (USFWS 1984). Many of the species seen in the area are associated with marine/intertidal habitats, where this project will have little to no impact. Consequently, species that utilize coastal/estuarine wetlands [river otter (*Lutra canadensis*), belted kingfisher (*Ceryle alcyon*)], will not be considered for further analysis. Table 4.5-4 lists 35 wildlife species dependent on freshwater wetlands (Johnson and O'Neil 2001). Large freshwater wetlands are found along the Dungeness River estuary, Cassalary Creek, Lower Bell Creek, and at Graysmarsh (see Section 4.4.2). Graysmarsh provides important habitat for a variety of birds, particularly wintering waterfowl and shorebirds. Up to 119 avian species have been seen at Graysmarsh and the adjacent marine waters during Audubon Society bird counts (Atkinson, unpublished). The USFWS in 1989 identified Graysmarsh as a high priority for habitat protection (Moriarty 1997).

Special-Status Species

Priority Habitats and Species (PHS) data from the WDFW identified seven species classified by WDFW, including two species listed by USFWS, as special-status species within the project area (WDFW 2002).

There are 11 active bald eagle nesting territories within the project area. Ten of these active territories are located within 800 feet of an irrigation main or lateral that may be upgraded, depending on the alternative selected (personal communication, Shelly Ament, Area Biologist, WDFW, telephone conversation with Paul Anderson, Foster Wheeler Environmental Corporation, October 8, 2002).

Within the project area, the PHS database also identified a peregrine falcon wintering territory, a great blue heron rookery, harlequin duck breeding territories along the Dungeness River, a merlin nest, and two osprey nests, all observed in the early to mid 1990s.

Table 4.5-4. Freshwater Wetland/Riparian-Dependent Wildlife Species in the Dungeness Project Area, Clallam County, Washington

Common Name[1/]	Scientific Name	Habitat Type[2/]
Pied-bill grebe[C]	*Podilymbus podiceps*	EM, OW
American bittern[C]	*Botaurus lentiginosus*	EM
Green heron	*Butorides virescens*	EM
Wood duck[C]	*Aix sponsa*	EM
Blue-winged teal[P]	*Anas discors*	EM, OW
Cinnamon teal[C]	*Anas cyanoptera*	EM, OW
Virginia rail[C]	*Rallus limicola*	EM
Sora[C]	*Porzana carolina*	EM
Common snipe[P]	*Gallinago gallinago*	EM, WM
Willow flycatcher[C]	*Empidonax traillii*	RIP
Marsh wren[C]	*Cistothorus palustris*	EM
American dipper[C]	*Cinclus mexicanus*	RIP
Common yellowthroat[C]	*Geothlypis trichas*	EM, SS
Pacific water shrew	*Sorex bendirii*	EM, WM, RIP
Little brown myotis	*Myotis lucifugus*	EM, OW, RIP, SS
Yuma myotis	*Myotis yumanensis*	EM, OW, RIP, SS
Keen's myotis	*Myotis keenii*	EM, OW, RIP, SS
Long-eared myotis	*Myotis evotis*	EM, OW, RIP, SS
Long-legged myotis	*Myotis volans*	EM, OW, RIP, SS
California myotis	*Myotis californicus*	EM, OW, RIP, SS
Silver-haired bat	*Lasionycteris noctivagans*	EM, OW, RIP, SS
Hoary bat	*Lasiurus cinereus*	EM, OW, RIP, SS
Townsend's big-eared bat	*Plecotus townsendii*	EM, OW, RIP, SS
Beaver	*Castor canadensis*	FO, RIP
Muskrat	*Ondatra zibethicus*	EM, OW
Mink	*Mustela vison*	EM, FO, RIP, SS
Northwestern salamander	*Ambystoma gracile*	FO, OW, RIP
Long-toed salamander	*Ambystoma macrodactylum*	FO, OW, RIP
Rough-skinned newt	*Taricha granulosa*	FO, OW, RIP
Ensatina	*Ensatina eschscholtzii*	FO, RIP
Western red-backed salamander	*Plethodon vehiculum*	FO, RIP
Western toad	*Bufo boreas*	EM, OW
Pacific tree frog	*Pseudacris regilla*	EM, FO, SS, WM
Red-legged frog	*Rana aurora*	EM, FO, RIP, SS

[1/] C = confirmed nesting record within the Dungeness Valley (WDFW 1996)
P = probable nesting record within the Dungeness Valley (WDFW 1996)
[2/] EM = emergent marsh, FO = forested wetland, OW = open water, RIP = riparian, SS = scrub-shrub wetland, WM = wet meadow
Source: USFWS 1984

In addition, eight species with special status were identified by cross-referencing the USFWS 1984 species list with the 2003 WDFW Species of Concern list. Those species include two amphibians (Western toad and red-legged frog), four mammals (Yuma myotis, Keen's myotis, long-eared myotis, and long-legged myotis), and two birds (green heron and willow flycatcher). Table 4.5-5 summarizes those species and their status.

Table 4.5-5. Special Status Species

Common Name	Scientific Name	Status[1/]
Bald eagle	*Haliaeetus leucocephalus*	FT[2/] / ST
Peregrine falcon	*Falco peregrinus*	FCo / SS
Harlequin duck	*Histrionicus histrionicus*	FCo
Merlin	*Falco columbarius*	SC
Purple martin	*Progne subis*	SC
Osprey	*Pandion haliaetus*	SM
Great blue heron	*Ardea herodias*	SM
Green heron	*Butorides virescens*	SM
Willow flycatcher	*Enpidonax traillii*	FCo
Yuma myotis	*Myotis Yumanensis*	FCo
Keen's myotis	*Myotis Keenii*	SC
Long-eared myotis	*Myotis evotis*	FCo / SM
Long-legged myotis	*Myotis volans*	FCo / SM
Western Toad	*Bufo boreas*	FCo / SC
Red-legged Frog	*Rana aurora*	FCo

[1/] FT = Federally Threatened; FCo = Federal Species of Concern; ST = State Threatened; SC = State Candidate for Listing; SS = State Sensitive; SM = State Monitor

[2/] Proposed for federal delisting July 1999.

Source: WDFW Web site, List of Species of Concern in Washington State, May 2003.

4.6 Built Environment

4.6.1 Land Use

"The Sequim-Dungeness area has gone from forest to farm to back yard in 150 years" (Eckert 1998). After EuroAmerican settlement in the mid-1800s, agricultural settlements flourished in the Sequim-Dungeness area for more than a century. The population growth common to much of western Washington during the 1960s and 1970s dramatically changed the demographics, and accordingly the land use, of the project area. Agricultural land use has decreased significantly through conversion to rural residential communities. "During the past 20 years, the unincorporated area of the Sequim-Dungeness region has grown almost five times more in population than the City of Sequim, the area's only incorporated city. More than 9,300 people moved into areas outside of the City, while only 2,000 moved into the City of Sequim. Nearly 70 percent of the regional planning area population lives in a rural area" (Clallam County 1995b). Figure 4.6-1 shows the growth in the number of wells, most of them for individual domestic water supply, reflecting the general residential use growth in the area. Since the end date of Figure 4.6-1, many more wells have been added (Thomas et al. 1999).

The highest residential density is within the City of Sequim, followed by the communities of Dungeness, Carlsborg, and smaller concentrations of development (Sunland, Bell Hill, etc.). Commercial and light industrial development generally follow the U.S. Highway 101 corridor, although the only industrial park in the area is north of U.S. Highway 101 in the Carlsborg urban growth area. The Sequim-Dungeness Regional Plan directs growth by means of a designated "urban growth area," limiting the availability of public services. Land use development is also directed by the Clallam County zoning codes, the County-Wide Comprehensive Plan (Clallam County 1995a), and the Critical Areas Ordinance.

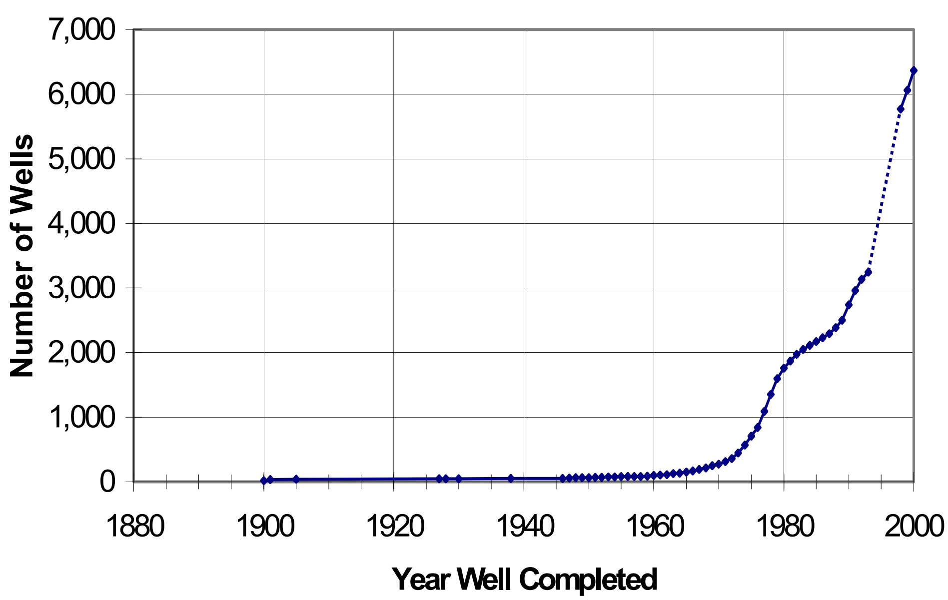

Figure 4.6-1. Cumulative Number of Wells in Clallam County, 1900-2000

Source: Clallam County Wells Database 2002

4.6.2 Public Services and Utilities

Clallam County and the City of Sequim provide public services and utilities in the study area. Available services include police and fire protection, electricity, public school districts, libraries, museums, solid waste disposal, drinking water supply, and sewer service (CCDCD 1992). Drinking water is supplied by Clallam County PUD #1, the City of Sequim, water associations, and community well systems. Most domestic sewage in the Sequim-Dungeness area is disposed by individual septic systems. The City of Sequim has a centralized sewer system serving an area about 3.5 miles square and a population of about 5,500 people (Dames and Moore 2000). More detailed information about water and sewer services in the study area can be found in section 4.3, Water Resources.

4.6.3 Recreation

Both formal and informal recreational opportunities are plentiful in the study area. Those that are relevant to the proposed alternatives include birding, sport fishing, and waterfowl hunting. According to the Olympic Peninsula Audubon Society (www.olympus.net), the most popular public birding locations are on the shores of Dungeness Bay, the Dungeness Recreation Area, Dungeness National Wildlife Refuge, and the Dungeness River Railroad Bridge Park, (established by the Jamestown S'Klallam Tribe and the Rainshadow Natural Science Foundation, and maintained by the Dungeness River Audubon Society). The Graysmarsh wetland does not allow general public access, but bird count events take place there annually (Moriarty 1997). In addition to the recreation areas and the National Wildlife Refuge mentioned above, there are two public parks along the Dungeness River, the Mary Wheeler Park and the Three Waters Park. There are public parks in Sequim as well, including the Carrie Blake Park on Bell Creek. Though waterfowl hunting remains a popular sport, annual harvest surveys show a significant decrease in waterfowl populations. The decrease is mostly due to the loss of habitat as grain fields are converted to residential land. WDFW is seeking funding to restore and protect waterfowl habitat (personal communication, Don Krage, Wildlife Biologist, WDFW, telephone conversation with April Magrane, Foster Wheeler Environmental, October 16, 2002). Two public sites allow hunting: the County's Voice of America Park and Sequim Bay. Graysmarsh and other private clubs, as well as individual landowners, permit hunting by invitation only.

4.6.4 Agricultural Crops

Of the 13,158 acres of agricultural land in the study area, 5,400 are commercially irrigated (Montgomery Water Group Inc. 1999). Common types of crops include hay, grain, berries, orchard fruits, and turf (CCDCD 1992). Lavender has recently increased in importance as well (City of Sequim Website www.cityofsequim.com). Land use changes in the last 30 years have resulted in a significant decrease of farming and of related irrigation. Agriculture has been replaced with rural residential development to a large extent (Eckert 1998). Where agriculture persists, flood irrigation is no longer permitted (WUA 2001).

4.6.5 Aesthetics

The rural and agricultural nature of the Sequim-Dungeness area is recognized as an asset by local citizens, visitors, and the County-Wide Comprehensive Plan (Clallam County 1995a). Irrigation is an essential component of both ranching and farming in this dry area, and open irrigation ditches and irrigation ponds are a part of the landscape that contributes to the rural scene. They are considered particularly attractive when lined with riparian vegetation such as cattails and willows.

4.6.6 Public Safety

Open irrigation ditches, while sometimes aesthetically attractive, are often found along narrow rural roads as well as higher-speed roads and highways. They can pose a hazard or increase damage to a vehicle that inadvertently leaves the roadway. Open ditches also provide a pathway for pollution to enter creeks or rivers and marine waters. In addition, vegetation is sometimes controlled using herbicides, which are considered by some to present a potential public safety risk.

5. Environmental Impacts

5.1 Introduction

Chapter 5 details and compares the impacts of the proposed Conservation Plan with the alternatives considered in detail in Chapter 3. It focuses on the elements of the environment from Chapter 4 that may be significantly affected and compares them against the central purpose and need for the project as well as the issues to be considered, as detailed in Chapter 2. The emphasis in this chapter is on the impacts to both surface and ground water and on the resources that depend on that water, including wetlands, fisheries, and drinking water.

5.2 Geology and Soils

The implementation of the Conservation Plan with any of the action alternatives will have no significant impact on geology or soils in the area. A small amount of soil disturbance expected during construction would be controlled by using Best Management Practices.

5.3 Water

This section documents and analyzes possible environmental effects from the implementation of alternatives, including the proposed Conservation Plan, on the water resources in the planning area. The first subsection concerns surface water, including the Dungeness River, small streams, and wetlands; the second section discusses ground water; the third refers to lack of effect on connectivity and continuity; the fourth section discusses effects to water supplies; the fifth section briefly refers to water rights, and the last section addresses water quality impacts.

5.3.1 Surface Water

Over the past 25 years, to evaluate the impact of piping irrigation ditches on ground water and streamflows, three ground water modeling efforts have been completed. The first effort to model the impacts of changes to the irrigation system was completed by Drost (Drost 1983). Two recent ground water modeling efforts were completed by consultants to Ecology and are referred to by the year they were completed. The Ecology 1999 ground water model was a limited calibration, steady-state model that targeted 1996 ground water flow conditions and the resultant impact of removing irrigation recharge on water levels and streamflow. Ecology's 1999 model results were incorporated into the Conservation Plan and the draft of this EIS. The 1999 model was developed by Pacific Groundwater Group (PGG) (Montgomery Water Group 1999).

Ecology's 2003 model developed by Foster Wheeler, which includes both a steady-state and a transient (monthly) model, was developed for the period from December 1995 to September 1997. The steady-state model was constructed to represent average annual conditions. The transient model was developed to evaluate the monthly fluctuations in ground water elevations and streamflows.

To provide a more comprehensive basis for the evaluation of alternative impacts of Alternatives 1, 2, 4, and 6 on streamflows in the Dungeness River, its tributaries (Bear, Hurd, and Matriotti Creeks), and independent creeks (Siebert, McDonald, Meadowbrook, Cooper, Cassalary, Gierin, Bell, and Johnson Creeks), the recently completed Ecology 2003 model results are used within this section.

Description of Ground Water Models

A brief summary of the three ground water models is provided below. For additional information, please refer to Drost (1983), the Conservation Plan (Ecology 1999 model) and Appendix B (Ecology 2003 model).

Drost (1983)

Drost (1983) developed a steady-state model to predict the possible decline in water levels in the shallow, middle, and lower aquifers after the elimination of all irrigation system leakage. The Drost model was calibrated to steady-state conditions defined for March 1979, a relatively stable period when minimum change was occurring between irrigation and non-irrigation seasons (Drost 1983).

Ecology 1999 Model

In 1999, to address changes in ground water recharge and discharge and to incorporate additional data on aquifer geometry, the Drost model was converted to a run on a versatile and well-accepted finite difference ground water flow model called MODFLOW (Harbaugh et al. 2000). The Updated Drost Model (referred to in this text as the Ecology 1999 model) was used to simulate 1996 conditions by replacing Drosts's estimate of well withdrawals and ground water recharge for the original March 1979 conditions with average annual values calculated for 1996.

Ecology 1999 model simulations were also completed for the case where irrigation recharge was removed, approximating a conservative approach to a fully lined (or piped) ditch condition. This condition was modeled by eliminating average annual ditch recharge to the shallow aquifer. Seasonal fluctuations in surface water and ground water recharge were beyond the scope of the modeling effort (Montgomery Water Group, Inc. 1999).

Ecology 2003 Model

In 2003, Ecology completed the development of a new regional ground water model of the Sequim-Dungeness area for use as a tool in analyzing the impacts of the EIS alternatives and to assist with other planning processes affecting ground water, streamflows, wetlands, and well development. This ground water model is referred to as the Ecology 2003 model.

The ground water model was developed using MODFLOW and the Ground Water Vistas pre- and post-processing software. Steady-state and transient (monthly) models were developed for the period from December 1995 to September 1997, which corresponds to the study period for comprehensive hydrogeologic assessment of the Sequim-Dungeness area completed by Thomas et al. (1999). The ground water model development consisted of a review of existing data, model development, model calibration, and analysis of the EIS alternatives contained within this document. The model will also be applied to other water resource management and planning questions in the watershed that are not addressed in this EIS.

The steady-state model was developed to represent average annual conditions during the study period from December 1995 to September 1997. The transient model was developed to evaluate the monthly fluctuations in ground water elevations and streamflows. The transient model required input of monthly parameters for each of the 22 months simulated during the study period. Appendix B contains a brief description of the Ecology 2003 model. The model was first calibrated using a series of parameters, many derived from Thomas et al. (1999). That version of the model, nicknamed "Cal17" and hereafter referred to as the 2003 model, was used for all EIS purposes. Subsequently, a sensitivity analysis on several model parameters, including hydraulic conductivity, was completed, resulting in a similar model referred to as 2003/Cal24. Please see Appendix B for details.

Comparison of Ecology 1999 and 2003 Model Results

A comparison of Ecology 1999 and 2003 steady-state model results for Alternative 2 (fully piped ditches) is presented in Figure 5.3-1.

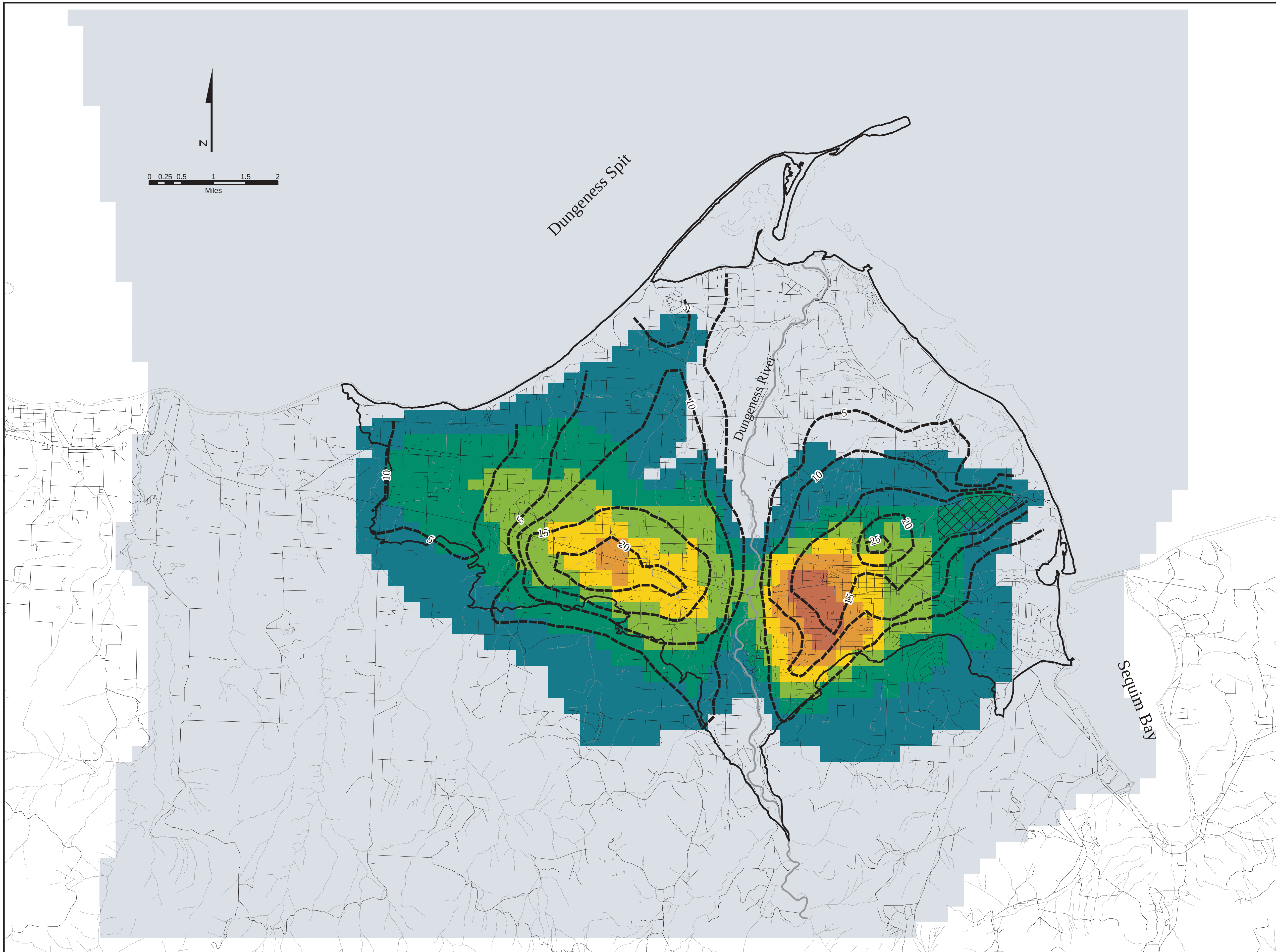

Figure 5.3-1
Model Results Comparison between Ecology Groundwater Models 1996 and 2003 for Study Area.
Decline in Water Levels for Shallow Aquifer for Alternative 2

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The Ecology 1999 model predicted declines in ground water levels of up to 25 feet in the shallow aquifer with implementation of Alternative 2. The Ecology 2003 model results predict declines in ground water levels of up to 7 feet in the shallow aquifer with implementation of Alternative 2. The difference between the Ecology 1999 and 2003 model results can be attributed primarily to the two major differences in model development and implementation:

1. Refined Irrigation Recharge

   In the Ecology 2003 model, only that portion of the irrigation recharge due to ditch leakage was removed for each alternative, and the recharge due to unconsumed field irrigation was left largely unchanged. By only removing that portion of irrigation leakage that would be eliminated by piping the ditches, the Ecology 2003 model presents a conservative, but refined, estimate of the impacts to ground water levels with implementation of the EIS alternatives.

2. Fully Calibrated Steady-State and Transient Models

   The Ecology 2003 ground water model reached a stable, converged solution with no dry cells for all steady-state and transient model simulations. The model was successfully calibrated for steady-state and transient conditions. A limited calibration was achieved in the Ecology 1999 model, but up to 11 dry cells remained at the end of the calibration process. This means that as the model ran its simulations, it inaccurately predicted a complete lack of ground water in some of its "cells" or area units. This caused the model results to be unreliable in the immediate vicinity of those cells (Figure 5.3-1).

Additional refinements in the Ecology 2003 model over the Ecology 1999 model include:

- The development of the flow system stratigraphy south of the original USGS study area to the foothills of the Olympic Mountains (48th parallel) and extended boundary conditions to the west, east (Schoolhouse point), and north into the Strait of Juan de Fuca. (Bathymetry for the northern portion of the grid was obtained from the Geological Survey of Canada.)
- The incorporation of ground water flow from bedrock into the southern portion of the study area from bedrock.
- The inclusion of ground water flow within the deep undifferentiated, unconsolidated deposits, which overlie the bedrock.
- The refinement of the model grid in areas of interest (along the Dungeness River) and in the vicinity of Graysmarsh.
- The implementation of the MODFLOW Streamflow-Routing Package to more completely model the interaction between the shallow aquifer and Dungeness River. (The stream package compares local ground water elevations to the water surface elevation in the river and determines the amount and direction of flow between the river and the ground water. In addition, the stream package performs an accounting of both surface flow in the river and flux between the river and ground water.) Simonds and Sinclair (2002) seepage data for the Dungeness River were used in the Ecology 2003/Cal17 calibration process.

The Ecology 2003 model results are used within this section to evaluate the impacts of Alternatives 1, 2, 4, and 6. Ecology 2003 ground water model outputs presented and discussed in this EIS are summarized in Table 5.3-1.

Table 5.3-1. Ecology 2003 Ground Water Model Output Summary

Model Run	Output
Steady-State (Average annual results from December 1995 to September 1997)	• Ground water contribution to Dungeness River by reach • Ground water contribution to streamflow • Water level distribution for Alternatives 1 (Existing Condition), 2, 4, and 6 in the shallow, middle, and lower aquifers
Transient (Monthly results from December 1995 to September 1997)	• Monthly ground water contribution to the Dungeness River by reach for period from December 1995 to September 1997 • Monthly Dungeness River streamflows for August to November 1996; August to September 1997 • Monthly estimates of ground water contribution to streams • Monthly water level distribution in shallow, middle, and lower aquifers for Alternatives 1 (Existing Condition), 2, 4, and 6 for December 1995 to September 1997

Dungeness River

Ecology 2003 model results available for the Dungeness River include both steady-state and transient ground water contribution to the river (Tables 5.3-2 and 5.3-3). Estimates of streamflow for selected low-flow months (August through November 1996, August and September 1997) are also summarized in Table 5.3-4. Table 5.3-5 presents September low-flow frequency data for the Dungeness River (based upon 1923 through 2001 September flows at the USGS gauge near Sequim).

To facilitate the discussion of ground water contribution and streamflows in the Dungeness, the river was divided into reaches defined by the Instream Flow Incremental Methodology (IFIM). Previous researchers have defined reaches in the Dungeness River in different ways (e.g., Bountry et al. 2002, Simonds and Sinclair 2002). However, because the IFIM is the generally accepted method for quantitatively relating streamflow in a particular river reach to potential fish habitat area, and this is an important issue within this EIS, the ground water contribution and streamflows for the Dungeness River were divided into those IFIM reaches identified by Wampler and Hiss (1991). The IFIM reaches for the Dungeness River are illustrated on Figure 5.3-2.

Alternative 1 – No Action

Under Alternative 1, the WUA would continue to withdraw up to 50 percent of the flow, including during the lowest flow, usually occurring in late August or early September. Based on the Thomas et al. (1999) measurements, irrigation season diversions would continue to range between 23.2 and 86.3 cfs. Irrigation-related recharge to the shallow aquifer would continue at a total rate of approximately 30.2 cfs. There would be no change in ground water contribution to the river as a result of reduced recharge to the shallow aquifer, and the tributaries and independent drainages currently receiving tailwater or irrigation seepage recharge from ground water would continue their approximate current flow. Based on their MOU trust water agreement, the WUA could also use water on up to 1,000 additional acres. At 0.02 cfs per acre, this would result in an additional 20 cfs of Dungeness River diversion.

Action Alternatives

Alternatives 2, 4, and 6 would impact the Dungeness River flow in three key ways:

1. By reducing the volume of water diverted from the Dungeness River for irrigation
2. By reducing the ground water contribution to the river (as a result of reduced ground water recharge to the shallow aquifer)
3. By potentially reducing tributary flows into the Dungeness (as a result of decreased streamflow in the tributaries themselves).

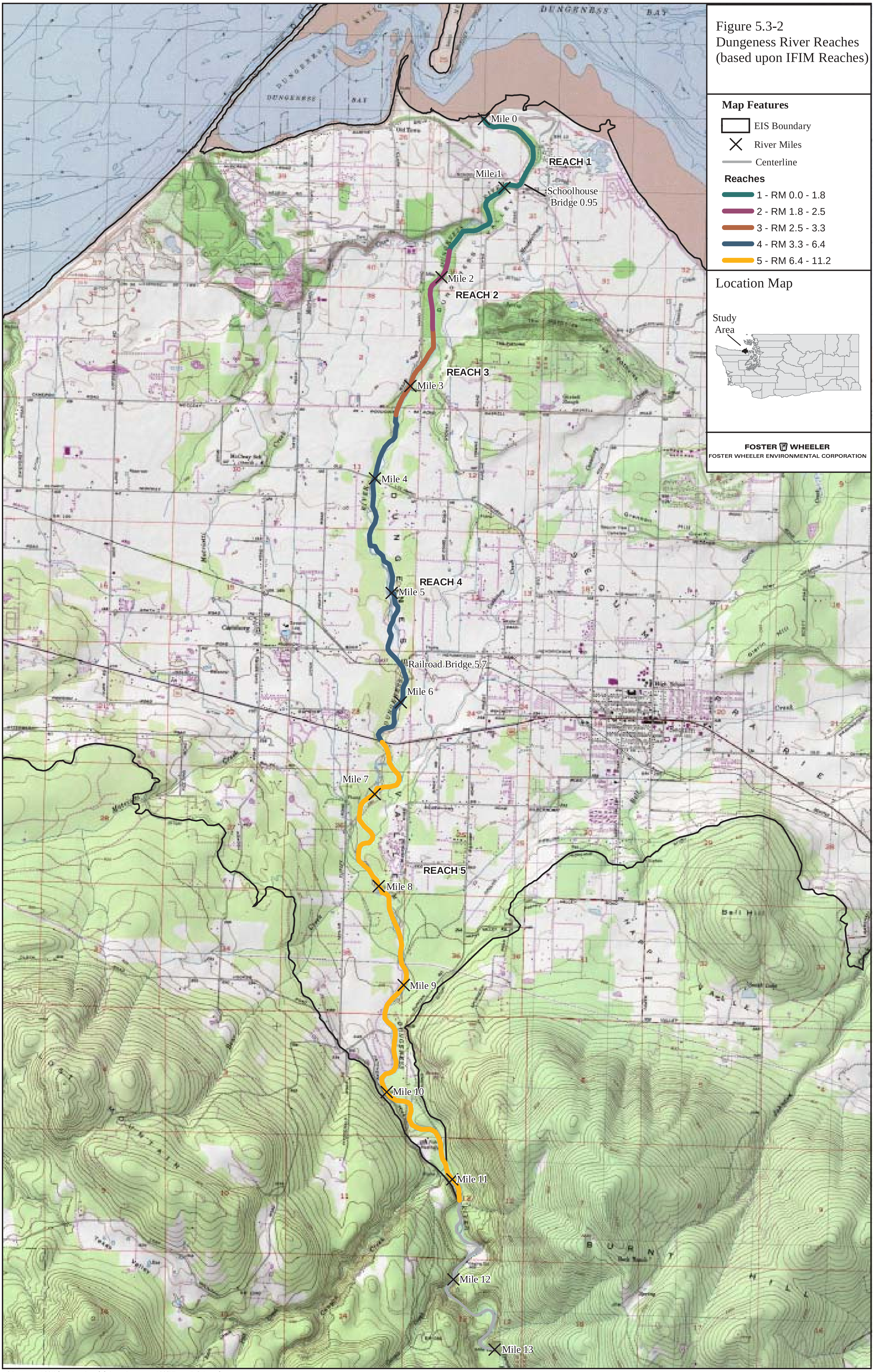
Figure 5.3-2
Dungeness River Reaches
(based upon IFIM Reaches)
Map Features
EIS Boundary
River Miles
Centerline
Reaches
1 - RM 0.0 - 1.8
2 - RM 1.8 - 2.5
3 - RM 2.5 - 3.3
4 - RM 3.3 - 6.4
5 - RM 6.4 - 11.2
Location Map
Study Area
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Mile 0
Mile 1
REACH 1
Schoolhouse Bridge 0.95
Mile 2
REACH 2
REACH 3
Mile 3
Mile 4
REACH 4
Mile 5
Railroad Bridge 5.7
Mile 6
Mile 7
REACH 5
Mile 8
Mile 9
Mile 10
Mile 11
Mile 12
Mile 13
DUNGENESS BAY
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Table 5.3-2. Ground Water Contribution to the Dungeness River, Steady-State Model Results

IFIM Analysis Reach [1/]	Alternative 1 (Existing Condition) Instream Flow Analysis Reach Totals (cfs) [2/, 3/]	Alternative 2 Instream Flow Analysis Reach Totals (cfs)	Alternative 4 Instream Flow Analysis Reach Totals (cfs)	Alternative 6 Instream Flow Analysis Reach Totals (cfs)
5	-1.7	-4.9	-4.5	-4.9
4	-13.6	-17.2	-16.6	-17.1
3	-0.6	-0.9	-0.8	-0.8
2	-1.3	-1.5	-1.5	-1.5
1	3.3	3.0	3.1	3.0
Total GW Contribution	-13.9	-21.4	-20.3	-21.3

[1/] Dungeness River Reach determined by Instream Flow Incremental Methodology (IFIM), (Wampler and Hiss, 1991):
Reach 1 = River Mile (RM) 0.0 to 1.8
Reach 2 = RM 1.8 to 2.5
Reach 3 = RM 2.5 to 3.3
Reach 4 = RM 3.3 to 65.4
Reach 5 = RM 6.4 to 11.2
[2/] cfs = cubic feet per second
[3/] Ground water contribution to surface water: sign convention from Thomas et al (1999):
Positive number = ground water is discharging (entering) creek (i.e., GAINING CREEK)
Negative number = surface water body is losing water to ground water (i.e., LOSING CREEK)

Table 5.3-3. Ground Water Contribution to the Dungeness River for Selected Months in 1996 and 1997, Transient Model Results

	Alternative 1							
Selected Month	Apr-96 Flow (cfs) [1/]	May-96 Flow (cfs)	Jun-96 Flow (cfs)	Aug-96 Flow (cfs)	Sep-96 Flow (cfs)	Oct-96 Flow (cfs)	Aug-97 Flow (cfs)	Sep-97 Flow (cfs)
Total GW Contribution to Dungeness [2/]	-14.8	-13.5	-16.2	-10.0	-10.8	-13.5	-10.9	-13.6

	Alternative 2							
Selected Month	Apr-96 Flow (cfs)	May-96 Flow (cfs)	Jun-96 Flow (cfs)	Aug-96 Flow (cfs)	Sep-96 Flow (cfs)	Oct-96 Flow (cfs)	Aug-97 Flow (cfs)	Sep-97 Flow (cfs)
Total GW Contribution to Dungeness	-17.9	-17.4	-20.8	-15.4	-16.3	-19.0	-16.4	-19.0
Difference with Alternative 1 (Existing Condition)	-3.1	-3.9	-4.6	-5.4	-5.5	-5.5	-5.5	-5.4
Percent Change in GW Contribution from Alternative 1	-21%	-29%	-28%	-54%	-51%	-41%	-51%	-40%

	Alternative 4							
Selected Month	Apr-96 Flow (cfs)	May-96 Flow (cfs)	Jun-96 Flow (cfs)	Aug-96 Flow (cfs)	Sep-96 Flow (cfs)	Oct-96 Flow (cfs)	Aug-97 Flow (cfs)	Sep-97 Flow (cfs)
Total GW Contribution to Dungeness	-16.7	-16.2	-19.6	-14.5	-15.6	-18.4	-15.4	-18.5
Difference with Alternative 1 (Existing Condition)	-1.9	-2.7	-3.4	-4.5	-4.8	-4.9	-4.5	-4.9
Percent Change in GW Contribution from Alternative 1	-13%	-20%	-21%	-45%	-44%	-36%	-41%	-36%

	Alternative 6							
Selected Month	Apr-96 Flow (cfs)	May-96 Flow (cfs)	Jun-96 Flow (cfs)	Aug-96 Flow (cfs)	Sep-96 Flow (cfs)	Oct-96 Flow (cfs)	Aug-97 Flow (cfs)	Sep-97 Flow (cfs)
Total GW Contribution to Dungeness	-17.8	-17.3	-20.7	-15.3	-16.2	-18.9	-16.3	-18.9
Difference with Alternative 1 (Existing Condition)	-3.0	-3.8	-4.5	-5.3	-5.4	-5.4	-5.4	-5.3
Percent Change in GW Contribution from Alternative 1	-20%	-28%	-27%	-53%	-50%	-40%	-50%	-40%

[1/] cfs = cubic feet per second
[2/] Ground water contribution to surface water: sign convention from Thomas et al (1999):
Positive number = ground water is discharging (entering) creek [i.e., GAINING CREEK]
Negative number = surface water body is losing water to ground water [i.e., LOSING CREEK]

Table 5.3-4. Selected Monthly Streamflows for the Dungeness River (by IFIM Reach), Transient Model Results

	Alternative 1						Alternative 2						Alternative 4						Alternative 6					
IFIM	Aug-96	Sep-96	Oct-96	Nov-96	Aug-97	Sep-97	Aug-96	Sep-96	Oct-96	Nov-96	Aug-97	Sep-97	Aug-96	Sep-96	Oct-96	Nov-96	Aug-97	Sep-97	Aug-96	Sep-96	Oct-96	Nov-96	Aug-97	Sep-97
Reach [1/]	River Flow (cfs) [2/]						River Flow (cfs)						River Flow (cfs)						River Flow (cfs)					
5	116.7	113.8	198.1	266.0	199.7	235.2	146.7	128.2	207.8	273.8	236.1	250.2	142.8	126.2	206.5	272.7	231.5	248.2	143.9	126.7	206.8	273.1	232.9	248.7
4	103.8	102.5	186.1	254.7	187.5	223.0	131.3	114.1	193.1	259.9	221.0	235.1	127.9	112.6	192.1	259.1	217.0	233.4	128.6	112.7	192.1	259.2	217.8	233.7
3	103.2	101.8	185.5	254.2	186.9	222.1	130.5	113.3	192.2	259.3	220.2	234.1	127.2	111.9	191.3	258.5	216.2	232.4	127.8	111.9	191.3	258.6	217.0	232.6
2	103.7	113.7	198.4	273.4	190.7	231.3	130.9	125.1	205.0	278.3	224.0	243.1	127.6	123.6	204.1	277.5	220.0	241.3	128.2	123.7	204.1	277.6	220.8	241.7
1	109.1	118.5	202.2	276.8	195.7	235.3	136.1	129.7	208.7	281.6	228.9	247.0	132.9	128.3	207.8	280.9	225.0	245.3	133.4	128.3	207.8	280.9	225.7	245.6
							Increase in River Flow (cfs) [3/,4/,5/]						Increase in River Flow (cfs)						Increase in River Flow (cfs)					
5	0.0	0.0	0.0	0.0	0.0	0.0	30.0	14.3	9.6	7.9	36.4	15.0	26.1	12.3	8.3	6.7	31.8	13.0	27.3	12.9	8.7	7.1	33.1	13.6
4	0.0	0.0	0.0	0.0	0.0	0.0	27.5	11.7	6.9	5.2	33.5	12.1	24.1	10.1	6.0	4.4	29.5	10.4	24.7	10.2	6.0	4.5	30.3	10.7
3	0.0	0.0	0.0	0.0	0.0	0.0	27.3	11.5	6.8	5.1	33.3	11.9	24.0	10.0	5.8	4.3	29.4	10.2	24.6	10.1	5.8	4.4	30.2	10.5
2	0.0	0.0	0.0	0.0	0.0	0.0	27.2	11.4	6.6	4.9	33.2	11.8	23.9	9.9	5.7	4.2	29.3	10.1	24.4	9.9	5.7	4.2	30.1	10.4
1	0.0	0.0	0.0	0.0	0.0	0.0	27.1	11.2	6.5	4.8	33.2	11.8	23.8	9.8	5.6	4.1	29.3	10.0	24.4	9.8	5.6	4.1	30.0	10.4

[1/] Reaches are those specified by IFIM:

1 RM 0 to 1.8
2 RM 1.8 to 2.5
3 RM 2.5 to 3.3
4 RM 3.3 to 6.4
5 RM 6.4 to 11.2

[2/] cfs = cubic feet per second

[3/] Increase in river flow by alternative is the difference between river flow with alternative implementation and the existing condition flow (Alternative 1) .

[4/] Increase in instream flows reflects irrigation savings associated with the EIS alternatives.

[5/] Change in river flow is based upon actual diversion and modeled leakage from the Dungeness to the shallow aquifer

Table 5.3-5. September Low-Flow Frequency Data for the Dungeness River at USGS, RM 11.8 (above all diversions) (1923 to 2001)

Exceedance Probability, P	Return Period, T (yr)	Qpk (cfs)	Qmin (cfs)
0.01	100	350	78
0.02	50	317	87
0.04	25	284	97
0.05	20	274	100
0.10	10	242	114
0.20	5	210	131
0.50	2	163	169

Qpk = Peak discharge in cubic feet/second (cfs)
Qmin = minimum discharge in cfs

Alternative 2 – Full Plan Implementation

Under Alternative 2, a total estimated water savings of 38.36 cfs would be realized from irrigation ditch improvements, which include piping, abandoning lines, constructing re-regulation reservoirs, and using 1 cfs of treated wastewater from the City of Sequim to replace water diverted from the Dungeness River.

Piping all the irrigation ditches as specified in Alternative 2 effectively eliminates ground water recharge from irrigation ditch leakage (amounting to approximately 30.2 cfs) and results in a decline of water levels in the shallow aquifer.

Ecology 2003 steady-state model results calibrated to December 1995 through September 1997 existing conditions (Alternative 1) estimate an average annual leakage from the Dungeness River to the shallow aquifer of 13.9 cfs (Table 5.3-2). The Ecology 2003 model results predict that the resultant lowering of water levels in the shallow aquifer associated with Alternative 2 will cause a resultant decrease in ground water contribution to the Dungeness River of approximately 7.5 cfs. Consequently, for Alternative 2, the sum of computed ground water inflow from the shallow aquifer and instream water loss to the aquifer from the various reaches of the Dungeness River results in a net average annual leakage to the shallow aquifer of 21.4 cfs (as compared with 13.9 cfs for Alternative 1).

Transient results for the Dungeness River/shallow aquifer interaction for the spring (April through June 1996) and fall (August through October 1996, August and September 1997) indicate that greatest monthly change in ground water contribution to the Dungeness River occurs in the fall (Table 5.3-3). Under Alternative 2, ground water contribution to the Dungeness River decreased approximately 5.4 to 5.5 cfs during September and October of 1996 and 1997. The change in ground water contribution to the Dungeness River in the spring is less dramatic than the fall, with a 20 to 30 percent decrease in ground water contribution (3.1 to 4.6 cfs) compared to Alternative 1.

Table 5.3-4 summarizes the estimated increase in streamflow in the Dungeness River by IFIM reach that would result from irrigation water savings for low-flow months in 1996 and 1997. Streamflows in Table 5.3-4 were based upon actual irrigation diversion during 1996 and 1997 and the modeled leakage to the shallow aquifer from the Dungeness. The decrease in streamflows from the upstream reach (IFIM Reach 5) to the downstream reach at the mouth of the river (IFIM Reach 1) reflects the modeled leakage from the river to the shallow aquifer.

In reviewing monthly estimates of streamflow (Table 5.3-4), it is evident that under Alternative 2, even with decreases in ground water contributions accounted for, savings for the month of August 1996 and 1997 equate to an estimated increase in streamflows of 30 to 36.4 cfs, respectively, over the existing condition (Alternative 1). Streamflows also vary in response to WUA diversions. For example, for those fall months outside the irrigation season (September, October, and November 1996) during which the WUA diversions are low, there is a corresponding reduction in water savings because the full Alternative 2 water savings of 38.36 cfs is not realized (as a result of less overall diverted water in the system to be saved).

With respect to streamflows, an additional, less quantifiable reduction in Dungeness River flow will also likely result from the reduction in flow contribution from Dungeness tributaries affected by reduced ground water recharge and the subsequent lowering of water levels in the shallow aquifer. With a reduction in shallow aquifer water levels, the Ecology 2003 steady-state model predicts that Matriotti Creek will experience a 38 percent decrease in ground water contribution to its streamflow. However, because Matriotti Creek enters the Dungeness in its lower reach (at RM 1.9), a reduction in flow contribution from Matriotti will not affect Dungeness River flows above RM 2.7.

The September low-flow frequency data for the Dungeness River are presented in Table 5.3-5. September flow data from the period of record from 1923 to 2001 were used to estimate flow exceedance probabilities from 0.01 (a one in 100-year flow event) to 0.50 (a one in 2-year flow event). Flow measurements used to construct this table were obtained from the USGS gauge 12048000 data at RM 11.2 and therefore do not reflect irrigation diversions. However, Table 5.3-5 is important in that it illustrates that an increase of even 15 cfs in the Dungeness in the upstream reach (IFIM Reach 5, Figure 5.3-2) may result in an important change in low-flow exceedance characteristics.

For example, the September low-flow event with a one in 100-year probability of occurrence is 78 cfs. Under Alternative 2, a streamflow increase of 15 cfs (as estimated by the Ecology 2003 model for September 1996 and 1997) would increase the minimum Dungeness River flow from 78 to 93 cfs, thereby resulting in a change in the frequency of flow occurrence from a one in 100-year event to approximately a one in 25-year flow event.

Alternative 4 – Economic Efficiency

The projects proposed for Alternative 4 are a subset of the projects listed in Alternative 2. These projects are expected to produce nearly the same reduction in diversion from the Dungeness River as Alternative 2, but at a savings of several million dollars. Under Alternative 4, total water savings of 33.42 cfs would be realized from irrigation ditch improvements, which include piping, abandoning lines, constructing regulation reservoirs, and using treated wastewater from the City of Sequim to replace water diverted from the Dungeness River.

Continued ground water recharge due to conveyance losses (seepage from irrigation ditches into underlying units after implementation of this alternative) is estimated to be 4.94 cfs. Recharge would occur along laterals in Agnew, Clallam, Dungeness District, Highland, and Sequim-Prairie systems. Fully piped laterals in Dungeness Company, Cline, Independent, and Eureka systems would be constructed as in Alternative 2, effectively eliminating ground water recharge in these areas from conveyance loss. Ground water recharge from on-field application would continue.

Under Alternative 4, the increased ground water recharge of approximately 4.94 cfs resulted in a slightly larger ground water contribution to both the Dungeness River and its tributaries than estimated for Alternative 2 (in which ground water recharge from the irrigation ditches was essentially zero). Model results for Alternative 4 estimate a decrease in ground water contribution from the Dungeness River to the shallow aquifer of 6.4 cfs over the existing condition (Alternative 1) (Table 5.3-2). As compared with Alternative 2, Alternative 4 results in 1.1 cfs less leakage from the Dungeness River to the shallow aquifer.

Transient results for Alternative 4 for the Dungeness River/shallow aquifer interaction for the spring (April through June 1996) and fall (August through October 1996, August and September 1997) indicate that the greatest decline in ground water contribution occurs in the fall for both 1996 and 1997 (Table 5.3-3). Under Alternative 4, ground water contribution to the Dungeness River declined by 4.9 cfs during the fall months compared to the existing condition (Alternative 1).

Table 5.3-4 summarizes the estimated increase in streamflow that would result from irrigation water savings for low-flow months in 1996 and 1997. Streamflows in Table 5.3-4 were based upon actual irrigation diversion and modeled leakage to the shallow aquifer from the Dungeness. For any given month, the decrease in streamflows from the upstream reach (IFIM Reach 5) to the downstream reach at the mouth of the river (IFIM Reach 1) reflects the modeled change in ground water contribution from the shallow aquifer.

Under Alternative 4 (Table 5.3-4), in IFIM Reach 5 (the upstream section of the river), WUA water savings for the month of August 1996 and 1997 equate to an estimated increase in streamflows of 26.1 and 31.8 cfs, respectively. As with Alternative 2, streamflows also vary in response to WUA diversions because, during those months outside the irrigation season in which the WUA diversions are low, the full Alternative 4 water savings of 33.42 cfs is not realized because there is less overall diverted water in the system to be saved.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

The projects proposed for Alternative 6 are a subset of the projects listed in Alternative 2. These projects are expected to reduce the effects to selected streams and Graysmarsh.

Under this alternative, irrigation laterals within the “approximate groundwater zone contribution to Graysmarsh” (AESI 1991) for Graysmarsh and the watersheds of Siebert Creek and Bell Creek would not be piped. This alternative would allow seepage from irrigation canals to continue to locally recharge the underlying shallow aquifer, as they do now. Providing local ground water recharge within the watershed of target creeks minimizes the reduction in base streamflow (as compared to modeled results for Alternative 2).

Under this alternative, all ditches would be piped except for those associated with Gierin Creek, Graysmarsh, Siebert Creek, and Bell Creek. The total water savings to the Dungeness would effectively be the Alternative 2 savings (38.36 cfs) less the unlined ditch and regulation reservoir savings in the areas described above (2.98 cfs). Consequently, diversions from the Dungeness River would be reduced by 35.38 cfs.

The local nature of ground water recharge under this alternative (2.48 cfs) and the distance of the creeks from the Dungeness River mean that the Alternative 6 impact to ground water contribution and streamflow to the Dungeness is very similar to the estimated effect of Alternative 2.

Under Alternative 6, the average annual change in ground water contribution to the Dungeness is estimated to be 7.4 cfs. The change in ground water contribution for Alternative 6 is 0.1 cfs less than Alternative 2 (7.5 cfs) and 1 cfs greater than Alternative 4 (6.4 cfs).

Monthly variations in ground water contribution to the Dungeness River from the shallow aquifer in Alternative 6 are consistent with Alternatives 2 and 4 in that the greatest decline in ground water contribution occurs in the fall months. Under Alternative 6, during the fall months, ground water contribution declines by approximately 5.4 cfs over Alternative 1

(Table 5.3-3). Under Alternative 6 (Table 5.3-4), in IFIM Reach 5, WUA water savings for the month of August 1996 and 1997 equate to an estimated increase in streamflows of 27.3 and 33.1 respectively.

Cumulative Impacts

The action alternatives would all reduce diversions from the Dungeness River, thereby increasing streamflow within the Dungeness. This is particularly important during late summer when flows are at their lowest. For all alternatives, the actual increase in streamflows would vary by month and the actual WUA diversion amount. However, an analysis of low-flow frequency data for September indicates that even a modest increase in streamflow of 15 cfs would result in a change in the frequency of flow occurrence from a one in 100-year event to approximately a one in 25-year flow. This enhancement of streamflow would be especially important for downstream fish populations trying to survive during low-flow drought conditions.

All the action alternatives would reduce irrigation recharge to the shallow aquifer and result in a decrease in ground water contribution to the Dungeness River. Increased pumping from the shallow aquifer would also reduce ground water recharge of the Dungeness River. If there is a significant decrease in precipitation or an earlier average snowmelt, the summer low-flows may drop even more. The contribution to Dungeness River flow from reduced diversions is even more important under these conditions than under current conditions to maintain and enhance fish habitat.

Streamflow for Other Streams

This section summarizes the impacts of Alternatives 1, 2, 4, and 6 to streamflows for both the Dungeness tributaries and other independent streams across the Sequim-Dungeness peninsula. Existing streamflow and tailwater data for fall and spring are summarized in Tables 5.3-6 and 5.3-7, respectively. Average annual estimates of ground water contribution and the change in ground water contribution for the action alternatives are presented in Table 5.3-8. Tables 5.3-9 through 5.3-11 summarize the changes in ground water and tailwater contribution in the creeks between Alternative 1 and Alternatives 2, 4, and 6. Estimates of ground water contribution to streamflow for selected low-flow months in 1996 and 1997 are contained in Tables 5.3-12 and 5.3-13. Ground water recharge estimates for Alternatives 2, 4, and 6 are presented in Table 5.3-14.

Implementation of the action alternatives would affect streamflows in the smaller creeks in the planning area primarily by the changes in irrigation tailwater and ground water recharge associated with piping of the ditches. The reduction in ground water recharge associated with piping of the ditches is predicted to cause a reduction in the water levels in the shallow aquifer. This reduction in shallow aquifer water levels in turn will likely impact the net ground water contribution to the smaller streams. For a stream such as Matriotti that is primarily ground water fed, changes in ground water recharge, such as the changes proposed under all the action alternatives, may result in over a 30 percent decrease in streamflow (Table 5.3-8).

Tailwater discharges to tributaries of the Dungeness and independent creeks have also been recognized to provide an important component of streamflow (Thomas et al. 1999). Tailwater discharges to creeks will be affected by the proposed construction of re-regulation reservoirs that are specifically designed and located to better manage (and capture) tailwater, although some tailwater discharge will remain.

Table 5.3-6. Streamflow Summary

		Streamkeepers Data 1999-2001		Wria Averaged Pre-1997 Data [3/]		Caldwell / Beacher Data 1997		DOE Gauge Flow Data					
Creek	Measuement Location (RM from mouth)	Fall Range [1/] (cfs)	Spring Range [2/] (cfs)	Fall Range [1/] (cfs)	Spring Range [2/] (cfs)	Measurement Location	Fall Range [1/] (cfs)	Measurement Location	Spring Range 2000 [2/] (cfs)	Sept 2000 (cfs)	Oct. 2001 (cfs)	Fall Range 2002 [1/] (cfs)	Spring Range 2003 [2/] (cfs)
Bear	N/D	N/D	N/D	N/D	N/D	**N/D**	N/D	**N/D**	N/D	N/D	N/D	N/D	N/D
Bell	N/D	N/D	N/D	2.0-5.7	2.4-7.3	**Schmuck Road**	2.0 - 2.9	**N/D**	N/D	N/D	N/D	N/D	N/D
Cassalary	0.5	1.2-1.7	1.5-1.6	2.2-5.2	3.4-5.8	**Woodcock Road**	2.5 - 3.7	**N/D**	N/D	N/D	N/D	N/D	N/D
	0.6		1.8	N/D	N/D								
	1.1	0.7-4.2	0.2-2.6	N/D	N/D								
	1.6	1.6-2.3	1.9-2.8	N/D	N/D								
Gierin [3/]	N/D	N/D	N/D	1.0-1.7	N/D	**Holland Road**	0.1 - 1.7	**N/D**	N/D	N/D	N/D	N/D	N/D
Johnson	0	1.7	N/D	0.3-4.9	1.4-3.6	**W. Sequim Road**	0.3 - 3.0	**N/D**	N/D	N/D	N/D	N/D	N/D
	0.6	1.3	N/D	N/D	N/D								
Meadowbrook	N/D	N/D	N/D	1.1-5.2	3.6-6.8	**Sequim-Dungeness Way**	3.6 - 4.3	**N/D**	N/D	N/D	N/D	N/D	N/D
Matriotti	N/D	N/D	N/D	1.8-14.9	5.7-11	**Lamar Lane**	2.5 - 4.5	**Olympic Game Farm**	12.8 - 13.9	11.8	12.3	N/D	N/D
McDonald	N/D	N/D	N/D	0.1-11	8.1-20	**Old Olympic Hwy**	0.4 - 11.0	**HWY 101**	N/D	N/D	N/D	N/D	0.54 - 1.22
Siebert	0.6	2.7-3.3	7.2-41.4	2.6-8.6	5.6-14	**Old Olympic Hwy**	6.0 - 8.6	**Old Olympic Hwy**	N/D	N/D	N/D	2.5 - 4.3	9.1 - 16.1
	3	2.4-2.9	6.1-39.1	N/D	N/D								
	3.8	2.1	3.4-35.5	N/D	N/D								
	9.3	0	1	N/D	N/D								

[1/] Fall Range = Measurements for September and October

[2/] Spring Range = Measurements for April and May

[3/] Surface water flows were measured by AESI (1999). Flows for Gierin Creek at station 3 (located at the culvert where Gierin Creek passes beneath Holland Road) ranged from 0.83 cfs (10/28/97) to 3.2 cfs (4/29/98) (AESI 1999).

cfs = cubic feet per second

N/D = No data available

Table 5.3-7. Tailwater Summary

Creek	Tailwater Gauge Location Creek Mile	 WUA Label	Average Seasonal Tailwater as Measured in 1997 (cfs)	Single Tailwater Ungauged Measurement 10/1997 (cfs)	Estimated Tailwater Capture from Re-regulation Reservoirs Construction (cfs)
Bear	ND	ND	ND	0.3	No Change
Bell	2.6	HW1	0.6	0.45	0.5
Cassalary	ND	ND	ND	0.01	0.3
Gierin	2.55	SW9	0.17	ND	No Change
	2.6	EW11	0.55	ND	No Change
Johnson	ND	HW2	1.27	ND	No Change
	ND	HW3	0.09	ND	No Change
Meadowbrook	0.85	DDW13	0.54	ND	0.5
Matriotti	3.4	D-kitchen	0.61	1.5	0.25
	2.9	CW26	0.55		0.16
McDonald	ND	ND	ND	0.3	No Change
Siebert	0.5	AW24	0.11	ND	No Change

cfs = cubic feet per second

Table 5.3-8. Change in Average Annual Ground Water Contribution to Streamflow as Compared to Alternative 1

Stream Name	Alt. 1 (cfs)	Alternative 2			Alternative 4			Alternative 6		
		GW Contribution to Stream (cfs)	Average Annual Change in GW Contribution (cfs)	Percent Change in GW Contribution Compared to Existing Condition [1/]	GW Contribution to Stream (cfs)	Average Annual Change in GW Contribution (cfs)	Percent Change in GW Contribution [1/]	GW Contribution to Stream (cfs)	Average Annual Change in GW Contribution (cfs)	Percent Change in GW Contribution [1/]
Siebert	3.2	3.2	0.0	0	3.2	0.0	0	3.2	0.0	0
McDonald	2.3	2.2	0.1	4	2.3	0.0	0	2.2	0.1	4
Matriotti	3.4	2.1	1.3	38	2.3	1.1	32	2.1	1.3	38
Cassalary	3.6	3.2	0.4	11	3.2	0.4	11	3.2	0.4	11
Gierin	0.8	0.7	0.1	13	0.7	0.1	13	0.8	0.0	0
Bell	2.4	2.3	0.1	4	2.3	0.1	4	2.3	0.1	4
Johnson	0.6	0.6	0.0	0	0.6	0.0	0	0.6	0.0	0

[1/] Change in ground water contribution as compared to Alternative 1 (Existing Condition)
cfs = cubic feet per second

Table 5.3-9. Comparison of Ground Water and Tailwater Discharge to Creeks for Alternatives 1 and 2, Steady-State Results

	Alternative 1				Alternative 2		
Creek [1/]	**Fall Range [2/]**	**Mean Seasonal Tailwater [3/] Single Ungauged Tailwater 10/97**	**Modeled Mean Annual Ground Water Discharge [4/]**	**Single Ground Water Discharge Measurement 10/7/97 [3/]**	**Net Tailwater after Reservoirs [5/]**	**Modeled Mean Annual Ground Water Discharge [4/]**	**Percent Change in Modeled Ground Water Discharge**
Siebert	2.7-3.3	0.11/no data	3.2	2.27	No change	3.2	0%
McDonald	0.1-11(d)	No data/0.03	2.3	No data	No change	2.2	5%
Meadowbrook	1.1-5.2(d)	0.54/No data	No data	1.37	0.04	No data	No data
Cooper	No data	No data	No data	No data	No data	No data	No data
Cassalary	1.2-1.7	No data/0.01	3.6	3.55	(RR)	3.2	11%
Gierin	0.83-3.2(a)	0.72/No data	0.8	0.84	No change	0.7	13%
Bell	0.8-2.6	0.60/0.45	2.4	2.35	0.1	2.3	8%
Johnson	0.3-4.9(d)	1.36	0.6	No data	No data	0.6	0%
Matriotti	1.8-14.9 (d)	1.16/1.5	3.4	7.98	0.75	2.1	38%
Hurd	No data	No data	No data	(gaining stream)	No data	No data	No data
Bear	7.1-7.7	No data/0.3	No data	No data	No data	No data	No data

[1/] All measurements reported in cubic feet per second (cfs)
[2/] (d) = Dames and Moore 2000; (a) = AESI 1999; unsigned=Streamkeepers
[3/] Thomas et al. 1999
[4/] Ecology 2003 Ground Water Model results in cubic feet per second (cfs)
[5/] (RR) = One re-regulating reservoir, no estimate of tailwater

Table 5.3-10. Comparison of Ground Water and Tailwater Discharge to Creeks for Alternatives 1 and 4, Steady-State Results

	Alternative 1				Alternative 4		
Creek [1/]	**Fall Range [2/]**	**Mean Seasonal Tailwater [3/] Single Ungauged Tailwater 10/97**	**Modeled Mean Annual Ground Water Discharge [4/]**	**Single Ground Water Discharge Measurement 10/7/97 [3/]**	**Net Tailwater after Reservoirs [5/]**	**Modeled Mean Annual Ground Water Discharge [4/]**	**Percent Change in Modeled Ground Water Discharge**
Siebert	2.7-3.3	0.11/no data	3.2	2.27	No change	3.2	0%
McDonald	0.1-11(d)	No data/0.03	2.3	No data	No change	2.3	0%
Meadowbrook	1.1-5.2(d)	0.54/No data	No data	1.37	0.04	No data	No data
Cooper	No data	No data	No data	No data	No data	No data	No data
Cassalary	1.2-1.7	No data/0.01	3.6	3.55	(RR)	3.2	11%
Gierin	0.83-3.2(a)	0.72/No data	0.8	0.84	No change	0.7	13%
Bell	0.8-2.6	0.60/0.45	2.4	2.35	0.1	2.3	4%
Johnson	0.3-4.9(d)	1.36	0.6	No data	No data	0.6	0%
Matriotti	1.8-14.9 (d)	1.16/1.5	3.4	7.98	0.75	2.3	32%
Hurd	No data	No data	No data	(gaining stream)	No data	No data	No data
Bear	7.1-7.7	No data/0.3	No data	No data	No data	No data	No data

[1/] All measurements reported in cubic feet per second (cfs)
[2/] (d) = Dames and Moore 2000; (a) = AESI 1999; unsigned=Streamkeepers
[3/] Thomas et al. 1999
[4/] Ecology 2003 Ground Water Model results in cubic feet per second (cfs)
[5/] (RR) = One re=regulating reservoir, no estimate of tailwater

Table 5.3-11. Comparison of Ground Water and Tailwater Discharge to Creeks for Alternatives 1 and 6, Steady-State Results

	Alternative 1				Alternative 6		
Creek [1/]	**Fall Range [2/]**	**Mean Seasonal Tailwater [3/] Single Ungauged Tailwater 10/97**	**Modeled Mean Annual Ground Water Discharge [4/]**	**Single Ground Water Discharge Measurement 10/7/97 [3/]**	**Net Tailwater after Reservoirs [5/]**	**Modeled Mean Annual Ground Water Discharge [4/]**	**Percent Change in Modeled Ground Water Discharge**
Siebert	2.7-3.3	0.11/no data	3.2	2.27	No change	3.2	0%
McDonald	0.1-11(d)	No data/0.03	2.3	No data	No change	2.2	4%
Meadowbrook	1.1-5.2(d)	0.54/No data	No data	1.37	0.04	No data	No data
Cooper	No data	No data	No data	No data	No data	No data	No data
Cassalary	1.2-1.7	No data/0.01	3.6	3.55	(RR)	3.2	11%
Gierin	0.83-3.2(a)	0.72/No data	0.8	0.84	No change	0.8	0%
Bell	0.8-2.6	0.60/0.45	2.4	2.35	No change	2.3	4%
Johnson	0.3-4.9(d)	1.36	0.6	No data	No data	0.6	0%
Matriotti	1.8-14.9 (d)	1.16/1.5	3.4	7.98	0.75	2.1	38%
Hurd	No data	No data	No data	(gaining stream)	No data	No data	No data
Bear	7.1-7.7	No data/0.3	No data	No data	No data	No data	No data

1/ All measurements reported in cubic feet per second (cfs)
2/ (w) = WIRA 18 draft plan (2001);(a) = AESI 1999; unsigned=Streamkeepers
3/ Thomas et al. 1999
4/ Ecology 2003 Ground Water Model results in cubic feet per second (cfs)
5/ (RR) = One re=regulating reservoir, no estimate of tailwater

Table 5.3-12. Ground Water Contribution to Streams for Selected Months in 1996 and 1997 for Alternatives 1 and 2, Transient Model Results

Streams	Existing Condition (Alternative 1)					Alternative 2				
	Aug-96	**Sep-96**	**Oct-96**	**Aug-97**	**Sep-97**	**Aug-96**	**Sep-96**	**Oct-96**	**Aug-97**	**Sep-97**
Siebert	3.3	3.3	3.3	3.3	3.3	3.2	3.3	3.3	3.3	3.3
McDonald	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Matriotti	2.6	2.7	2.7	3.0	2.9	1.9	1.9	1.9	2.0	2.0
Cassalary	3.4	3.4	3.4	3.3	3.3	3.1	3.1	3.1	3.1	3.1
Gierin	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7
Bell	2.3	2.4	2.4	2.2	2.2	2.3	2.3	2.3	2.3	2.3
Johnson	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6

Table 5.3-13. Ground Water Contribution to Streams for Selected Months in 1996 and 1997 for Alternatives 4 and 6, Transient Model Results

Streams	Alternative 4					Alternative 6				
	Aug-96	**Sep-96**	**Oct-96**	**Aug-97**	**Sep-97**	**Aug-96**	**Sep-96**	**Oct-96**	**Aug-97**	**Sep-97**
Siebert	3.3	3.3	3.3	3.3	3.3	3.2	3.3	3.3	3.3	3.3
McDonald	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Matriotti	2.1	2.1	2.1	2.2	2.1	2.0	1.9	1.9	2.1	2.0
Cassalary	3.2	3.2	3.2	3.1	3.1	3.2	3.2	3.2	3.1	3.1
Gierin	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Bell	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3
Johnson	0.7	0.7	0.7	0.7	0.6	0.7	0.7	0.7	0.7	0.7

Table 5.3-14. Remaining Ground Water Recharge from Leaky Ditches for Alternatives 4 and 6 as Compared to Alternative 2

EIS Alternatives	Agnew District (cfs)	Dungeness Company (cfs)	Cline District (cfs)	Clallam Company (cfs)	Dungeness District (cfs)	Independent Company (cfs)	Highland District (cfs)	Sequim-Prairie Company (cfs)	Eureka Company (cfs)	Summary of Estimated Ground Water Recharge (cfs)
Alternative 2	0	0	0	0	0	0	0	0	0	**0**
Alternative 4	2.62	0	0	0.61	0.67	0	0.45	0.59	0	**4.94**
Alternative 6	0.50	0	0	0	0	0	0.26	1.72	0	**2.48**

cfs = cubic feet per second

Alternative 1 – No Action

There would be no reduction in streamflow in other streams due to the implementation of the Conservation Plan under this alternative. However, other measures that lead to reduced diversion could still adversely affect streamflow in small streams. Ongoing withdrawals for domestic and commercial use from the shallow aquifer could reduce ground water contributions to small streams. Continued residential development and associated ground water development could withdraw additional ground water that would otherwise have reached a stream.

Alternative 2 – Full Plan Implementation

For Alternative 2, the average annual change in ground water discharge to streams modeled showed a percentage reduction of 0 percent in Siebert and Johnson Creeks to a reduction of 38 percent in Matriotti Creek (Table 5.3-8).

Average seasonal tailwater discharge (as gauged in 1997) varied from 0.11 cfs (Siebert Creek) to 1.27 cfs (Johnson Creek). No seasonal gauged tailwater data were available for McDonald, Cassalary, and Bear Creeks. However, ungauged tailwater estimates for these creeks of 0.03, 0.01, and 0.3 cfs, respectively, were made in October 1997 (Tables 5.3-9 and 5.3-9).

Alternative 2 impacts are discussed below by creek. Ground water contribution to creeks currently is augmented by irrigation recharge to ground water, but there is a natural base flow contribution as well. Because none of the alternatives will affect the base flow contribution, the following discussion highlights the reduction in ground water contribution to streams as predicted by the Ecology 2003 model. Table 5.3-8 summarizes the average annual changes in ground water and tailwater contribution to the creeks under Alternatives 1, 2, 4, and 6.

Dungeness River Tributaries

Bear Creek: This creek was not modeled, but ditches lined within the Bear Creek watershed (Agnew District: laterals A-4, A-5 and A-6) would reduce ground water recharge in this area by an estimated 0.37 cfs and could affect streamflows in Bear Creek.

Matriotti Creek: Under Alternative 2, a reduction in ground water contribution of 1.3 cfs (or 38 percent) is estimated to occur in Matriotti Creek. Because ground water and irrigation tailwater compose a significant portion of its flow, Matriotti Creek is the most affected by the reduction in aquifer recharge associated with piping of the irrigation ditches. Based upon Ecology 2003 model results for 1996 and 1997, seasonal declines in ground water contribution to Matriotti Creek are predicted to be greatest in August and September (Tables 5.3-12 and 5.3-13).

The total 1997 average seasonal tailwater discharge to Matriotti was measured at 1.16 cfs. The reduction in tailwater discharge to the creek from re-regulation reservoir(s) is estimated to be 0.16 cfs in Clallam Company and 0.25 cfs in Dungeness Company.

Hurd Creek: This creek was not modeled. Hurd Creek depends upon ground water for a significant component of its flow. Consequently, a decrease in ground water contribution to the creek may occur as a result of reduced irrigation recharge associated with Alternative 2.

Independent Creeks

Siebert Creek: No net average annual change in ground water contribution is expected as a result of Alternative 2 (Table 5.3-8). However, transient model results for August 1996 indicate a 0.1 cfs decline in ground water discharge to Siebert Creek (Tables 5.3-12 and 5.3-13) in this month. Siebert Creek is located at the westernmost extent of the irrigation system and, in 1997, received an average seasonal tailwater discharge of 0.11 cfs.

Because Siebert Creek receives a large component of its flow from snowmelt and rainfall, as the Ecology 2003 model estimates, it is largely unaffected by changes to the irrigation system.

No re-regulation reservoirs are planned that would affect tailwater discharge to Siebert Creek.

McDonald Creek: Ecology 2003 model simulations predicted that an average annual reduction in ground water contribution of 0.1 cfs would occur under Alternative 2. No seasonal differences were predicted for the fall low-flow months (Tables 5.3-12 and 5.3-13). A single ungauged tailwater measurement of 0.03 cfs was made in October 1997. No re-regulation reservoirs are planned that would affect tailwater discharge to McDonald Creek.

Meadowbrook Creek: Meadowbrook Creek was not modeled. However, the estimated reduction in tailwater discharge to the creek from re-regulation reservoir(s) is 0.5 cfs, capturing approximately 96 percent of the tailwater discharge to Meadowbrook Creek.

Cassalary Creek: An average annual decline in ground water contribution of 0.4 cfs is predicted to occur based upon Ecology 2003 model results. Seasonally, for the fall low-flow months, the decline in ground water contribution was predicted to be slightly lower for Cassalary (0.3 cfs) than the average annual decline (Tables 5.3-12 and 5.3-13). Although no average seasonal tailwater discharge measurements for Cassalary are available, a single ungauged flow measurement of 0.01 cfs was recorded for the creek in October 1997. The estimated reduction in tailwater discharge to the creek from re-regulation reservoir(s) is 0.3 cfs.

Gierin Creek: Under Alternative 2, a reduction in the estimated average annual ground water contribution of 0.1 cfs (13 percent of the annual ground water contribution to the creek) is predicted to occur based upon Ecology 2003 model results. Seasonally, model results for August and September 1997 show a decrease in ground water contribution to Gierin Creek of 0.1 cfs (Tables 5.3-12 and 5.3-13).

Two tailwater discharge measurements are available for Gierin Creek (Table 5.3-7). These measurements were obtained at separate gauge locations along the creek and are reported as 0.17 and 0.55 cfs (Table 5.3-7).

The total 1997 average seasonal tailwater discharge to Gierin Creek was measured at 0.72 cfs.

No re-regulation reservoirs are planned that would affect tailwater discharge to Gierin Creek.

Bell Creek: Under Alternative 2, a reduction in estimated average annual ground water contribution of 0.1 cfs is predicted to occur based upon Ecology 2003 model results. This reduction in ground water contribution equates to a net annual decline in ground water contribution to the creek of 4 percent. Seasonally, ground water model results predicted a 0.1 cfs decline in August through September 1996 and a 0.1 cfs gain in ground water contribution for August and September 1997 (Tables 5.3-12 and 5.3-13).

Tailwater discharge in 1997 was measured to be 0.60 cfs to the creek. The estimated reduction in tailwater discharge to the creek from re-regulation reservoir(s) is 0.5 cfs, capturing approximately 83 percent of the tailwater discharge to Bell Creek.

Johnson Creek: No net average annual change in ground water contribution is predicted as a result of Alternative 2 (Table 5.3-8). Seasonally, model results for September 1997 show a 0.1 cfs decline in ground water discharge to Johnson Creek for this low-flow month (Table 5.3-12). Cumulative tailwater discharge in 1997 to Johnson Creek was measured to be 1.36 cfs. No re-regulation reservoirs are planned that would affect tailwater discharge to Johnson Creek.

The changes described above with respect to ground water and tailwater contribution to affected streams do not, in themselves, constitute a significant impact. However, the changes in surface water flow may affect ground water quality, wetlands, and fish. Accordingly, the potential impacts of the change in ground water contribution and tailwater 7discharge are discussed in the following sections within this chapter: Section 5.3.6 (Water Quality), Section 5.4 (Wetlands), and Section 5.5 (Fish). This would leave 4.94 cfs recharging the shallow aquifer as a result of conveyance loss.

Alternative 4 – Economic Efficiency

Under Alternative 4, a total water savings of 33.42 cfs would be realized from irrigation ditch improvements that include piping, abandoning lines, constructing re-regulation reservoirs, and using treated wastewater from the City of Sequim to replace water diverted from the Dungeness River.

Ground water recharge due to remaining conveyance losses (seepage from irrigation ditches into the underlying shallow aquifer) is estimated to be 4.94 cfs for this alternative (Table 5.3-14). Recharge would occur along laterals in Agnew, Clallam, Dungeness District, Highland, and Sequim-Prairie. Fully piped laterals in Dungeness Company, Cline District, Independent Company, and Eureka Company would be constructed as in Alternative 2, effectively eliminating ground water recharge in these areas.

Under Alternative 4, with the exception of Matriotti and Cassalary Creeks, increased ground water recharge (compared to Alternative 2) of approximately 4.94 cfs does not alter the changes in ground water contribution to streams as discussed in Alternative 2.

For Matriotti Creek, for Alternative 4, the average annual ground water contribution changed from a modeled decline of 1.3 cfs (38 percent) in Alternative 2 to a decrease in ground water contribution of 1.1 cfs (32 percent). Modeled seasonal declines in ground water contribution for Matriotti Creek varied from 0.5 cfs (August 1996) to 0.8 cfs (August and September 1997) (Tables 5.3-12 and 5.3-13).

The decrease in average annual ground water contribution for Cassalary Creek was the same between Alternatives 2 and 4 (0.4 cfs). However, low-flow seasonal declines were slightly less for Alternative 4 (0.2 cfs) as compared to Alternative 2 (0.3 cfs).

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

The projects proposed for Alternative 6 are a subset of the projects listed in Alternative 2. These projects are expected to reduce the effects to selected streams and Graysmarsh.

Under this alternative, irrigation laterals within the watersheds of Gierin Creek, Siebert Creek, and lower Bell Creek would not be piped. This alternative would allow seepage from irrigation canals to locally recharge the underlying shallow aquifer. Providing local ground water recharge within the watershed of target creeks would potentially minimize the reduction in base streamflow as modeled in Alternative 2.

Under this alternative, all other ditches would be piped as presented in the Conservation Plan. The total water savings to the Dungeness would effectively be the Alternative 2 savings (38.36 cfs) less the unlined ditch and regulation reservoir savings in the areas described above (2.99 cfs). Consequently, diversions from the Dungeness River would be reduced by 35.38 cfs.

Ecology 2003 model results indicate that, with the exception of Gierin Creek, the local nature of ground water recharge under this alternative and the comparatively small amount of local proposed annual ground water recharge (2.48 cfs) do not impact the ground water contribution to the majority of streams in the study area.

With the exception of Gierin Creek, the predicted average annual ground water contribution to all creeks modeled is the same as for Alternative 2. For Gierin Creek, the average annual ground water contribution remains the same as the existing condition (Alternative 1). No changes to seasonal ground water contribution to Gierin Creek were predicted compared to Alternative 1.

Cumulative Impacts

Both independent streams and tributaries to the Dungeness River have been massively altered in the last 150 years. Not only have their watersheds been largely converted out of forest and into agriculture and, especially in the last 30 years, into rural residential land uses, but the channels themselves are altered. Gierin, Cooper, Cassalary, and Bell Creeks have all been channelized. (A brief summary of the history of Gierin Creek and the associated Graysmarsh wetlands can be found in Appendix H.) Gierin and Cooper Creeks have tide gates, which change how salt water enters and interacts with the fresh water (Cooper Creek tide gate was partially removed in 1995 [Haring 1999]). Most of these changes were originally designed to increase agricultural use.

In addition to the above changes in creeks, the irrigation conveyance system has been supplying the creeks through artificial ground water recharge (Tables 5.3-9 through 11). Implementation of the action alternatives would reduce the irrigation conveyance recharge. This reduction in ground water recharge would augment the continued reduction in ground water recharge due to annual increases in consumptive uses and pumping of shallow aquifer water for domestic and other human uses.

5.3.2 Ground Water

This section discusses the impact to water levels in all three aquifers as a result of implementation of Alternatives 1, 2, 4, and 6. As previously discussed, Alternatives 2, 4, and 6 consist of various water savings configurations that eliminate or reduce the majority of the irrigation ditch leakage to the shallow aquifer. While the impact of this reduction in recharge does result in the water level declines discussed in this section, it is important to note that, based upon the Ecology 2003 model water budget, the recharge to the shallow aquifer from irrigation ditch leakage accounts for only 3 to 5 percent of the total aquifer recharge. Precipitation recharge, unconsumed field irrigation recharge, septic return, wastewater application, and leakage from the Dungeness River and streams compose the remaining 95 to 97 percent of aquifer recharge.

The small variation in aquifer recharge via irrigation ditch leakage between Alternatives 2, 4, and 6 (5 percent, 3 percent, and 4 percent of total aquifer recharge) also accounts for the subtle and local variations in water level declines between these alternatives.

Monthly variations in water level distribution in all three aquifers were also evaluated. In general, monthly (transient) water level distributions mimicked the areas of water level decline noted in the steady-state model. However, the steady-state model results generally predict slightly greater water level declines than the transient results because the steady-state model does not incorporate aquifer storage. The transient model better accounts for aquifer storage because it employs aquifer storage coefficients to model the release of water in the aquifer system.

Alternative 1 – No Action

Ground water levels would not decline as a result of the reductions in irrigation recharge from implementation of the Conservation Plan if none of the action alternatives were implemented. However, other measures to reduce diversion could still reduce artificial aquifer recharge (see Appendix A). Ongoing and new withdrawals for domestic and commercial use from the shallow aquifer could also reduce ground water levels.

Alternative 2 – Full Plan Implementation

Figure 5.3-3 presents the average annual (steady-state) predicted decline in the water levels in the shallow aquifer for Alternative 2. Under Alternative 2, maximum water level declines of 6 to 7 feet are centered west of Sequim and east of the Dungeness River. West of the Dungeness River, maximum water level declines in the shallow aquifer of up to 5 to 6 feet are predicted. In the northeastern corner of the study area, less than a foot of water level decline is predicted.

Monthly variations in water level distribution in the shallow aquifer for Alternative 2 were also plotted. In general, monthly water level distributions mimicked the areas of water level decline noted in the steady-state model, although the steady-state model results generally predict slightly greater water level declines than the transient results (due to the way in which these two models treat the aquifer storage [see Appendix B]).

Figure 5.3-4 presents the predicted water level decline under the transient model for August 1996. The greatest area of water level decline is still located between Sequim and the Dungeness River; however, the magnitude of the greatest decline is approximately 4 to 5 feet, as compared with the predicted average annual (steady-state) decline of 6 to 7 feet (Figure 5.3-3).

Maximum water level declines of between 5 and 6 feet are predicted for the middle and lower aquifers in response to Alternative 2. Because the hydraulic connection between the shallow, middle, and lower aquifers is variable and not well-defined across the study area, in the Ecology 2003 model, vertical flow was controlled primarily by available literature estimates of leakage and model calibration requirements. As more field data are collected, the vertical hydraulic connection between aquifers will be better refined.

Alternative 4 – Economic Efficiency

Under Alternative 4, a total of 33.42 cfs would be saved from diversion and would remain in the Dungeness River as a result of irrigation ditch improvements, which include piping, abandoning lines, constructing regulation reservoirs, and using treated wastewater from the City of Sequim.

Ground water recharge due to remaining conveyance losses (seepage from irrigation ditches into underlying units) is estimated to be 4.94 cfs for this alternative (Table 5.3-14).

Under Alternative 4, the remaining ground water recharge of approximately 4.94 cfs results in a greater local ground water recharge than in Alternative 2. Figure 5.3-5 presents average annual (steady-state) predicted water level declines in the shallow aquifer for Alternative 4. Maximum water level declines for Alternative 4 are the same as Alternative 2 (6 to 7 feet); however, the areal extent of this decline is smaller in Alternative 4.

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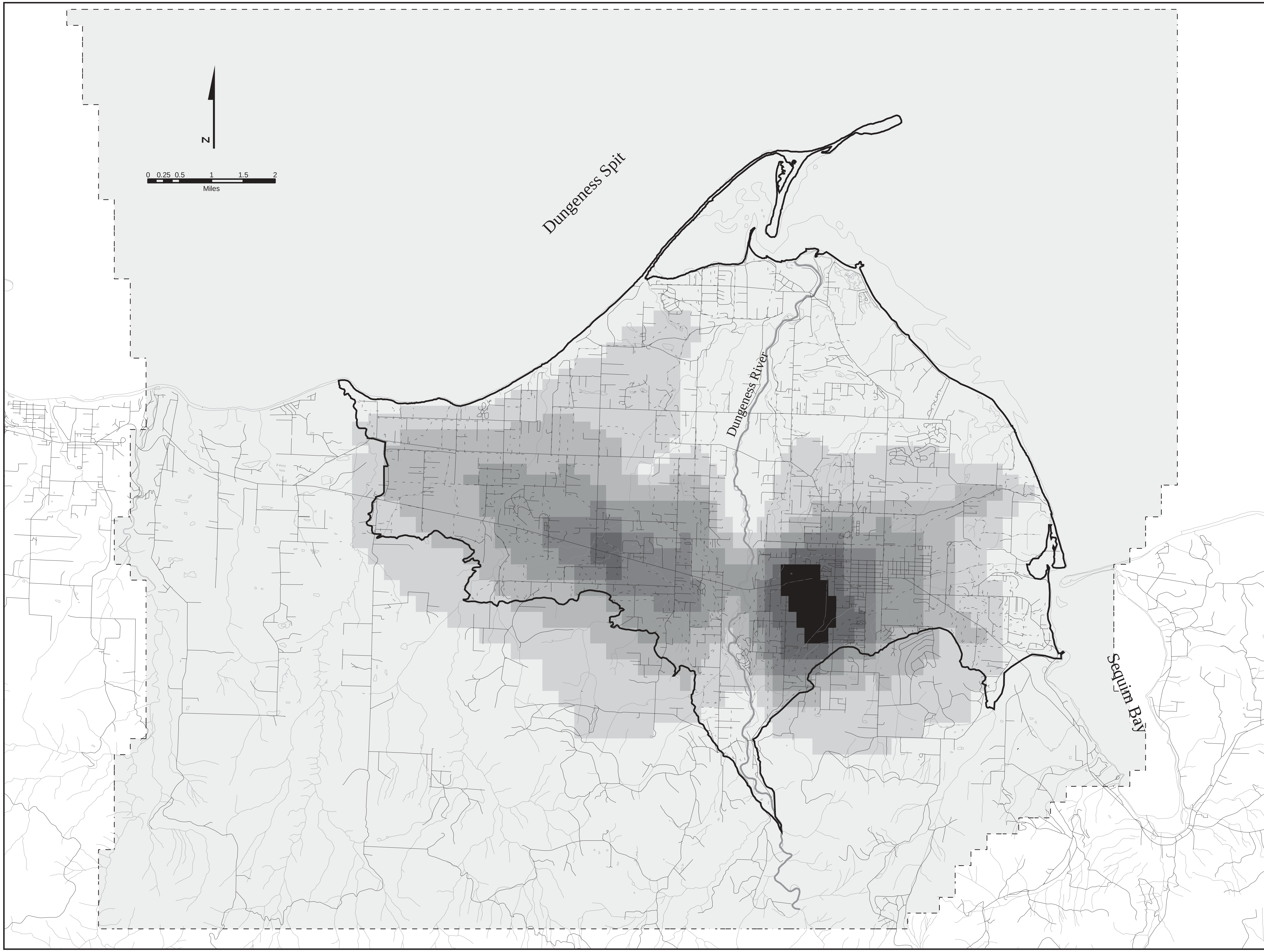
Figure 5.3-3
Modeled Decline in Water Levels in the Shallow Aquifer, Steady-State Model Results EIS Alternative 2



Location Map

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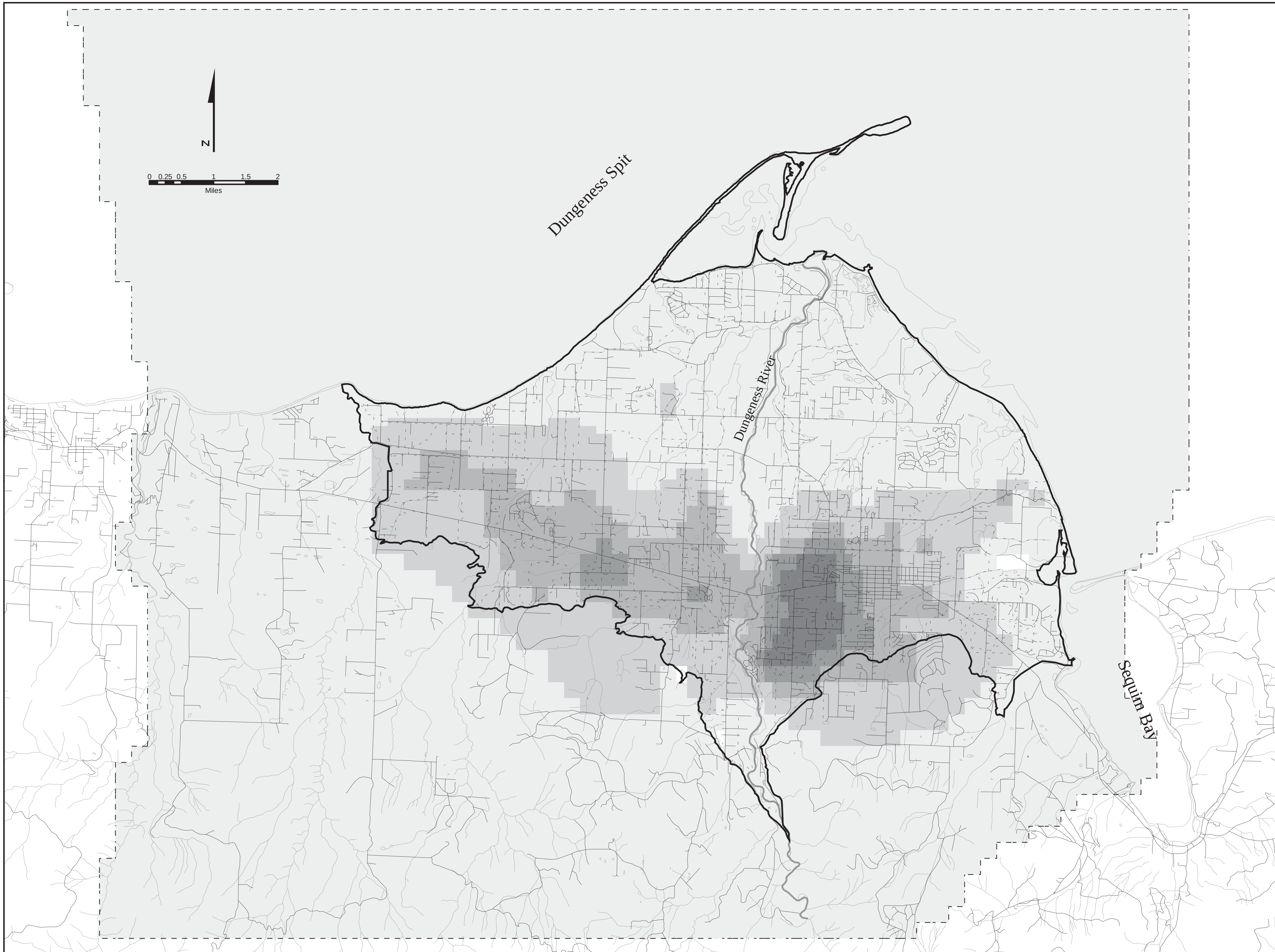
Figure 5.3-4
Modeled Decline in Water Levels in the Shallow Aquifer for August 1996, Transient Model Results EIS Alternative 2



Map Features

- EIS Boundary
- Dungeness River
- Streams
- Irrigation Ditches
- Roads
- Model Grid Boundary

Alternative 2 - August 1996
Water Level Decline in Ft

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7

Location Map

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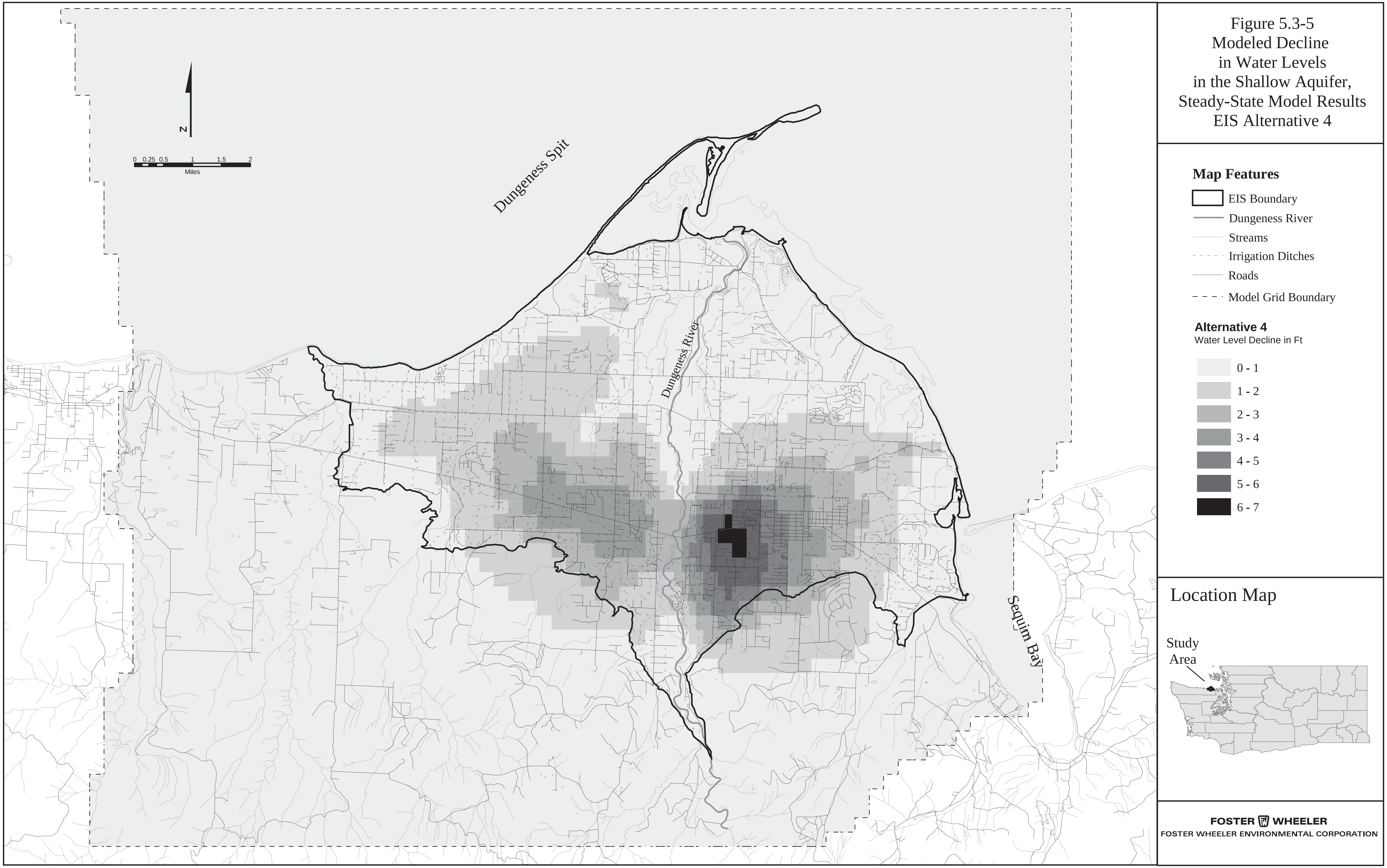

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Figure 5.3-6 presents the predicted water level decline, for Alternative 4 in August 1996. The greatest area of water level decline is still situated between Sequim and the Dungeness River. The magnitude of the greatest decline is approximately 4 to 5 feet, as compared with the predicted average annual (steady-state) decline of 6 to 7 feet (Figure 5.3-5). Maximum water level declines of between 5 and 6 feet are predicted for the middle and lower aquifers in response to Alternative 4.

The differences in predicted water levels for the shallow aquifer between Alternatives 2 and 4 are shown on Figure 5.3-7. As compared to Alternative 2, predicted water level elevations for Alternative 4 in the shallow aquifer are up to 3 feet higher in the western corner of the study area, 1 foot higher along the southern boundary, and up to 2 feet higher south of Gierin Creek. These predicted differences in water level elevations reflect the change in irrigation recharge between Alternatives 2 and 4. For Alternative 4, irrigation recharge occurs along laterals in Agnew, Clallam, Dungeness District, Highland, and Sequim-Prairie systems, providing recharge to the shallow aquifer system in these areas.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

Under Alternative 6, a total of 35.38 cfs would be saved from diversion and would remain in the Dungeness River as a result of ditch improvements, which include piping, abandoning lines, constructing regulation reservoirs, and using treated wastewater from the City of Sequim.

The projects proposed for Alternative 6 are a subset of the projects listed in Alternative 2. These projects are expected to reduce the effects to selected streams and Graysmarsh.

Under this alternative, only those irrigation laterals within the "zone of contribution" (AESI 1991) for Graysmarsh and the watersheds of Siebert Creek and lower Bell Creek would not be piped as compared to Alternative 2. This alternative would allow seepage from irrigation canals to locally recharge the underlying shallow aquifer. Providing local ground water recharge within the watershed of target creeks and wetlands would potentially minimize the reduction in base flow for these creeks as modeled for Alternative 2. Diversions from the Dungeness River would be reduced by 35.38 cfs.

Figures 5.3-8 and 5.3-9 present the average annual and August 1996 predicted declines in water levels for the shallow aquifer under Alternative 6. The local nature of ground water recharge under this alternative, and the comparatively small amount of local proposed annual ground water recharge (2.48 cfs) result in declines in the shallow aquifer that are very similar to Alternative 2 (with the exception of those areas of the shallow aquifer recharge near Gierin, Siebert, and Bell Creeks targeted by this alternative). For Alternative 6, predicted maximum annual average water level declines for the middle and lower aquifer were 5 to 6 feet.

The differences in predicted shallow aquifer water levels for Alternatives 2 and 6 are shown on Figure 5.3-10. As compared to Alternative 2, predicted water level elevations for Alternative 6 in the shallow aquifer are up to 1 foot higher near Siebert Creek, 1 foot higher south of Bell Creek along the southeastern study area boundary, and up to 3 feet higher south of Gierin Creek. These predicted differences in water level elevations reflect the change in irrigation recharge between Alternatives 2 and 6, specifically areas of shallow aquifer recharge near Gierin, Siebert, and Bell Creeks.

Cumulative Impacts

The water balance in the project area (which includes surface and ground water components) has been altered in the last 150 years. Infiltration from rainfall has changed with the land cover change away from forest and into farms, fields, and impervious surfaces associated with urbanization, roading, and rural residential development (Kittredge 1948). There is now increased surface runoff during storm events and probable reduced infiltration over the planning area.

The large increase in use of ground water for domestic, industrial, public, and irrigation purposes, especially over the last 30 years, has also affected all of the aquifers but has probably reduced the water levels in the shallow aquifer most significantly over time. This use is predicted to increase over time (Clallam County 1995b).

Finally, agricultural land uses and irrigation practices have changed, reducing the demand for irrigation water as on-farm efficiency improved and flood irrigation techniques were prohibited. In addition, there has been a change away from dairy farming with intensely irrigated pastures and towards specialty crops like lavender and vegetable seed, which has reduced the demand for water and thus the deep percolation due to excess irrigation. Also, much land has been taken out of agriculture and into rural residential development, which changes the frequency and duration of irrigation, although it does not eliminate it. Thus, ground water levels, especially in the shallow aquifer, have been declining over time due to a number of factors.

The proposed changes would reduce irrigation ditch leakage into the shallow aquifer. This decrease in recharge would likely exacerbate water level reductions in the shallow aquifer in addition to those caused by changes in infiltration, changes in agricultural practices, and significant increases in pumping.

5.3.3 Connectivity and Continuity

None of the action alternatives would alter the physical characteristics of the aquifers and aquitards, including connectivity and continuity.

5.3.4 Water Supplies

This section discusses impacts to well yields for exempt wells and non-exempt water supply systems. Exempt wells include uses that do not exceed 5,000 gallons per day, such as single family domestic wells and small stock-watering operations. Non-exempt wells require water rights and typically use more than 5,000 gallons per day. Examples of non-exempt wells include public water supply wells, irrigation wells, and commercial and industrial wells (which exceed 5,000 gallons per day).

A decline in the static water level in an aquifer can result in the loss of some portion of a well's total available yield. What is important in evaluating impacts to exempt and non-exempt water supply wells is the assessment as to whether the estimated hypothetical loss in well yield has the potential to impact actual water use. Because the analysis of potential impacts of water level declines is especially important in the shallow aquifer, where shallow well depths limit available drawdown in some water supply wells, the analysis of exempt water supply wells focuses on this aquifer. However, for non-exempt (public) water supply wells, all wells within a particular water supply system (for which information was available) were considered with respect to potential impact, regardless of depth or aquifer completion.

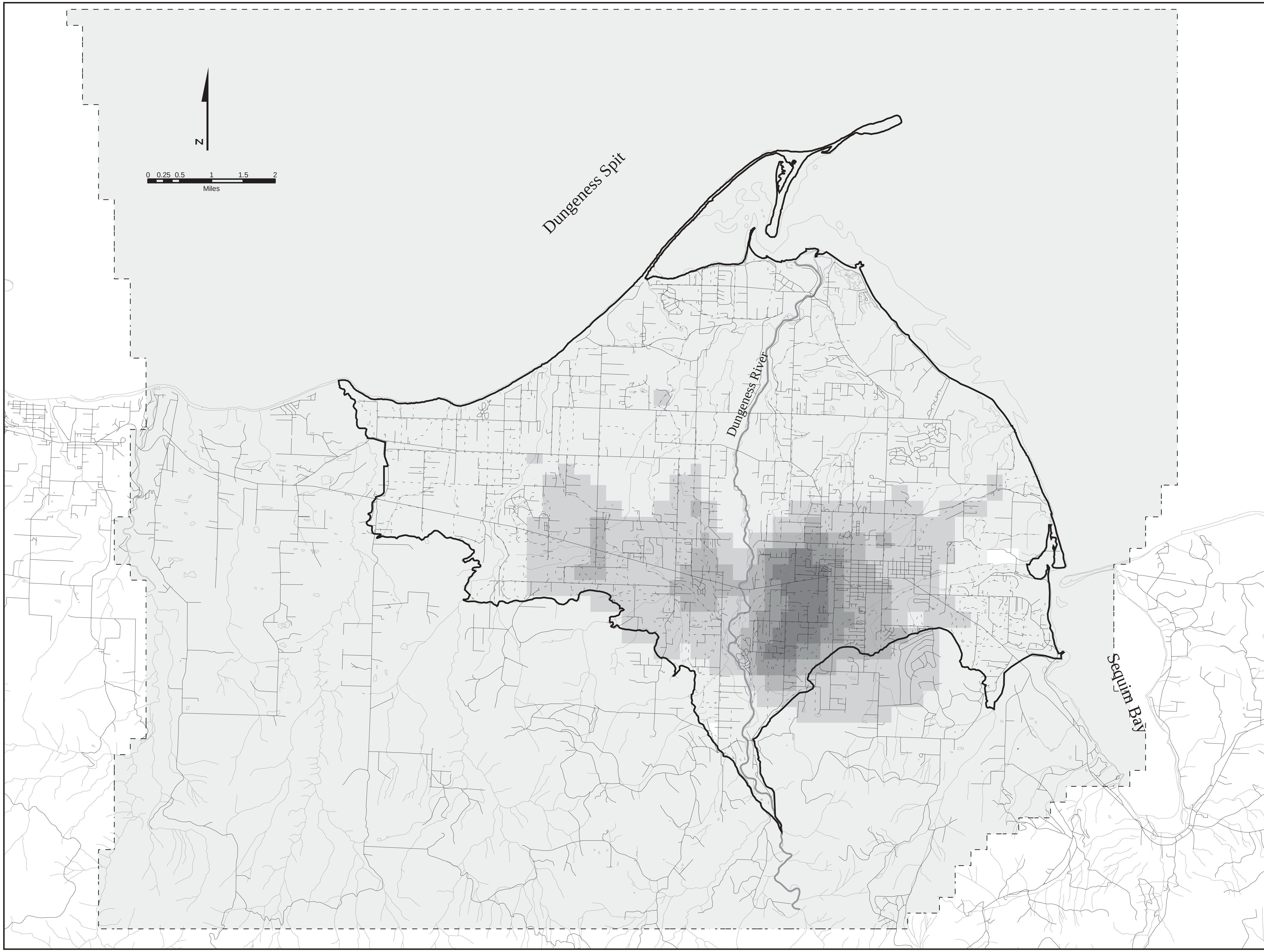

Figure 5.3-6
Modeled Decline in
Water Levels in the
Shallow Aquifer for
August 1996,
Transient Model Results
EIS Alternative 4

Map Features

EIS Boundary
Dungeness River
Streams
Irrigation Ditches
Roads
Model Grid Boundary

Alternative 4 - August 1996
Water Level Decline in Ft

0 - 1
1 - 2
2 - 3
3 - 4
4 - 5
5 - 6
6 - 7

Location Map

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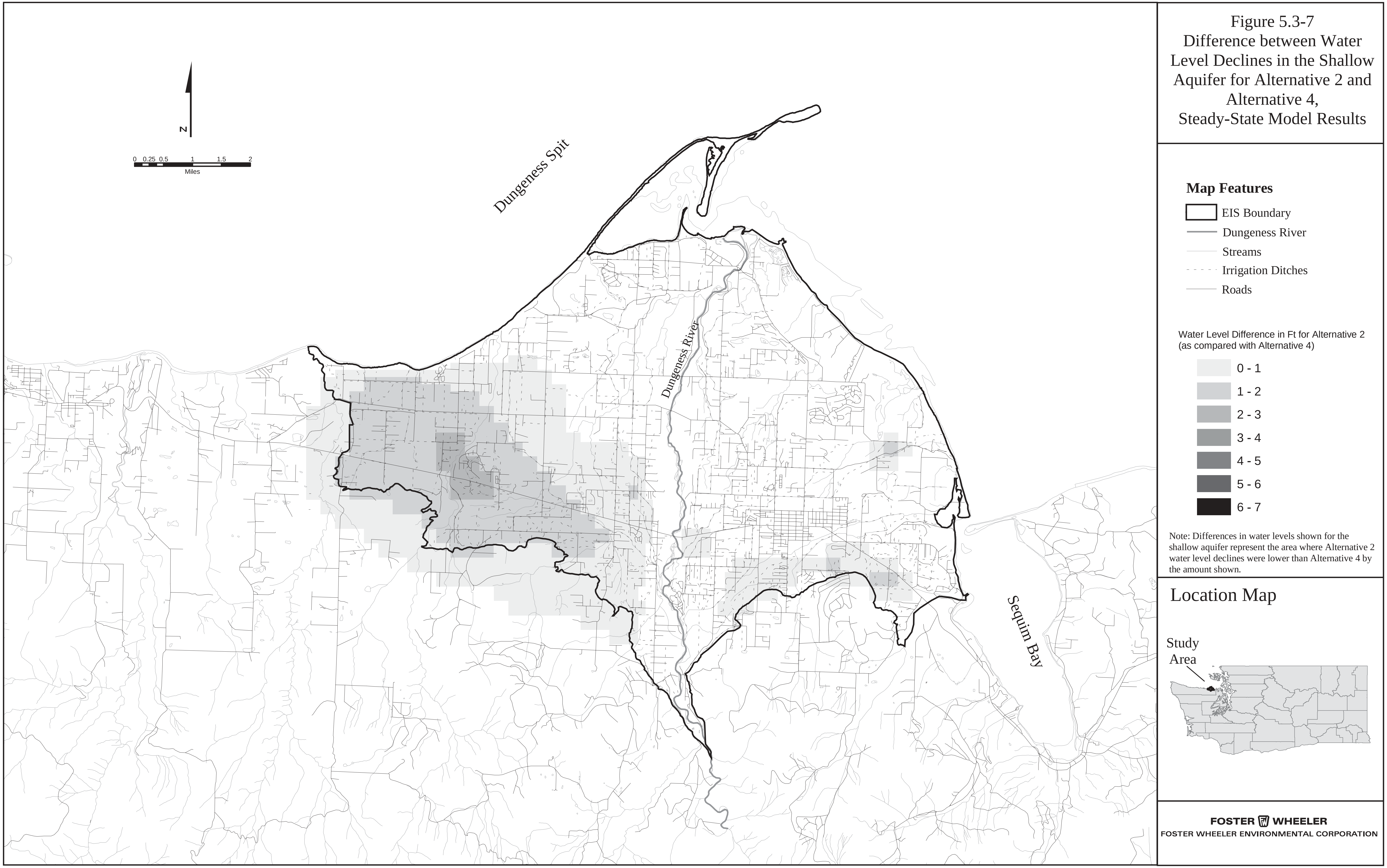

Figure 5.3-7
Difference between Water Level Declines in the Shallow Aquifer for Alternative 2 and Alternative 4, Steady-State Model Results

Note: Differences in water levels shown for the shallow aquifer represent the area where Alternative 2 water level declines were lower than Alternative 4 by the amount shown.

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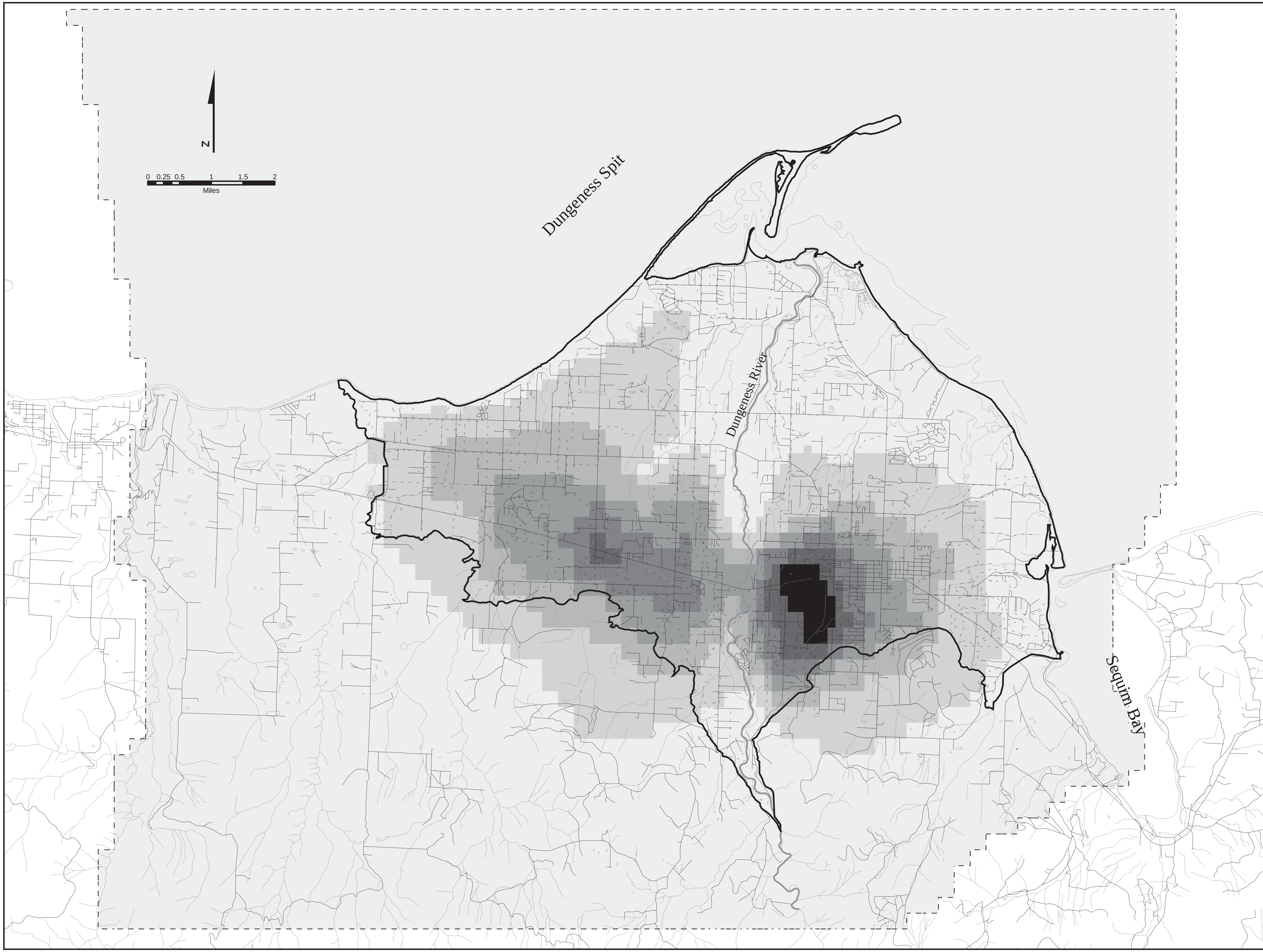


Figure 5.3-8
Modeled Decline in
Water Levels in the
Shallow Aquifer,
Steady-State Model Results
EIS Alternative 6

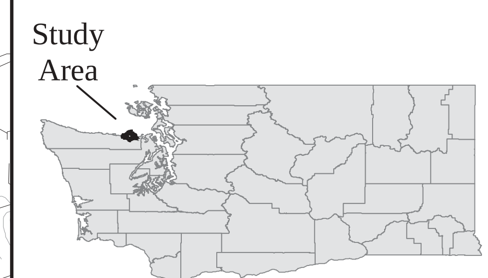
Map Features

- EIS Boundary
- Dungeness River
- Streams
- Irrigation Ditches
- Roads
- Model Grid Boundary

Alternative 6
Water Level Decline in Ft

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7

Location Map



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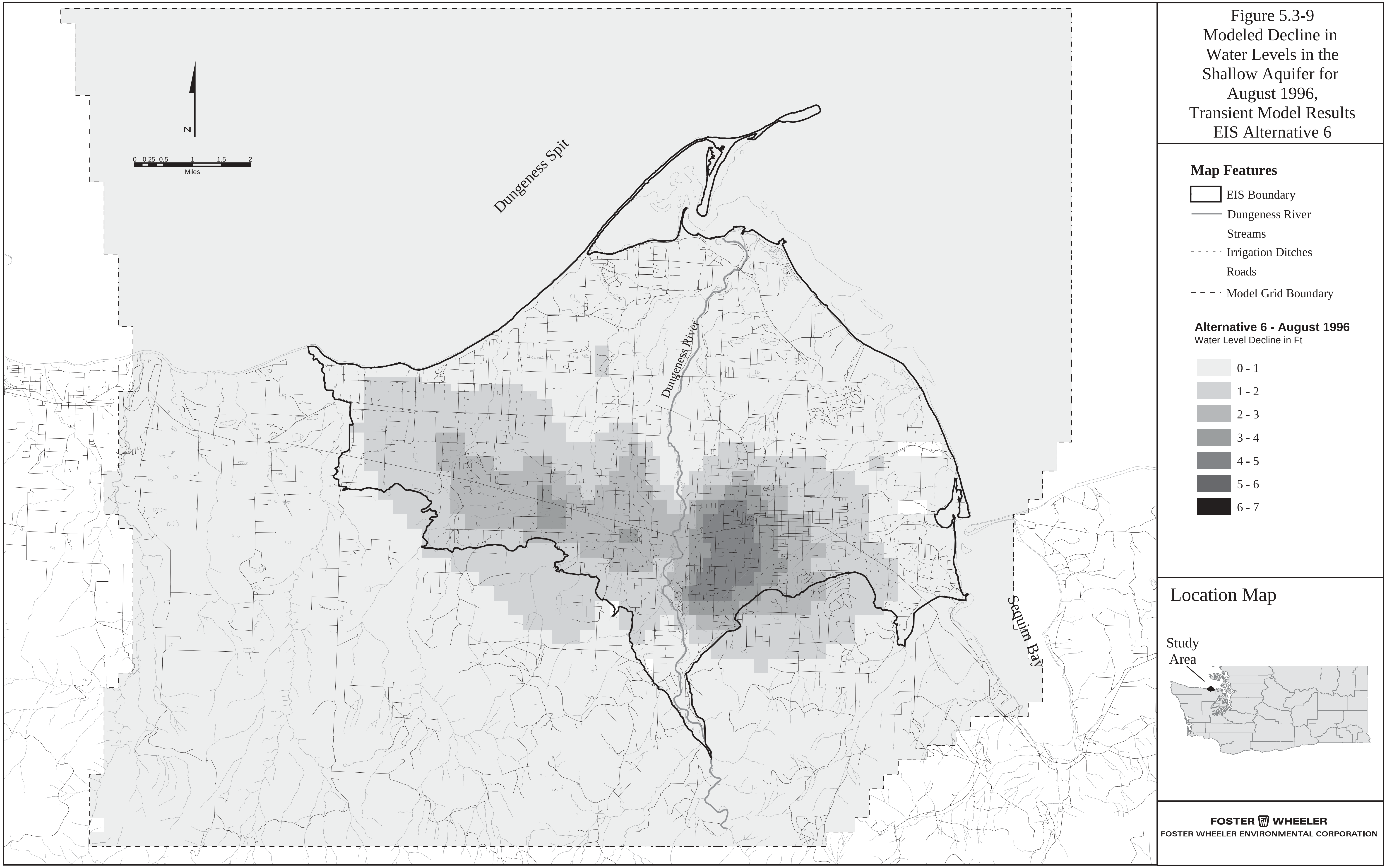

Figure 5.3-9
Modeled Decline in Water Levels in the Shallow Aquifer for August 1996, Transient Model Results EIS Alternative 6

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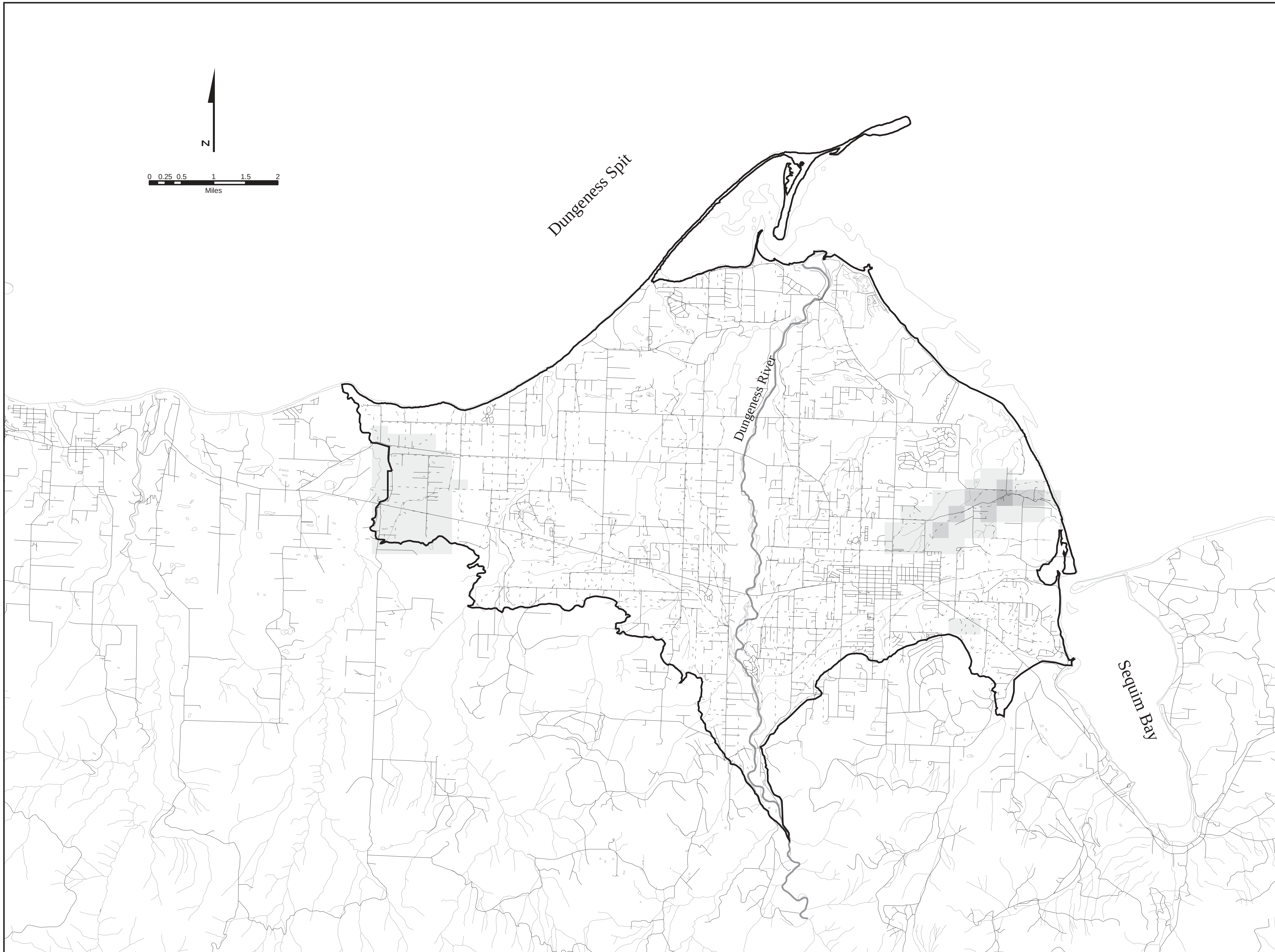

Figure 5.3-10
Difference between Water Level Declines in the Shallow Aquifer for Alternative 2 and Alternative 6, Steady-State Model Results

Map Features

- EIS Boundary
- Dungeness River
- Streams
- Irrigation Ditches
- Roads

Water Level Difference in Ft for Alternative 2 (as compared with Alternative 6)

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7

Note: Differences in water levels shown for the shallow aquifer represent the area where Alternative 2 water level declines were lower than Alternative 6 by the amount shown.

Location Map

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Alternative 1 – No Action

Well yields would not decline as a result of the Conservation Plan if none of the action alternatives were implemented because artificial recharge would continue to supplement ground water by about 38.36 cfs. However, other measures to reduce diversion could still adversely affect aquifer recharge and therefore well yields. Ongoing withdrawals for domestic and commercial use from the shallow aquifer could reduce ground water levels further. New wells constructed in the shallow aquifer would further reduce ground water availability. Transferring demand to the middle or lower aquifers by drilling deeper wells or by deepening existing wells could minimize or postpone this impact.

Alternative 2 – Full Plan Implementation

<u>*Exempt Water Supply Wells*</u>

To address impacts to exempt water supply wells (typically single-family domestic wells), Ecology estimated the maximum hypothetical yield for exempt water supply wells completed within the shallow aquifer. To obtain sufficient information to complete the well yield analysis, the Clallam County well database (which contains the necessary well yield and drawdown data) was reviewed. Out of approximately 3,342 well entries reviewed, only 540 wells had sufficient data to estimate the hypothetical well yield.

The potential yield of a well depends upon the specific capacity of the well and the available drawdown in the well casing. Specific capacity is a combined measure of both well efficiency and the ability of the aquifer to yield water to the well. The specific capacity of a well is expressed as the number of gallons per minute that a well will produce per foot of pumping drawdown. Available drawdown is defined as the distance in the well casing between the static water level and the pump intake. The maximum hypothetical yield of a well can be estimated by multiplying the specific capacity by the usable available drawdown. Wells lose utility when available drawdown is reduced such that the maximum hypothetical yield becomes insufficient to meet the water demands of the user.

For this analysis, screened intervals in the wells were assumed to be at the bottom of the wells (since screened intervals were not listed in the well database). Available drawdown was calculated with a buffer of 15 feet to allow for pump placement, seasonal water level variations, and well interference effects.

Figure 5.3-11 presents the density and well distribution of the 540 wells across the study area. The greatest well densities were noted west of Sequim and east of the Dungeness River and to the north of the study area, west of the Dungeness. The depth and distribution of wells across the shallow aquifer is believed to be somewhat representative of the range in conditions that would be experienced as a result of predicted water level declines.

With the information above, maximum hypothetical well yields were calculated, and the potential reduction in well yield from piping the irrigation ditches under Alternatives 2, 4, and 6 was evaluated using two water use criteria:

1. 0.6 gallons per minute (gpm) or 800 gallons per day. This number is based upon the fact that Clallam County considers this yield adequate for domestic water supply if a holding tank is installed (personal communication, Ann Soule, Clallam County Hydrogeologist and Water Supply Scientist to Penny Eckert, Foster Wheeler Environmental, November 13, 2002).
2. The maximum water use of an exempt well (5,000 gallons per day) or 3.5 gpm.

To evaluate well yield impacts, wells were categorized by aquifer. Of the 540 total wells, 492 were constructed in the shallow aquifer, 42 were completed in the middle aquifer, and 6 wells were located in the lower aquifer. While the number and distribution of wells in the shallow aquifer does enable some general interpretation regarding the overall impact of the action alternatives on private water supplies in the area, due to the limited amount of well data for the middle and lower aquifers, only a preliminary qualitative assessment of impact can made for these aquifers.

The results of the well yield analysis for the 492 shallow aquifer wells are presented in Figure 5.3-12. The well yield distribution for Alternative 1 (Existing Conditions) shows the estimated distribution of wells among yield classes for the average annual conditions from December 1995 through September 1997.

The bar charts for Alternatives 2, 4, and 6 show the changed distribution of the same 492 wells among yield classes due to the changes in irrigation ditch recharge between these three alternatives.

Using the criterion that well yields below 0.6 gpm represent a reduction in yield, under Alternative 1 (Existing Conditions), approximately 1 percent of the wells were estimated to have insufficient capacity at the present. For Alternative 2, the predicted decline in water levels in the shallow aquifer results in a total of 4 percent of wells that are estimated to experience a decline in well yield (i.e., a well yield below 0.6 gpm). Effectively, this means that, under Alternative 2, an additional 3 percent of wells (or approximately 16 wells) may experience a loss of function. Alternatively, if well yields below 3.5 gpm represent insufficient well yield, then under current conditions an estimated 7.3 percent of the 492 wells (36 wells) have insufficient yield. Under the predicted water level declines in the shallow aquifer for Alternative 2, the percentage of wells estimated to experience insufficient yield increases to 12.6 percent (or 62 wells).

For the middle aquifer, if a yield of 0.6 gpm or less is considered insufficient, approximately 2 percent (1 well) has an insufficient yield under existing conditions. For all three alternatives, out of 42 wells, the yield of three wells decreased below 0.6 gpm (7.5 percent increase). For the lower aquifer, no change or reduction in well yield was noted in the six private wells analyzed.

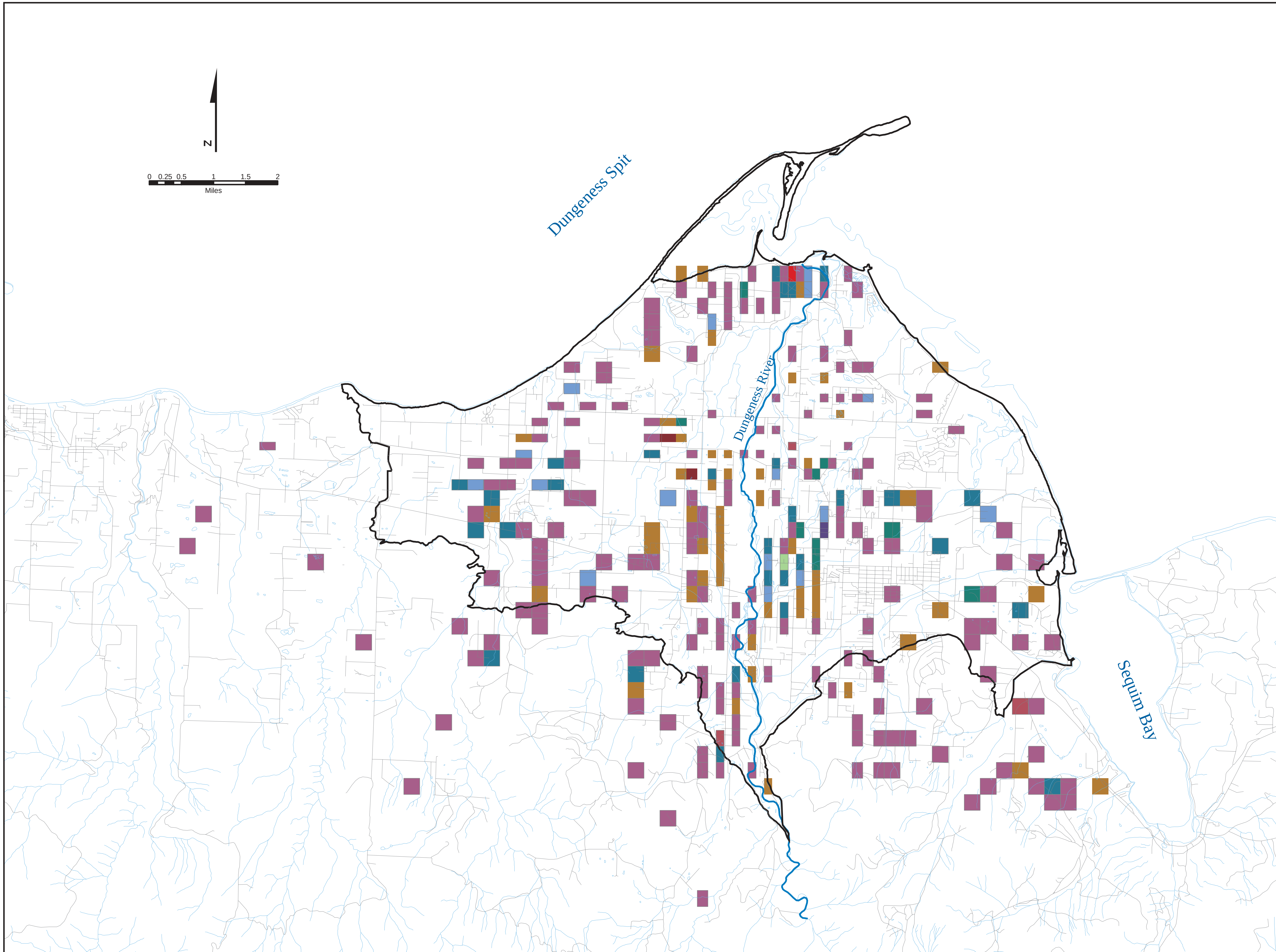
Non-Exempt (Public) Water Supply Wells

Among the key public water supply systems on the Dungeness-Sequim peninsula that rely on ground water, the City of Sequim, PUD #1 of Clallam County, and the Sunland Water District are included.

The City of Sequim operates two wellfields: the Silberhorn Wellfield and the Port Williams Wellfield. Each wellfield consists of two active wells. In the planning area considered for this EIS, PUD #1 operates the Loma Vista Wellfield (consisting of three production wells), the Smithfield Drive Wells (two active wells), the Carlsborg Well, and the Mains Farm Property Association Wellfield (three wells, but only one is active). The Sunland Water District operates two domestic wells and two irrigation wells north of the Port Williams Wellfield.

Table 5.3-15 summarizes well depth, available aquifer test, and specific capacity data. An estimate of the change in well yield based upon the calculated specific capacity of the well and its location relative to the average annual predicted declines for Alternatives 2, 4, and 6 is also summarized in Table 5.3-15. The change in well yield among Alternatives 2, 4, and 6 is generally within 10 gpm or less. The more important issue is the magnitude of

Figure 5.3-11
Distribution of Wells Across the Study Area for Well Yield Analysis



Map Features

- EIS Boundary
- Dungeness River
- Roads

Number of Wells per Model Grid

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 13

Location Map

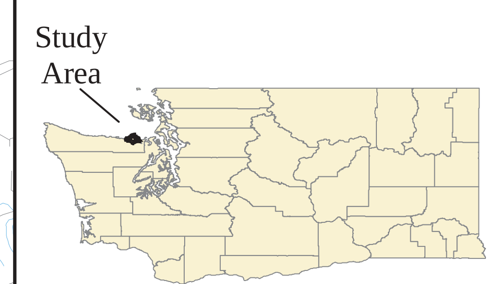


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Figure 5.3-12. Well Yield Distribution for Alternatives 1, 2, 4 and 6 in the Shallow Aquifer

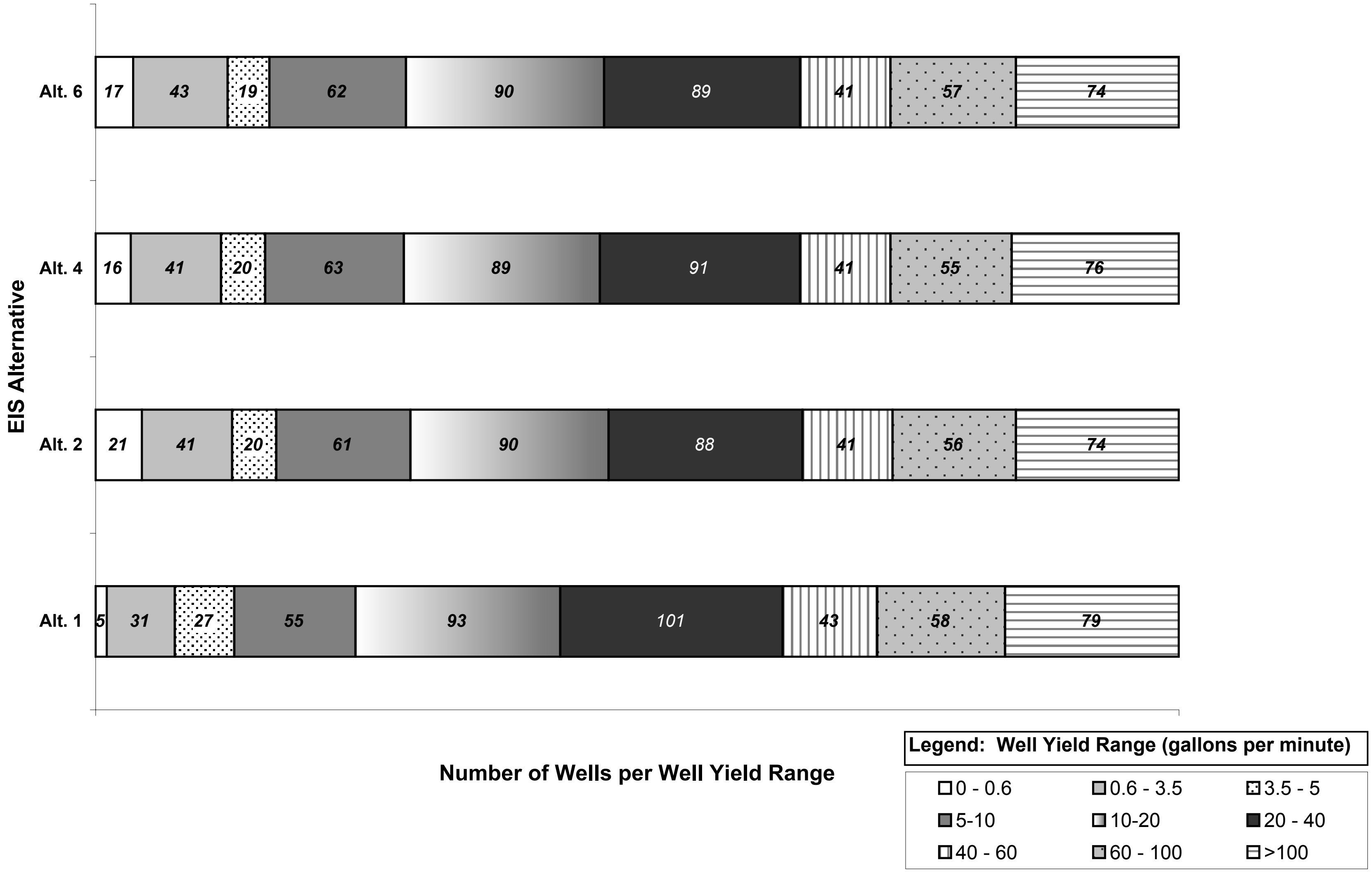


Table 5.3-15. Non-Exempt (Public) Water Supply Wells Yield Analysis for Selected Water Supply Systems

Public Water Supply System Well ID	Well Depth (ft bls) [1/]	Maximum Sustained Well Yield During Aquifer Test (gpm) [2/, 3/]	Observed Drawdown During Aquifer Test (feet)[4/]	Estimated Specific Capacity (gpm per foot)[5/]	Well Screened in Aquifer	Estimated Decrease in Well Yield Under Alternative 2 (gpm)[6/]	Estimated Decrease in Well Yield Under Alternative 4 (gpm)	Estimated Decrease in Well Yield Under Alternative 6 (gpm)
City of Sequim								
Port Williams Well #1	417	575	83	6.9	Lower	14	12	11
Port Williams Well #2	379	685	150	4.6	Lower	9	8	7
Silberhorn Well #2	186	48	301	6.3	Shallow	33	30	33
Silberhorn Well #3	172	58	367	6.7	Shallow	35	32	35
Public Utility District (PUD) #1 of Clallam County								
Mains Farm Property Association Well #2	537	298	19	16.1	Lower	15	14	15
Mains Farm Property Association Well #3 (inactive)	125	50	30	16.7	Shallow	9	7	9
Smithfield Drive Well #1	163	50	47	1.1	Shallow	4	3	4
Smithfield Drive Well #2	298	76	21	3.7	Middle	16	13	16
Loma Vista Well #1	136	290	29	10.0	Shallow	63	57	62
Loma Vista Well #2	130	50	3	16.7	Shallow	104	96	103
Loma Vista Well #3	130	198	26	7.5	Shallow	47	43	47
PUD #1 Clallam County Carlsborg Well	177	320	14	22.3	Shallow	72	57	71
Sunland Water District Domestic Wells								
Sunland Domestic Well #1	250	550	32	17.5	Middle	23	20	19
Sunland Domestic Well #2	124	620	13	49.6	Shallow	32	27	26

[1/] bls = below land surface
[2/] gpm = gallons per minute
[3/] Well yields were obtained from Aquifer Test data volunteered by the City of Sequim, PUD #1, and Sunland Water District.
[4/] Observed drawdown refers to the change in water level in the well in response to pumping at the maximum sustained yield (during the Aquifer Test).
[5/] Specific capacity is a combined measure of both well efficiency and the ability of the aquifer to yield water to the well. Specific capacity is calculated by dividing the maximum sustained yield of the well during the Aquifer Test by the observed drawdown. For example, for Port Williams Well #1: (575 gpm/83 ft) = 6.9 gpm/foot.
[6/] The estimated decrease in well yield for Alternatives 2, 4, and 6 was calculated by multiplying the specific capacity of the well by the steady-state modeled decrease in water levels in the appropriate aquifer (as determined by the screened interval of the well).

predicted change that the various water supply systems will experience relative to the required use.

Public water supply systems that may experience an impact to their yield are those wellfields situated within the shallow aquifer in the area in which the largest water level declines of 7 feet are predicted to occur. Figure 5.3-13 presents the estimated change in well yield among action alternatives. The City of Sequim Silberhorn Wellfield and the PUD #1 Loma Vista Wellfield are predicted to lose the most potential well capacity. Total loss of available production for the two Silberhorn wells under any of the action alternatives would range from 30 to 33 gpm for Silberhorn Well #2 and between 32 and 35 gpm for Well #3 (Table 5.3-15, Figure 5.3-13). The total cumulative reduction in yield for the Silberhorn Wellfield would be approximately 62 to 68 gpm.

Loma Visa Well #1 is predicted to lose between 57 and 63 gpm under the various action alternatives. Loma Vista Well # 2 is estimated to experience the greatest decline in yield, from 96 gpm (Alternative 4) to 104 gpm (Alternative 2). Loma Vista Well #3 is also predicted to see a decline in capacity of between 43 to 47 gpm for the action alternatives. Table 5.3-15, Figure 5.3-13). Ecology 2003 model results predict declines near the PUD #1 Carlsborg Well, located to the west of the Dungeness, that will result in a 57 to 72 gpm loss in well yield. Sunland Domestic Well #2, completed in the shallow aquifer, is predicted to experience a decline in potential yield of between 26 to 32 gpm. The same magnitude of decline (between 19 and 23 gpm) is also expected for Sunland Well #1, constructed in the middle aquifer at a depth of 250 feet.

Other Non-Exempt (Public) Water Supplies

There are several other smaller public water suppliers in the area. While they have not been analyzed for well level declines, they may experience some reduction in capacity after implementation of Alternative 2.

Alternative 4 – Economic Efficiency

Exempt Water Supply Wells

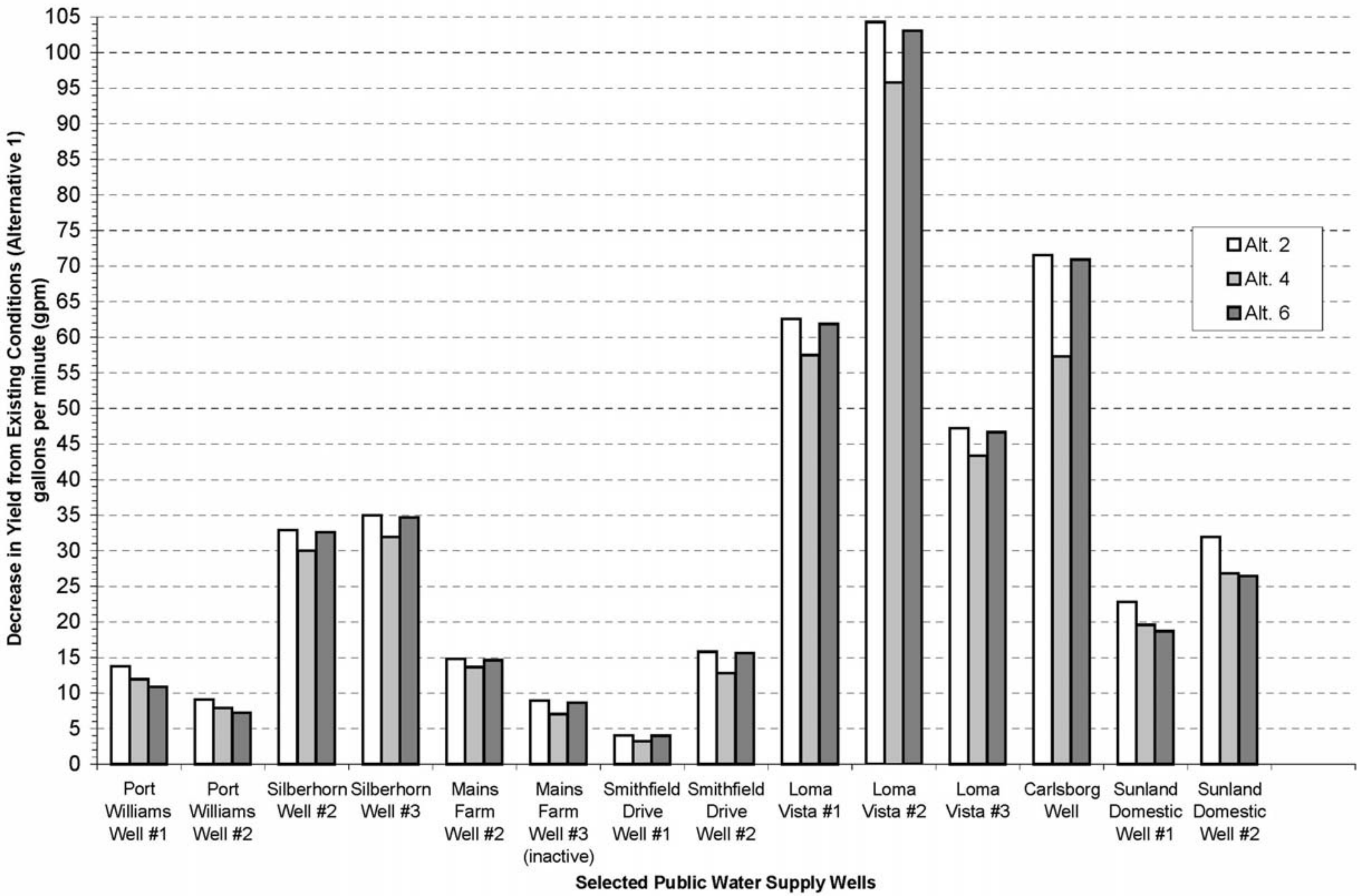
Using the criterion that well yields below 0.6 gpm represent an impairment, under Alternative 1 (Existing Conditions), approximately one percent of the wells (5 wells) were estimated to have insufficient capacity. For Alternative 4, the predicted decline in water levels in the shallow aquifer results in a total of 3.3 percent of wells that are predicted to experience an impairment of well yield (i.e., a well yield below 0.6 gpm). This change represents a 2 percent increase (or 11 wells) which will experience an impairment of yield as a result of Alternative 4.

Alternatively, assuming that well yields below 3.5 gpm represent insufficient yield, then under current conditions 7.3 percent of the 492 wells (36 wells) were estimated to have insufficient yield. Under the predicted water level declines in the shallow aquifer for Alternative 4, the percentage of wells estimated to experience an impairment of yield increases to 12 percent (57 wells).

Non-Exempt Public Water Supplies

Under this alternative, impacts to non-exempt water supplies are similar to those seen under Alternative 2.

Figure 5.3-13
Estimated Decrease in Well Yield under EIS Alternatives 2, 4 and 6
for Selected Non-Exempt (Public) Water Supply Wells



Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

Exempt Water Supply Wells

If a well yield below 0.6 gpm represents insufficient well yield, under Alternative 1 (Existing Conditions), approximately one percent of the wells (5 wells) were estimated to have insufficient capacity. For Alternative 6, the predicted decline in water levels in the shallow aquifer results in a total of 3.5 percent of wells (or 17 wells) that are predicted to experience insufficient well yield (i.e., a well yield below 0.6 gpm).

When the criteria to evaluate insufficient well yield is set at a yield of 3.5 gpm or less, then an estimated 36 wells (7.3 percent of the 492 wells) were estimated to have insufficient yield under existing conditions. Under the predicted water level declines in the shallow aquifer for Alternative 6, the percentage of wells estimated to experience insufficient yield increases to 12 percent (or 59 wells).

Non-Exempt (Public) Water Supplies

Under this alternative, impacts to non-exempt water supplies are similar to those seen under Alternative 2.

Cumulative Impacts

Exempt Wells

The Ecology water supply analysis for exempt wells was limited to less than 15 percent of the wells across the Sequim-Dungeness peninsula (due to the availability of construction and well data). However, the depth and distribution of wells across the shallow aquifer is believed to be somewhat representative of the range in conditions that exists within the study area. Consequently, to complete the analysis of Cumulative Impacts, the percentage of well yields identified as insufficient given a certain criteria (either 0.6 gpm or 3.5 gpm) in the analysis of 540 exempt wells was translated to the 3,342 wells across the entire study area. Effectively, this means that under Existing Conditions (Alternative 1), using a criterion of acceptable yield as either greater than or equal to 0.6 gpm, one percent of existing wells, or 33 wells across the study area, are currently defined as having insufficient yield. Under the implementation of Alternatives 2, 4, and 6, with a maximum predicted decline in the shallow aquifer of 6 to 7 feet (and using the same 0.6 gpm criterion for acceptable yield), implementation of the EIS alternatives would result in an additional 2 to 3 percent of exempt wells across the study area with insufficient yield. This translates to the total number of wells experiencing insufficient yield (primarily in the shallow aquifer) as a result of the EIS alternatives to between 77 (Alternative 4) and 100 (Alternative 2).

If the definition of an insufficient yield is changed to reflect a well yield equal to or less than 3.5 gpm, then implementation of the EIS action alternatives would result in a 4.7 percent (Alternatives 2 and 4) to 5.3 percent (Alternative 2) increase in exempt wells with insufficient yield in the shallow aquifer. Across the study area, this equates to between 157 wells (Alternatives 2 and 4) to 177 wells (Alternative 2) that would experience insufficient yield.

Non-Exempt (Public) Water Supply Wells

Under the water level declines predicted by the Ecology 2003 model, non-exempt (public) water supply wells will lose a portion of their yield, but will still maintain production capacity yields. While this is different than for exempt wells (a percentage of which will lose their yield entirely, as discussed above), for non-exempt (public) water supply wells whose yields are larger, the implications and impacts of any of the action alternatives are significant. Silberhorn Wellfield production wells were estimated to lose a cumulative production capacity of 62 to 68 gpm. The Loma Vista Wellfield is predicted to experience a total decline in production of 196 to 214 gpm, and the Carlborg Well could experience a 57 to 72 gpm decline in capacity. The cumulative decline in well yield for the Sunland Water District (Domestic Wells #1 and #2) is predicted to be approximately 45 to 55 gpm.

Over the past 7 to 10 years, there has been a decline in observed shallow aquifer levels (Section 5.3.2, Thomas et al. 1999, Pacific Ground Water Group 2002a). This decline is likely due to a combination of factors, including increased withdrawals for exempt and non-exempt water supplies. Since the Thomas study period, numerous additional wells have been drilled in the shallow aquifer (Ecology well database). It is probable that the shallow aquifer levels will continue to decline due in part to increased withdrawals. The predicted ground water level decline likely with the implementation of any of the action alternatives should be considered as a cumulative additional impact to the shallow aquifer in this context.

5.3.5 Water Rights

An effort was made to map the distribution of ground water certificates, permits, and claims in the project area. A total of 237 water permits and certificates and 697 claims were found in Ecology's WRATS database. Figure 5.3-14 plots the distribution of the allotted annual withdrawal (Qa) in acre-feet per township, range, and section. No assessment has been performed as to the actual use under these rights, or whether some rights may have been relinquished through non-use.

Currently, 13,721 acre-feet per year of ground water certificates and permits for annual ground water withdrawal have been issued within the study area. Figure 5.3-14 illustrates the distribution of ground water certificates and permits (annual volumes) as compared to the predicted average annual water level declines for the shallow aquifer under Alternative 2 (the most conservative scenario). West of Sequim and east of the Dungeness River, a large volume of ground water permits and certificated withdrawals (1,936 acre-feet per year) are situated within the area predicted by the Ecology 2003 model to experience the maximum water level decline (6 to 7 feet). Given the overlap of certificated/permitted withdrawals with the area of greatest predicted water level decline, it is likely that some impairment of certificated rights may occur. However, because the water rights database cannot currently be correlated with the wells database used to complete the exempt well yield analysis, a more quantitative assessment of water rights impacts is difficult.

A comparison of non-exempt (public) water supply system annual permitted/certificated withdrawals (Qa values from Ecology's WRATS database) with available 1996 ground water extraction data for non-exempt water supply systems (Table 4.3-6) was completed. For the majority of non-exempt (public) water supply systems, 1996 well withdrawals were below the certificated or permitted right for these systems.

An effort was also made to review the distribution of ground water claims (number of claims per township, range, and section). However, because the majority of claims listed did not have discharge volumes (Qi or Qa) associated with them, their relevance could not be assessed (see Figure 5.3-15).

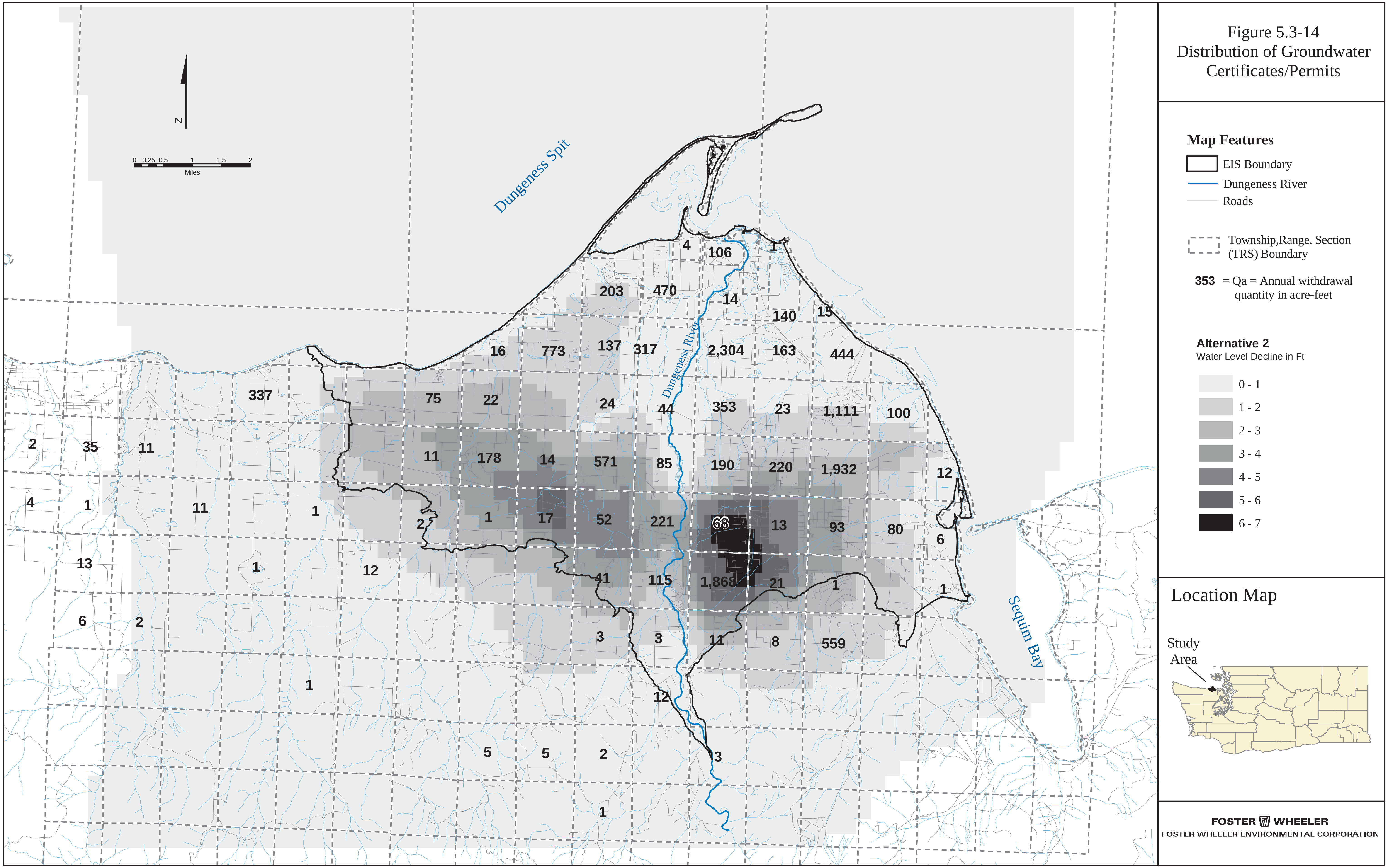


Figure 5.3-14
Distribution of Groundwater Certificates/Permits

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5.3.6 Water Quality

This section discusses the potential effects of implementation of the Conservation Plan on water quality in the project area. Water quality in the Dungeness River, its tributaries, the independent creeks in the area, and the ground water in the planning area is described and analyzed.

Dungeness River

The water quality issues in the project area are complex. There are insufficient data available to determine the sources, transport pathways, and fate of the pollutants of concern within the project area. Detailed studies such as the fecal coliform TMDL study (Sargeant 2002) and the USGS ground water study (Thomas et al. 1999) did not pinpoint the sources of fecal coliform in surface waters or nitrates in ground water. The interaction between the shallow aquifer and the surface waters in the project area is complex, with alternating sections of streams losing or gaining water from the shallow aquifer, making it difficult to trace contaminant pathways. The extensive modifications to the hydrologic system (including diversions, ditches, tailwater flows, irrigation, and ground water pumping) further complicate the issue.

In particular, fecal coliform levels are difficult to predict. Because bacteria are living organisms, they multiply under favorable conditions (warmth, nutrients, substrate) and die off under unfavorable conditions (cold, sunlight, adsorption). They can be transported with sediment and organic material, deposited, and resuspended or transported during a runoff event. There can be a high concentration source of fecal coliform in the watershed that acts as a point source to a stream for the period of time that the source is present or conditions are favorable for fecal coliform growth. More continuous (although episodic) loading occurs from leaking septic systems that contribute to shallow ground water or directly to streams. Other sources of pollutants include, but are not limited to, stormwater and animal access to streams and ditches.

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Other existing plans could be implemented (Table 3.3-1, Current Conditions) including the continued implementation of the TMDL Water Cleanup Plan and associated Clean Water Strategy (Hempleman and Sargeant 2002), the Dungeness Bay TMDL (Sargeant 2002), and various salmon recovery efforts that may affect water flows in ditches and streams. If the TMDL goals were aggressively pursued within the project area, water quality in the Dungeness River would be expected to improve. However, increased development within the project area could contribute to water quality problems as the density of residential land use increases. Increases in impervious surfaces, storm water runoff, septic systems, pet waste, fertilizer use on lawns and gardens, and private wells could exacerbate water quality problems in the area under all of the alternatives. Streamflow would remain low during late summer and early fall, leading to higher concentrations of pollutants in the Dungeness River and other surface waters.

Water Quality Issues Common to All Action Alternatives

The action alternatives propose to increase the efficiency of the irrigation water conveyance system through improvements such as piping ditches, installing re-regulation reservoirs, and other improvements. As described in the surface and ground water sections, these improvements would alter the flow of water in streams and ditches and the exchange between the surface and the shallow aquifer. The action alternatives would not change the causes of water pollution in the project area, but could affect the transport, routing, timing, and concentrations of potential pollutants.

There is insufficient information available to analyze or predict water quality effects from the action alternatives quantitatively. The following assumptions were used for estimating potential effects:

- Piping ditches isolates them from potential sources of fecal coliform.
- Reducing tailwater returns to streams would reduce fecal coliform loading.
- Piping ditches would reduce storm water capture and routing into streams.
- Late summer/fall low flows would decrease in some areas due to reduction in the ground water contribution and tailwater returns, which would exacerbate water quality problems.
- Nitrate concentrations would increase in areas with lower ground water discharge.

Alternative 2 – Full Plan Implementation

Water quality of the Dungeness River would be expected to improve under this alternative because of the overall increases in flows and reductions in contributions from ditches. The Ecology 2003 model predicts that flow in the Dungeness River would increase up to 36 cfs during low-flow periods with the implementation of Alternative 2 (see Table 5.3-4). Matriotti Creek and several ditches are noted as significant sources of fecal coliform to the Dungeness River. By reducing tailwater returns and potential storm water capture by ditches that directly or indirectly contribute to the Dungeness, fecal coliform loading could be reduced, particularly during the irrigation season.

Alternative 4 – Economic Efficiency

For the Dungeness River, this alternative would be similar to Alternative 2, with slightly lower flows in the Dungeness. The Ecology 2003 model predicts that flow in the Dungeness River would increase 10 to 30 cfs during low-flow periods with the implementation of Alternative 4 (see Table 5.3.4). This is 2 to 4 cfs less than Alternative 2.

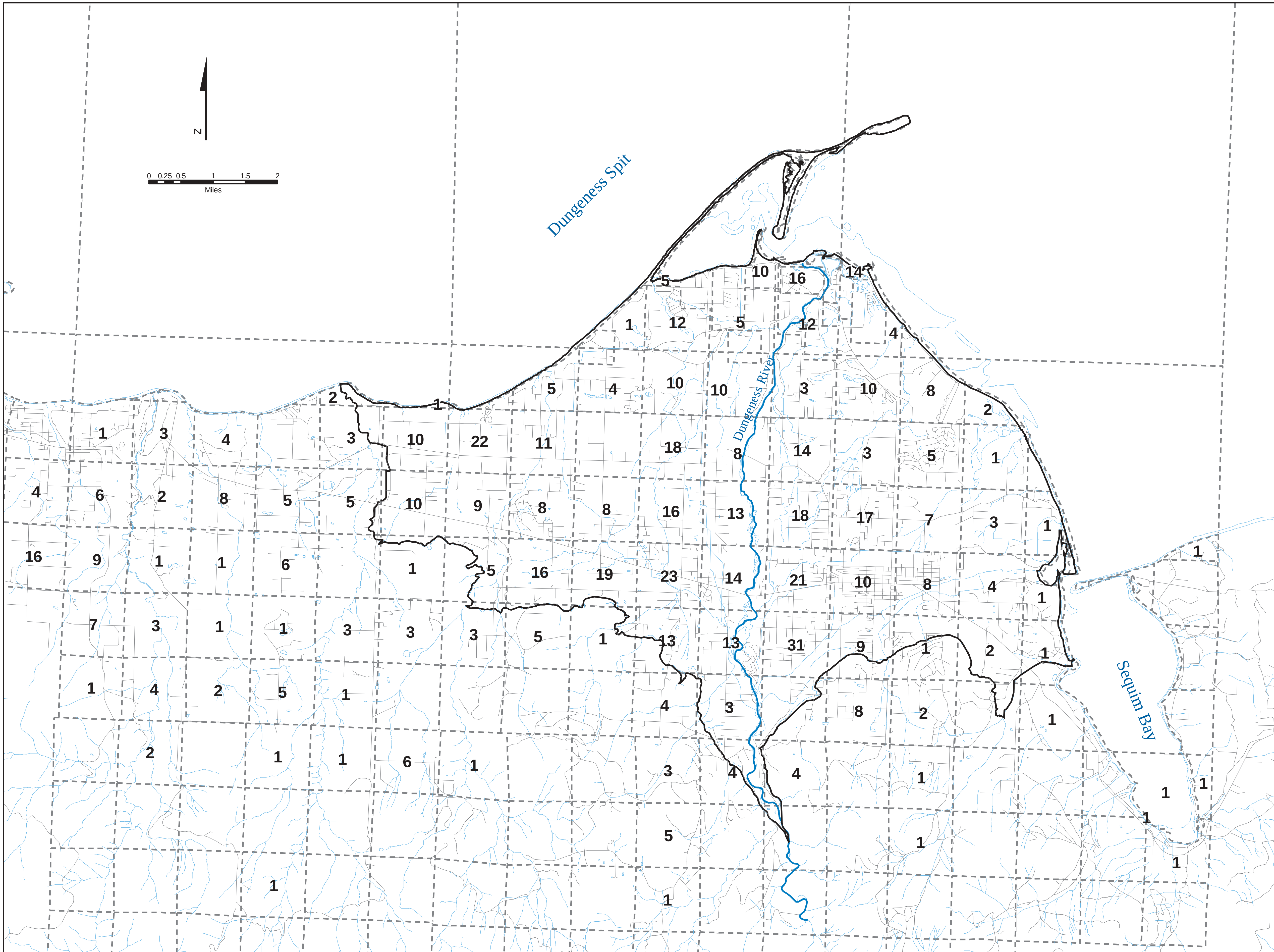
Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

For the Dungeness River, this alternative would be similar to Alternative 2, with slightly lower flows in the Dungeness. The Ecology 2003 model predicts that flow in the Dungeness River would increase 10 to 31 cfs during low-flow periods with the implementation of Alternative 6 (see Table 5.3.4). This is 2 to 3 cfs less than Alternative 2.

Cumulative Impacts

Implementation of any of the action alternatives would not alter any sources of pollution, although it may alter pathways for that pollution to reach either surface or ground water. The sources of pollution themselves are being actively addressed by Clallam County and others with education and intervention programs. A cleanup strategy has been written and will be implemented in the near future (Hempleman and Sargeant 2002). The action alternatives all reduce diversion and therefore leave more water in the Dungeness River, especially during low flows of summer and fall. This would increase water volume and decrease pollutant concentrations relative to the current situation. The increase in streamflow in the Dungeness River would dilute pollutants and provide more fresh water directly to the Dungeness Bay at the mouth of the river.

Figure 5.3-15
Distribution of Groundwater Claims



Map Features

- EIS Boundary
- Dungeness River
- Roads
- Township, Range, Section (TRS) Boundary

Location Map

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Small Streams

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.3-1 Current Conditions), including the continued implementation of the Clallam County Cleanup Plan and associated Clean Water Strategy (Hempleman and Sargeant 2002), the Dungeness Bay TMDL (Sargeant 2002), and various salmon recovery efforts that may affect water flows in ditches and streams. If the TMDL goals are aggressively pursued within the project area, water quality in project area streams would be expected to improve. However, increased development within the project area could contribute to water quality problems as the density of residential land use increases.

Alternative 2 – Full Plan Implementation

Section 5.3.2 describes the changes in flow expected for streams for which data are available (no data for Johnson Creek) in the project area. Based on the Ecology 2003 model results, flow is expected to decrease in McDonald, Cassalary, Gierin, Bell, Meadowbrook, and Mattriotti Creeks due to decreased tailwater and/or ground water contribution (see Table 5.3-8). Decreases in flows, particularly during the low-flow season, could exacerbate water quality problems due to the effects of reduced dilution. This would be offset by a reduction in tailwater flow in some creeks (Bell, Cassalary, and Meadowbrook) that could be contributing fecal coliform and other pollutants. For parameters such as temperature, pH, and dissolved oxygen in particular, lower flows would be expected to decrease the water quality. See Table 5.3-16 for effects of the alternatives.

Alternative 4 – Economic Efficiency

This alternative would not pipe as many ditches as Alternative 2. As a result, the ground water contribution to streams in the project area, would not be reduced as much as in Alternative 2. This would result in higher low flows and result in less of an impact on water quality than Alternative 2. Based on the Ecology 2003 model results, flow is expected to decrease in Meadowbrook, Cassalary, Gierin, Bell, and Mattriotti Creeks due to decreased tailwater and/or ground water contribution (see Table 5.3-10).

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

Alternative 6 would pipe all ditches except for those associated with Gierin Creek, Graysmarsh, Siebert Creek, and Bell Creek. This alternative would result in an additional 2.49 cfs of recharge to the shallow aquifer due to conveyance loss. This alternative would maintain flows in Gierin and Siebert Creeks, which currently have relatively good water quality, and would allow some aquifer recharge in the area north and east of Sequim; this alternative could potentially reduce water quality degradation effects associated with reduced flows in streams in that area. Based on the Ecology 2003 model results, flow is expected to decrease in McDonald, Meadowbrook, Cassalary, Bell, and Mattriotti Creeks due to decreased tailwater and/or ground water contribution (see Table 5.3-11).

Cumulative Effects

The effects of the action alternatives could both reduce water availability for dilution purposes in small creeks, especially in late summer, and eliminate opportunities for pollution to enter surface waters. Other activities in the planning area could add to pollutant loading, including continued residential development with its associated fertilizer loading, increases in impervious surfaces, and increasing numbers of exempt wells and septic systems. Fecal coliform loading has been examined through the TMDL process (Hempleman and Sargeant 2002, Sargeant 2002) and will likely decrease as programs to reduce levels in the watershed are implemented.

Ground Water

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Other existing plans could be implemented (Table 3.3-1 Current Conditions) including the continued implementation of the Sequim-Dungeness Water Quality Cleanup Plan and associated Clean Water Strategy (Hempleman and Sargeant 2002), the Dungeness Bay TMDL (Sargeant 2002), and various salmon recovery efforts that may affect water flows in ditches and streams. However, increased development within the project area could contribute to water quality problems as the density of residential land use increases. Increases in impervious surfaces, storm water runoff, septic systems, pet waste, fertilizer and chemical use on lawns and gardens, and private wells could exacerbate ground water quality problems in the area. Maintaining current levels of artificial ground water recharge of about 38.36 cfs would not contribute to further degradation of water quality. However, open ditches will continue to provide a pathway for pollutants, especially fecal coliform and surface-derived nitrates, to enter the ground water.

Issues Common to All Action Alternatives

Ground water quality problems (nitrate and fecal coliform) are known to occur around Agnew and north of Sequim, and potential problem areas were noted in the area around Carlsborg. All of the action alternatives reduce the amount of ground water recharge from the irrigation system. Results for predicted water quantity changes from the Ecology 2003 model are available for Alternatives 2, 4, and 6. Reductions in ground water recharge could degrade ground water quality by reducing the dilution of pollutants in the shallow aquifer. Reductions in ground water recharge might also lead to increased saltwater intrusion, particularly in areas of coastal development that are supplied by wells, including land adjacent to Dungeness Bay and Sequim Bay are areas identified as having potential saltwater intrusion problems. However, because ground water levels are predicted to decline less than one foot in these areas, it is unlikely that any of the action alternatives would significantly contribute to saltwater intrusion.

The TMDL study for the lower Dungeness River (Sargeant 2002) looked at the lower 3.2 river miles of the Dungeness River for fecal coliform loading. It was based on samples taken along the river and in tributaries and ditches as well as in ditches that discharge to salt water. It identified particular ditches and tailwaters that probably significantly contribute to fecal coliform loading. All of those ditches are treated equally under all alternatives; that is, they are proposed for pipelining in all action alternatives. The only exception is a single ditch in the Clallam Company, labeled C-3 in the Conservation Plan, which would not be piped under Alternative 4 and might continue to provide a pollution pathway from surface water runoff directly to Matriotti Creek. There is no substantial difference among the action alternatives in terms of pollution pathway changes.

Table 5.3-16. Surface Water Quality Comparison Across Alternatives

WaterBody	Alternative 1/Current Concerns	Alternative 2	Alternative 4	Alternative 6
Dungeness River	Fecal coliform – Exceeded during irrigation season at one site; exceeds shellfish growing area standards pH – Exceeded standard in three samples (Sargeant 2002) 303(d) listed for instream flow, TMDL completed for fecal coliform	Flows would increase approximately 12 to 34 cfs during low-flow months. See Table 5.3-4. Fecal coliform would likely decrease due to reduction in tailwater returns. Effect on pH is unknown.	Flows would increase approximately 10 to 30 cfs during low-flow months. See Table 5.3-4. Fecal coliform would likely decrease due to reduction in tributary tailwater returns. Effect on pH is unknown.	Flows would increase approximately 10 to 31 cfs during low-flow months. See Table 5.3-4. Fecal coliform would likely decrease due to reduction in tributary tailwater returns. Effect on pH is unknown.
Meadowbrook Creek	Fecal coliform – Most samples did not meet standards Temperature – Five exceedences pH – Five readings below standards DO – Five readings below standards (Sargeant 2002)	Flows would decrease by at least 0.5 cfs from captured tailwater. Temperature, DO, and pH problems would likely intensify due to lower flows. Reduction in tailwater would likely mitigate some of the effects, and reduce fecal coliform loads.	Similar to Alternative 2.	Similar to Alternative 2.
Meadowbrook Slough	Fecal coliform – About half of the sampling locations met standards Temperature – Five exceedences pH – Five readings below standards DO – Three readings below standards (Sargeant 2002)	Alternative 2 would likely have a negligible effect on Meadowbrook Slough unless more water is allowed to flow through it.	Same as Alternative 2.	Same as Alternative 2.
Cooper Creek	Fecal coliform – Did not meet standards Temperature – Two samples did not meet standards pH – One sample was below standard (Sargeant 2002)	Flows were not modeled in this creek; however, the ground water is predicted to drop 0 to 1 foot in this vicinity. There are no ditches near or connecting to this stream, so changes in water quality from this alternative are not likely.	There are no ditches near or connecting to this stream, so changes in water quality from this alternative are not likely.	There are no ditches near or connecting to this stream, so changes in water quality from this alternative are not likely.

Table 5.3-16. Surface Water Quality Comparison Across Alternatives

Water Body	Alternative 1/Current Concerns	Alternative 2	Alternative 4	Alternative 6
Golden Sands Slough	Temperature – Seven exceedences (Sargeant 2002)	Due to its location, this slough is not expected to be affected by this alternative.	Due to its location, this slough is not expected to be affected by this alternative.	Due to its location, this slough is not expected to be affected by this alternative.
Matriotti Creek, Tributaries, and Ditches	Fecal coliform – Major source of fecal coliform to Dungeness; only 12 out of 46 sampling locations/periods met standards pH – Two samples exceeded the standard; one sample was below the standard DO – Two samples were below the standard (Sargeant 2002) 303(d) listed for fecal coliform, TMDL completed	Ecology 2003 model predicts a 38% decrease in ground water in addition to reductions in tailwater contribution to the creek. See Table 5.3-7. DO and pH problems would likely intensify due to lower flows. Reduction in tailwater flows from tributaries would likely mitigate some of the effects, and reduce fecal coliform loads. Pathway for pollutants to enter surface water in ditches would be largely eliminated, thus reducing fecal coliform pollution.	Slightly higher flows and reduced tailwater inflow could result in slightly higher water quality than Alternative 2. Ecology's 2003 model predicts a 32% decrease in ground water in addition to reductions in tailwater contribution to the creek. See Table 5.3-8.	Same effects as Alternative 2.
Hurd Creek	Fecal coliform – Standards met during wet season and annually, exceeded during irrigation season (Sargeant 2002)	Hurd Creek was not modeled in 2003; however, the ground water is predicted to drop 0 to 1 foot in the vicinity of lower Hurd Creek and 1 to 2 feet in the vicinity of upper Hurd Creek.	Alternative 4 does not propose to pipe the ditches closest to Hurd Creek, which could result in higher flows and better water quality (than Alternative 2) if the water quality is maintained in the ditch.	Similar to Alternative 2.
Bell Creek	Fecal coliform – Numerous samples, all exceeding standards collected between 1985 and 1991 (Ecology 2000) DO – Standards exceeded during summer months Ammonia – One sample exceeded the acute standard out of 25 measurements (City of Sequim 2001) 303(d) listed for fecal coliform	Tailwater return flows would decrease by 0.3 cfs. This would have a negative impact on water quality during low-flows. Ecology 2003 model predicts a 4% (-0.1 cfs) decrease in ground water contribution to flow. See Table 5.3-7.	Same as Alternative 2.	This alternative would have little effect on the water quality of Bell Creek. Most of the flow would be maintained, as well as tailwater returns.

Table 5.3-16. Surface Water Quality Comparison Across Alternatives

Water Body	Alternative 1/Current Concerns	Alternative 2	Alternative 4	Alternative 6
Cassalary Creek	Fecal coliform – Three samples collected in 1991 exceeded the standard (Ecology 2000) 303(d) listed for fecal coliform	Ecology 2003 model predicts a 11% (-0.4 cfs) decrease in ground water contribution to flow in addition to reduction in tailwater. See Table 5.3-7. Reduction in tailwater would likely mitigate some of the effects of lower flows, and potentially reduce fecal coliform loads.	Similar to Alternative 2.	Compared to Alternative 2, only one less ditch in the Cassalary Creek watershed would be piped. It is uncertain whether this change would affect water quality.
Gierin Creek	Potentially affected by animal waste (Haring 1999)	Ecology 2003 model predicts a 13% (-0.1 cfs) decrease in ground water contribution to flow. See Table 5.3-7.	Similar to Alternative 2.	This alternative would have little effect on the water quality of Gierin Creek. Most of the flow would be maintained, as well as tailwater returns.
Bear Creek	Sediment – At high flows, water and sediment can flow through Agnes Irrigation system channels into Bear Creek (Haring 1999)	Bear Creek would be unaffected by this alternative.	Bear Creek would be unaffected by this alternative.	Bear Creek would be unaffected by this alternative.
McDonald Creek	Fecal coliform – Potentially elevated levels Temperatures – Exceeded at one location (Haring 1999)	Ecology 2003 model predicts a 4% (-0.1 cfs) decrease in ground water contribution to flow. See Table 5.3-7. There are no proposed reductions in tailwater return flow. Lower flows could degrade water quality, particularly temperature and fecal coliform.	Ecology 2003 model predicts no change in ground water contribution to flow under this alternative. Higher flows and reduced tailwater inflow could result in slightly higher water quality than Alternative 2.	Same effects as Alternative 2.
Siebert Creek	Low levels of fecal coliform with fair to good temperature conditions (Haring 1999)	Ecology 2003 model predicts no change in ground water contribution to flow under this Alternative. See Table 5.3-7. There are no proposed reductions in tailwater return flow. Lower flows could degrade water quality, although there are no current problems.	Water quality is not likely to be affected. No predicted change in ground water contribution to flow.	This alternative would have little or no effect on Siebert Creek. No predicted change in ground water contribution to flow.

Alternative 2 – Full Plan Implementation

Alternative 2 would reduce ground water levels the most of any of the alternatives—up to 7 feet in some locations (See Figure 5.3-3 for steady state and Figure 5.3-4 for August 1996 transient data). The predicted areas of greatest decline, the area north of Sequim and the area west of the Dungeness River, are areas of recognized water quality problems. If nitrate loading levels from the surface remain the same, there is a potential for nitrate concentrations in the shallow aquifer to increase due to reduction in water volume for dilution from the irrigation system (Thomas et al. 1999).

Alternative 4 – Economic Efficiency

Alternative 4 would not reduce conveyance loss as much as Alternative 2, and would result in maintaining an artificial 4.94 cfs recharge to the aquifer. Figure 3.3-2 shows the locations where the ditches would be piped or left unchanged. Some recharge would still likely continue even in the areas of greatest decline described in Alternative 2, which would reduce potential ground water degradation in those areas relative to Alternative 2. See Figure 5.3-5 for steady state and Figure 5.3-6 for August 1996 transient model results, with predicted decline in shallow aquifer water levels.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

Alternative 6 would pipe all ditches except for those associated with Gierin Creek, Graysmarsh, Siebert Creek, and Bell Creek (see Figure 3.2-3). This would result in maintaining an artificial recharge of about 2.48 cfs of ground water from conveyance loss, mostly in the area north of Sequim. This could result in less ground water decline in the area north of Sequim than Alternative 2, and a corresponding reduction in potential ground water degradation in that area. This alternative would not likely affect potential ground water degradation in other areas and would be similar to Alternative 2 in those areas. See Figure 5.3-7 for steady state and Figure 5.3-8 for August 1996 transient model results, with predicted decline in shallow aquifer water levels.

Cumulative Effects

The effects of the action alternatives in combination with other actions occurring on the watershed could cause further degradation in shallow ground water quality. Continued residential development with its associated nitrogen loading, domestic use of chemicals, increases in impervious surfaces, and increasing numbers of exempt wells and septic systems would be expected to reduce ground water recharge and increase loading of potential contaminants. Nitrate levels in the shallow aquifer are below standards but have been increasing, particularly in areas of ground water level decline (Thomas et al. 1999). Saltwater intrusion has not been a serious issue yet, but decreases in ground water recharge and increased consumption along the coast could lead to problems. However, this project does not reduce ground water heads significantly along the coast.

5.4 Vegetation and Land Cover

Because none of the action alternatives would alter general vegetation or land cover in the water supply planning area, this section discusses the potential effects on wetlands in general. A specific discussion of the potential effects of each alternative on project area wetlands follows.

5.4.1 General Effects on Wetlands

Direct discharges from irrigation systems and increased water table levels from leaking irrigation ditches provide an artificial supply of water to many wetlands in the project area (CCDCD 1995, PSCRBT 1991). Over the last 100 years, irrigation has altered ground water recharge and discharge, enhanced streamflow, and augmented or created wetlands. Irrigation, tailwater, irrigation runoff, and increased ground water levels due to irrigation each potentially provide water to wetlands. The natural runoff patterns that fed streams and wetlands also have been altered through farming and development in the area.

Changing the source water of a wetland can be expected to have an effect on the wetland condition and possibly on its vegetation and functions. The type and extent of the effect depends on the specific environment of the wetland. Most wetlands have more than one source of water, such as ground water and precipitation or subsurface flow and precipitation. The frequency, duration, and timing of saturation or inundation in wetlands could be influenced by changes in water source.

In Section 4.4.2, the wetlands in the project area were categorized according to their primary source of water. As discussed below, the alternatives may have an effect on the ground water and/or on the surface water supply to the wetlands. Subsequent sections examine how these changes in water supply could affect hydrophytic vegetation and, in turn, its ability to perform some functions. Changes to hydrologic, biogeochemical, and habitat functions are discussed in general. Finally, a discussion of the effects on wetlands in the project area from implementation of the alternatives is presented.

General Effects on Wetland Water Sources

According to the Clallam County database, the shallow aquifer (ground water) is a major source to 75 percent of the wetland acreage in the project area and most of the wetlands larger than 100 acres (Figure 4.4-5). Reduction in the level of the aquifer would be expected to reduce the water supply to these wetlands. The changes to the depth of ground water are presented in Section 5.3. In general, the 2003 ground water model predicts that the proposed actions are expected to reduce the ground water level in the shallow aquifer in the project area by amounts varying between 0 and 7 feet.

The wetlands that are not supplied by ground water are primarily perched wetlands supplied by surface and shallow subsurface flows. They represent 25 percent of the acres of wetland in the project area and 49 percent of the wetlands less than 100 acres. They occur mostly in the southern and western section of the project area (Figure 4.4-5). The shallow subsurface flows, or interflow, that are not part of the aquifer are not large enough to be evaluated in the ground water model. These subsurface flows in the project area would generally be supplied by precipitation, irrigation, and storm water. If the water sources are depleted due to reduced leakage and tailwater, the wetland hydrologic regime can be expected to change during the irrigation season. This would not affect water levels during other months. The continued use of irrigation for agriculture and landscape amenities would allow some of the source to remain in the area. The range of change to an individual wetland could vary considerably, the most severe effect being the elimination of enough source water that the wetland would change to upland. Conversely, there could also be very little visible effect if the change is within the range of tolerance for the dominant plants in a given wetland. However, even if there is little visible change in vegetation, there may be changes to wetland biochemistry and biota that may not be visible and could affect various functions.

General Effects on Vegetation

An evaluation of the hydrologic needs of some of the common wetland plants in western Washington shows that water level fluctuations and water depth, in the early and intermediate growing seasons, are key to the development of wetland vegetation. This evaluation shows that forested communities are the driest community types, shrub communities are the next driest, and emergent are the wettest of the community types (Cooke and Azous 1996). This agrees with the general descriptions of wetland communities in Cowardin et al. (1979) and those used in a Washington State Department of Natural Resources (WSDNR) classification of freshwater wetland vegetation (WSDNR 1994). Each community type can tolerate a range of water level fluctuations. Generally, shrub wetlands are the most tolerant, while emergent wetlands have a more narrow range of tolerance. Northwest forested wetlands have relatively narrow hydrologic fluctuations because the water depths generally fluctuate near or at the soil surface (Cooke and Azous 1996). Each plant species also has a tolerance range, with the more common species generally having a broader range than the uncommon species.

Changes in water source of a wetland may affect the vegetation type and species composition. Generally, many trees in forested wetlands have developed root systems adapted to seasonal dry periods and may be less affected by reductions in the source of water to a wetland. Emergent wetland species are specifically adapted to inundated or saturated soil conditions. Their extent is likely to be reduced if a wetland loses its source of water. Emergent wetland species may be replaced with emergent upland species or may become shrub communities over time with a loss in water sources. However, individual wetlands with drought-tolerant species may be tolerant of and adapt to new conditions and remain unchanged.

General Effects on Wetland Functions

The reduction in ground water and surface water is likely to result in a reduction in wetland acreage. Wetlands are recognized as important primarily due to the functions that they perform. This is true whether they are historically natural wetlands or if they have been artificially created or enhanced by irrigation in the area. Additional direct effects of the projects on wetland will be evaluated according to the change in potential to perform the functions.

Section 4.4.2 assessed the potential for wetlands to perform functions given their condition today. There is also a component of functional assessment that indicates whether there is the opportunity to perform the function. For example, if the wetland has the soils, vegetation, and hydrologic regime to remove toxins, it has the potential to function. If the area is not developed and toxins do not enter the wetland, there is no opportunity to remove the toxins, but the potential to perform the function remains. It is also notable that there may be a reduction in the potential of a wetland to perform certain functions with a loss in wetland area. However, the area may continue to have the potential to provide aspects of the function as an upland area.

Sediment Removal

This is generally performed by filtration or physical blockage by the vegetation of sediment in water moving through the wetland. The potential for the function to be performed with a reduced source of water generally will not change unless there is a significant change in the vegetation, such as a major change in emergent vegetation. However, if the source of water is reduced or lost, the opportunity to remove sediments may also be reduced or lost because there is less water moving through the wetland. Generally, the ability to perform the sediment removal function remains in the land and can be performed when water is reintroduced. However, the magnitude of sediment removal may depend on the remaining vegetation type.

Nutrient and Toxin Removal

The potential for this function to be performed may be affected by reduction or loss of water source to the wetland. Vegetation and soils would still be present to trap nutrient or toxin bearing sediment. However, a major change in vegetation type may alter the capacity to trap sediments.

Nutrient cycling could be altered by a change in the period of anaerobic conditions and aerobic decomposition. Alternating cycles of anaerobic and aerobic conditions generally enhance the ability of wetlands to perform this function. The potential to perform this function in wetlands that are permanently saturated would increase if periods of aeration were introduced. However, the potential to perform this function may decrease with a reduction in saturation/aeration cycles. Thus, proposed project actions could increase or decrease this function in a given area depending on the extent and duration of saturation prior to and after the implementation. The saturation/aeration cycles are not known for the project wetlands and this aspect of the nutrient and toxin removal function will not be discussed for individual wetlands.

There could also be a loss of opportunity to perform this function. If the source water is reduced and no longer brings nutrients and toxins into the wetland, the opportunity to remove them is lost or reduced.

Peak Flow Reduction

A reduction in source water to a wetland would not affect the geomorphic features that are the primary factors controlling the potential to perform this function. Thus, there should not be a reduction in the potential of a wetland to reduce peak flows and flooding. Also, if water levels are lower in a wetland, its capacity to accept additional water during peak flows may increase. Only the opportunity to perform this function may be reduced with a reduction in water supply in an area. Therefore, this will not be discussed in the individual wetland sections.

Production and Export

A reduction in source water could reduce emergent wetland acreage, a high organic matter production community type. It could also reduce this function by reducing the wetland's ability to export the organic material. If the vegetative cover remains, there would continue to be production, although at a lower rate if the area is significantly drier or if the emergent wetlands are reduced. Additional impact to this function would be a loss or reduction of the mechanism to move the organic matter to adjacent water systems. This effect would be most pronounced in wetlands connected to streamflows as export occurs in moving water.

Ground Water Recharge

The overall recharging of ground water is addressed in the Ground Water section (Section 5.3.2).

General Habitat

This function could be reduced by a change in vegetation types or by a loss of open water in the wetland.

Invertebrates and Amphibians

The amount of open water, interspersal of the open water, and number and interspersion of vegetation are the factors influencing invertebrates and amphibians that could be most affected by a reduction in water source. Reduced water could cause a shift in vegetation that may reduce breeding habitat for amphibians. Reduced water may also lead to a shift to terrestrial invertebrates. Other factors, such as development in the wetland or its buffer or the availability of plant litter, would not be affected by the proposed alternatives. Thus, habitat quality for invertebrates and amphibians could be affected by the proposed actions in wetlands with open water.

Anadromous Fish and Resident Fish

If the loss of the water source reduces the water in a stream in a wetland, the habitat for fish could be reduced. This effect is addressed in the Fisheries section (Section 5.5).

Wetland Birds

A reduction in source water to a wetland could result in a loss of open water, a change in vegetation structure, or a loss of food sources. These changes could reduce the potential for an individual wetland to provide habitat for wetland-related birds. Other factors related to wetland bird habitat, such as the wetland's proximity to a stream or the Strait of Juan de Fuca or development in the wetland or its buffer, would not change with the proposed alternatives. This effect is also discussed in the Wildlife section (Section 5.5).

Wetland Mammals

If the source water were reduced by enough to reduce the amount of open water or the interspersal of the water within the wetland, there would be an effect on wetland mammal habitat. Other factors, such as development in the wetland and its buffers, and connectivity to other wetlands and natural areas would not be affected by the proposed alternatives.

5.4.2 Effect of the Alternatives on Wetlands in the Project Area

The Ecology 2003 model allows for more accurate estimates of the impacts of each of the three action alternatives on the shallow aquifer than the Ecology 1999 model. However, the relationship of the shallow aquifer to each of the wetland complexes is unknown. While some of the wetlands have been delineated in the field, most have been identified through aerial photo interpretation and historical research. The relationship of a wetland to the shallow aquifer is only part of the story. The lower aquifers become artesian and flow to the surface in some places, including Graysmarsh. Thus, the classification of a wetland as ground water-fed does not, by itself, predict the wetland's response to a drop in shallow aquifer level.

Therefore, this section was written from a "worst-case scenario" point of view. It is assumed that the modeled drop in shallow aquifer is directly correlated to a similar drop in wetland water level and water input. This is likely to be an overestimate of the impacts of aquifer level changes on wetlands, but is required under SEPA where the relationship is unknown (WAC 197-11-080).

The Ecology 2003 ground water model included an analysis of changes to the ground water level in the shallow aquifer by month to determine the differences over a year. This transient-state model run shows that the ground water level decline is generally less in the early months of the year and grows during the irrigation season. As described above, wetlands are more sensitive to early and mid-growing season changes than they are to late growing season changes. Table 5.4-1 shows the ground water decline for ground water-fed wetlands in March, June, and September. While there may be a slight difference in ground water level change between the months, it is not likely to create a significant difference in the effect of the alternatives. Therefore, the steady-state run of the Ecology 2003 ground water model, also shown in Table 5.4-1, was used to prepare the effects section below. The greater ground water decline in the steady-state run is related to the inclusion of the aquifer storage capacity in the transient run and not in the steady-state run. See Section 5.3.2 for further explanation.

The following section addresses the effects of the alternatives on wetlands in the project area, discussed in terms of wetlands larger than 100 acres and wetlands less than 100 acres. Figure 5.4-1 shows the location of wetlands relative to the level of decline in ground water for Alternative 2. Because results of the model are very similar for Alternatives 2, 4, and 6 (as explained in Section 5.3), maps were not produced for wetlands for each alternative.

Wetlands Larger Than 100 Acres

Table 5.4-2 provides the average change in ground water in the shallow aquifer in the area of wetlands larger than 100 acres for Alternatives 2, 4, and 6. The model shows that although there may be small, localized effects from piping or not piping a particular ditch, it is the overall impact of the entire alternative that matters to the shallow aquifer levels. At the end of this section, Table 5.4-3 provides a summary of effects on the larger wetlands in the project area.

Table 5.4-1. Ground Water Level Decline in the Shallow Aquifer for Ground Water-Sourced Wetlands

Decline in Ground Water Level (feet)	Acres				Percent of Acres			
	Transient-State			Steady-State	Transient-State			Steady-State
	March	June	September		March	June	September	
Under 1	1,800	1,707	1,760	1,614	86	81	84	77
>1 to 2	256	310	237	237	12	15	11	11
>2 to 3	39	74	92	146	2	4	4	7
>3 to 4	0	5	5	90	0	0	0	4
>4			0	8	0	0	0	0
Total	**2,095**	**2,095**	**2,095**	**2,095**	**100**	**100**	**100**	**100**

Source: Ecology 2003 Ground Water Model, Alternative 2

Table 5.4-2. Average Predicted Decline in Ground Water Level by Alternative in the Wetlands Larger than 100 Acres (feet)

Wetland	Alternative		
	2	4	6
Graysmarsh	1	1	1
Cassalary Creek	<1	<1	<1
Matrotti Creek Complex	<1	<1	<1
Dungeness Estuary	<1	<1	<1
Bell Creek Estuary	<1	<1	<1
Lower Bell	2	2	2
Lower Dungeness	<1	<1	<1
Agnew Perched	Perched, not aquifer-fed		

Source: Ecology 2003 Ground Water Model, weighted average change in feet

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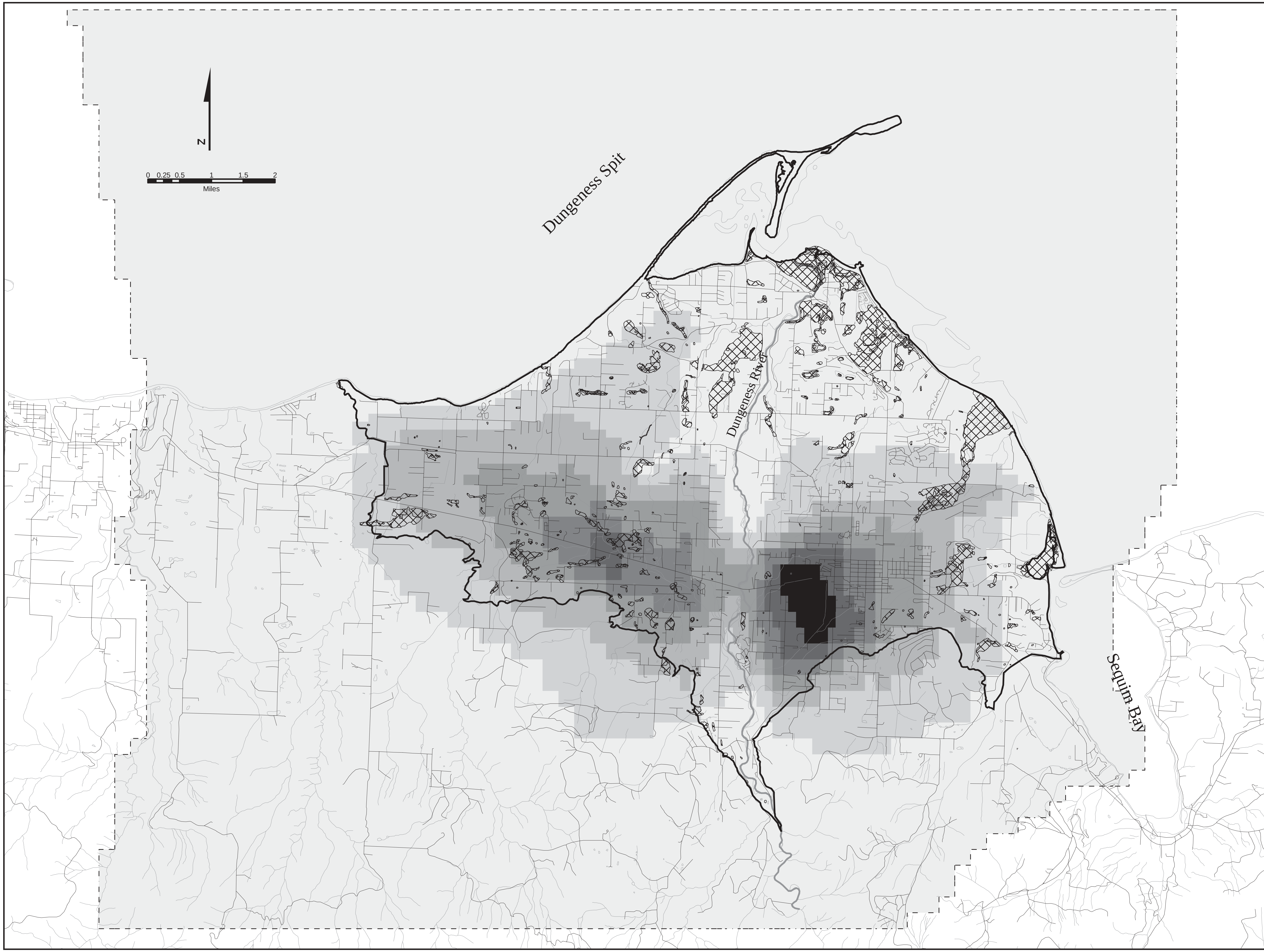
Figure 5.4-1
Modeled Decline in Water Levels for Shallow Aquifer, Steady-State Model Results
EIS Alternative 2



Map Features

- EIS Boundary
- Dungeness River
- Streams
- Wetland
- Roads
- Model Grid Boundary

Alternative 2
Water Level Decline in Ft

- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- 6 - 7

Location Map

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

Q:\projects_2002\dungeness\workdir\maps\maps_jan2003\alt2_diff_bw_wetlands.mxd

Graysmarsh

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

Alternative 2 – Full Plan Implementation

Two sources of predictions are currently available regarding Graysmarsh and Gierin Creek. One is the 2003 ground water model described in Section 5.3. The other is the set of predictions made by AESI (1999) regarding flow changes in Gierin Creek and therefore in Graysmarsh based on a conceptual model of the hydrogeology and results from various prior studies. Both indicate that there would be a decrease in ground water contribution to Gierin Creek and Graysmarsh if all the ditches that contribute ground water to the creek were pipelined, which is the case for Alternative 2.

The 2003 model predicted that the ground water level in the area of Graysmarsh would decline by between zero and three feet (Figure 5.4-1). The emergent wetland area and a portion of the forested area closest to the Strait of Juan de Fuca, approximately 230 acres, is predicted to have a decline in ground water of less than 1 foot. The area further from the Strait of Juan de Fuca, most of the forested or scrub-shrub area, is predicted to experience a larger decline in ground water level, between 1 and 3 feet. The weighted average of decline in ground water for Graysmarsh is approximately 1 foot. The 2003 model also predicted that the ground water contribution to Gierin Creek would be reduced by less than 0.1 cfs, or less than 15 percent of the ground water contribution (Table 5.3-7).

AESI estimated that pipelining and tailwater reduction proposed in the Dungeness-Quilcene Water Resources Management Plan could reduce the source water to Graysmarsh by about half (AESI 1999). A re-regulating reservoir, shown in the Conservation Plan as being implemented within the "approximate ground water zone of contribution to Graysmarsh" as designated by AESI (1999), has since been eliminated from consideration. No reservoir is planned in the "zone of contribution" to Graysmarsh.

The estimates show a loss in source water that would be expected to reduce the length of time that the wetland is saturated and the size of the wetland. The volume of water in ponds and streams would be reduced, especially during the drier months. The large emergent part of the wetland, close to the Strait of Juan de Fuca, may be affected by the altered ground water level. The brackish marsh is in the area with the smallest decline in ground water but it may be affected by less freshwater input from Gierin Creek and ground water. The salinity may extend farther inland during drier months of the year; however, the tidegate restricts saltwater entrance. The species in the emergent plant community, amphibians, and invertebrates would be expected to change with a change in salinity. The altered water supply may affect the emergent plants in the inundated area between the pond and the brackish marsh. The emergent plants may be replaced with other emergent plants or shrubs more tolerant of dry periods. The altered water supply is not expected to significantly affect the forest, scrub-shrub, or barley field vegetation areas of the property.

Table 5.4-3. Summary of the Effects of the Alternatives on Larger Wetlands Potential to Perform Functions

Wetland	Assessment of Potential to Perform Function (Alternative 1)	Effects of Alternatives 2, 4, and 6	Expected Potential to Perform Functions with Implementation of Alternatives 2, 4, or 6
Graysmarsh			
Sediment Removal	Moderate	Minimal to Medium	Moderate to Low
Nutrient/Toxin Removal	Moderate	Minimal to Medium	Moderate to Low
Production & Export	Moderate	Minimal to Medium	Low
General Habitat	High	Minimal to Medium	High to Moderate
Invertebrates/Amphibians	High	Medium to High	Moderate to Low
Wetland Birds	High	Medium	Moderate
Wetland Mammals	High	Medium to High	Moderate to Low
Cassalary Creek			
Sediment Removal	Moderate	Minimal to Medium	Moderate to Low
Nutrient/Toxin Removal	Moderate	Minimal to Medium	Moderate to Low
Production & Export	Moderate	Minimal	Low
General Habitat	Low	Minimal	Low
Invertebrates/Amphibians	Low	Minimal	Low
Wetland Birds	Moderate	Minimal	Moderate
Wetland Mammals	Moderate	Minimal	Moderate
Matriotti Creek Complex			
Sediment Removal	Moderate	Minimal	Moderate
Nutrient/Toxin Removal	Moderate	Minimal	Moderate
Production & Export	Moderate	Minimal	Moderate
General Habitat	Low	Minimal	Low
Invertebrates/Amphibians	Low	Minimal	Low
Wetland Birds	Low	Minimal	Low
Wetland Mammals	Low	Minimal	Low
Dungeness Estuary			
Sediment Removal	Low	Minimal	Low
Nutrient/Toxin Removal	Low	Minimal	Low
Production & Export	Moderate	Minimal	Moderate
General Habitat	High	Minimal	High
Invertebrates/Amphibians	High	Minimal	High
Wetland Birds	High	Minimal	High
Wetland Mammals	High	Minimal	High
Bell Creek Estuary			
Sediment Removal	Low	Minimal	Low
Nutrient/Toxin Removal	Low	Minimal	Low
Production & Export	Low	Minimal	Low
General Habitat	Moderate	Minimal	Moderate
Invertebrates/Amphibians	Moderate	Minimal	Moderate
Wetland Birds	High	Minimal	High
Wetland Mammals	Low	Minimal	Low

Table 5.4-3. Summary of the Effects of the Alternatives on Larger Wetlands Potential to Perform Functions (continued)

Wetland	Assessment of Potential to Perform Function (Alternative 1)	Effects of Alternatives 2, 4, and 6	Expected Potential to Perform Functions with Implementation of Alternatives 2, 4, or 6
Lower Bell Creek			
Sediment Removal	Moderate	Minimal to Medium	Moderate to Low
Nutrient/Toxin Removal	Moderate	Minimal to Medium	Moderate to Low
Production & Export	Moderate	Medium	Low
General Habitat	Moderate	Medium	Low
Invertebrates/Amphibians	Moderate	Medium to High	Low
Wetland Birds	Moderate	Medium	Low
Wetland Mammals	Moderate	Medium to High	Low
Lower Dungeness			
Sediment Removal	Moderate	Minimal	Moderate
Nutrient/Toxin Removal	Moderate	Minimal	Moderate
Production & Export	Moderate	Minimal	Moderate
General Habitat	Moderate	Minimal	Moderate
Invertebrates/Amphibians	Low	Minimal	Low
Wetland Birds	Low	Minimal	Low
Wetland Mammals	Low	Minimal	Low
Agnew Perched (not aquifer-fed – minimal to no impact from any alternative implementation)			
Sediment Removal	High	Minimal	High
Nutrient/Toxin Removal	High	Minimal	High
Production & Export	Low	Minimal	Low
General Habitat	Low	Minimal	Low
Invertebrates/Amphibians	Low	Minimal	Low
Wetland Birds	Low	Minimal	Low
Wetland Mammals	Low	Minimal	Low

In general, Alternative 2 would be expected to affect all wetland functions, principally due to the loss of wetland area. In addition, microhabitats would be altered by lower summer water levels. However, some aspects of the functions can continue to be performed by upland areas. Estimated effects on the potential to perform wetland functions follows.

Sediment Removal: The current potential of Graysmarsh to perform this function was rated moderate. The potential of the wetland to perform this function would be affected if the emergent vegetation is largely replaced with scrub-shrub vegetation. This is not likely in the forested and scrub-shrub areas and is not expected to happen in the emergent areas. The large emergent wetland area lies in the area with the smallest change in ground water. While there may be a change in the amount of emergent vegetation in Graysmarsh, it is not expected to be substantial enough to cause a significant decline in the potential to perform this function. The effects are expected to be minimal to medium depending on the change to the emergent vegetation.

Nutrient and Toxin Removal: The current potential of Graysmarsh to perform this function was rated moderate. While there may be a change in the amount of emergent vegetation in this area, it is not expected to be substantial enough to cause a significant decline in the potential to perform this function. The opportunity to perform this function may also be reduced. The effect is expected to be minimal to medium depending on the change to the emergent vegetation.

Production and Export: The current potential of Graysmarsh to perform this function was rated moderate. The wetland would still produce organic material but the export would be limited by the flow of Gierin Creek. The flow is expected to be reduced, not eliminated, so it would still be able to transport organic material at times. However, primary production in the emergent areas may be reduced. The effect is expected to be minimal to medium depending on the change in production.

General Habitat: The potential for this function was rated high. A reduction in source water could affect vegetation. It may result in less area with emergent wetland plants, but might increase the interspersal of upland and wetland areas within the wetland. The net effect may be neutral. The open water pond and stream might be smaller during the summer. This could reduce the potential for general habitat. The net effect on this function is expected to be minimal to medium depending on the change to the open water component.

Invertebrates and Amphibians: The current potential for this wetland to provide habitat was rated high because of the presence of open water. The reduction in source water might reduce the potential for invertebrate and amphibian habitat. As noted in Section 5.3, salinity may extend farther inland during drier months of the year and could render those areas less suitable as habitat for amphibians and invertebrates that require fresh water. The net effect on this function would be expected to be medium to high depending on the timing and amount of reduction in open or standing freshwater in the summer.

Wetland Birds: The current potential for the wetland to provide bird habitat was rated high. The reduction in source water might result in a smaller pond, stream, and/or an increase in the brackish components of the former estuary at times during the year. An increase in the size of the brackish component of the former estuary should not affect the overall bird habitat because shore birds will forage in saltwater flats as well as freshwater marshes. A loss in wetland habitat for invertebrates and amphibians may reduce the primary food source for birds in freshwater areas. A reduction in water supplied to Graysmarsh may reduce the habitat for individuals/pairs for some bird species. As the water source and vegetation changes, the species distribution or composition may change. Because the alternative is not likely to eliminate the habitat, the effect is judged to be medium.

Wetland Mammals: The current potential for this function was rated high. Open water is necessary for wetland mammal habitat. The reduction in water source may result in a reduction or a loss of habitat. The effect would be medium to high depending on the amount of open water loss.

Alternative 4 – Economic Efficiency

The amount of pipelining would be reduced compared to Alternative 2. In particular, one canal in Alternative 4 (SP-7) in the local area would not be piped. Leakage from this canal is estimated to be less than 10 percent of the total leakage in the local area (Montgomery Water Group, Inc. 1999). Additionally, the general artificial ground water recharge in Alternative 4 is not reduced by as much as Alternative 2 due to fewer piped canals in the project area. The map of the difference in the water level decline between Alternative 2 and 4 (Figure 5.3-7) shows a reduced decline of approximately 1 foot for Alternative 4 in an area south of Graysmarsh when compared with Alternative 2. This area of higher water level for Alternative 4 overlaps with Graysmarsh for approximately 20 acres in the forested and scrub-shrub area of the wetland. While a local difference in the shallow aquifer water levels is shown between alternatives, the Ecology 2003 model predictions for change to the shallow aquifer and the overall weighted average of change by acre are basically the same for Graysmarsh for Alternatives 2 and 4. Therefore, while there may be small, localized differences, the effects to the wetland and its functions are expected to be the same as for Alternative 2.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

This alternative was designed to reduce effects to higher value wetlands and streams, including Graysmarsh. The ditches in the "approximate ground water zone of contribution to Graysmarsh" (AESI 1999) would not be piped, reducing the loss of recharge to the shallow aquifer in the local area. The map of the difference in the water level decline between Alternatives 2 and 6 (Figure 5.3-10) shows a reduced decline for Alternative 6 in an area south of Graysmarsh. The area with about 1-foot reduction overlaps with Graysmarsh for approximately 20 acres in the forested and scrub-shrub area of the wetland. However, the Ecology 2003 model predicts that the change from Alternative 2 would have a minimal effect (average less than 0.5 feet) on ground water levels in the Graysmarsh area. The predictions for change to the shallow aquifer and the overall weighted average of change by acre are basically the same as for Alternative 2. Therefore, while there may be small localized differences, the effects to the wetland and its functions are expected to be the same as for Alternative 2.

<u>*Cassalary Creek*</u>

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

Alternative 2 – Full Plan Implementation

Cassalary Creek is ground water-fed, is not adjacent to irrigation ditches, and is not affected by tailwater flows. When the irrigation canals were shut down from October 1 to 21, 1997, the creek was not found to have lower flows (Montgomery Water Group, Inc. 1999). Canal DD-4 is used to irrigate an area in the vicinity of the western portion of Cassalary Creek wetland for livestock (personal communication, Mike Jeldness, Dungeness River Water Users Association, to Penny Eckert, Foster Wheeler Environmental, October 3, 2002). This is not expected to change for any of the proposed alternatives.

The Ecology 2003 model predicts that full pipelining would reduce the average ground water level in the shallow aquifer in the Cassalary Creek wetland area by less than 1 foot (Figure 5.4-1). The model also predicts a reduction of less than 0.5 cfs, or less than 15 percent of the ground water contribution to Cassalary Creek (Table 5.3-7).

The reduction in the shallow aquifer may result in a shorter time that the wetland is saturated or reduce the size of the wetland. This hydrologic alteration would not likely significantly affect the wetland vegetation because it is predominantly forest, scrub-shrub, or farmed and grazed emergent species. However, primary production in the fields may be reduced due to drier conditions unless the fields could be irrigated. The estimated effects on the potential for this wetland to perform functions are described below.

Sediment Removal: The current potential of Cassalary Creek wetland to perform this function was rated moderate. The potential of the wetland to perform this function would be affected if the emergent vegetation is largely replaced with scrub-shrub vegetation. This is not likely in the forested and scrub-shrub areas. It also is not likely that emergent vegetation in the managed areas (grazed or farmed) would substantially change because they are managed. The effect is expected to be minimal.

Nutrient and Toxin Removal: The potential for the Cassalary Creek wetland to perform this function was rated moderate. Reducing the source of water may affect the emergent component of the wetland and thus affect the ability to trap nutrients or toxins. However, the opportunity to perform this function may also be reduced. The effect of Alternative 2 is expected to be minimal to medium.

Production and Export: The potential for the Cassalary Creek wetland to perform this function was rated moderate. The overall production is not expected to be reduced in the areas of potential export and export is not expected to be reduced significantly. The effect of Alternative 2 is expected to be minimal.

General Habitat, Invertebrates and Amphibians: The potential for Cassalary Creek wetland to perform these functions was rated as low and effects would be minimal.

Wetland Birds and Wetland Mammals: The potential for the Cassalary Creek wetland to provide these functions was rated as moderate. Birds may use the grazed or farmed fields for forage and this habitat would not be likely to be affected by the proposed actions. The other wetland bird and mammal habitat in the wetland is along Cassalary Creek and Cooper Creek. There is expected to be minimal impact to these functions.

Alternatives 4 and 6

Alternatives 4 and 6 are a subset of actions from Alternative 2 and also should not have a significant effect on this wetland's functions. The Ecology 2003 ground water model predicts declines of less than 1 foot in the ground water level in the shallow aquifer in the Cassalary Creek wetland area for Alternatives 4 and 6. This is the same predictions as for Alternative 2 and the effects are expected to be the same.

<u>*Matriotti Creek Complex*</u>

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

Alternative 2 – Full Plan Implementation

Matriotti Creek is not inside this wetland but runs along the northern edge. This wetland is ground water-fed and has tailwater input to the southern edge of the wetland and into Lotzgesell Creek (the west fork of the tributary that flows into Matriotti Creek). The tailwater flow is limited to the irrigation season and is estimated to be 0.37 cfs. The tailwater would be greatly reduced or eliminated by the installation of a re-regulating reservoir. The Ecology 2003 model predicts that full pipelining would reduce the average ground water level in the shallow aquifer in this wetland area less than 1 foot (Figure 5.4-1). There are no data available for the ground water input for the tributary that flows through this wetland. However, nearby Matriotti Creek flows into the Dungeness River and is expected to experience a reduction in ground water input of 1.3 cfs, or 39 percent of the ground water contribution to the creek.

The decline in ground water, combined with the reduction in the tailwater source of water during the irrigation season is likely to affect the wetland complex. It may either have a much shorter wet period or lose much of its area. The hydrologic alteration would not likely significantly affect the wetland vegetation because it is predominately farmed and grazed. However, primary production in the fields may be reduced due to drier conditions unless the fields could be irrigated. The effects on the potential for this wetland to perform functions are expected to be as follows.

Sediment Removal and Nutrient and Toxin Removal: The potential of the Matriotti Creek wetland to perform these functions was rated moderate. Losing a large portion of the wetland's source of water is not likely to affect vegetation and its ability to remove sediment, nutrients, or toxins, but the opportunity to perform this function would likely be reduced. The effect is expected to be minimal.

Production and Export: The potential of the Matriotti Creek wetland to perform these functions was rated moderate. The overall production and export is not expected to be reduced significantly because it is largely managed vegetation. The effect is expected to be minimal.

General Habitat, Invertebrates and Amphibians, Wetland Birds and Mammals: The potential for the Matriotti Creek wetland to perform these functions was rated as low and any effect would be minimal.

Alternative 4 – Economic Efficiency

One canal just below the southern tip of the wetland (C-5) would not be piped in this alternative. The leakage from this canal is small (0.04 cfs) but may have some direct effect on the lower edge of the wetland. The Ecology 2003 model predicts the decline in the ground water level of the shallow aquifer in the Matriotti Creek wetland area to be less than 1 foot in Alternative 4. This is the same prediction as in Alternative 2 and the effects are expected to be the same.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

All canals and ditches with local ground water recharge that probably directly influences the Matriotti complex wetlands would be piped under Alternative 6, as they would be in Alternative 2. The Ecology 2003 model predicts the decline in the ground water level of the shallow aquifer in the Matriotti Creek wetland area to be less than 1 foot in Alternative 6. This is the same prediction as in Alternative 2 and the effects are expected to be the same.

Dungeness Estuary

The Dungeness estuarine wetland is open to salt water and is affected by tidal and wave action. The portion of the wetland that is further upstream is also influenced by the river and by ground water. The Ecology 2003 ground water model predicts that full pipelining would reduce the average ground water level in the shallow aquifer in this wetland area by less than 1 foot in Alternatives 2, 4, and 6. The alternatives show an increase in flow in the Dungeness River that would influence the area of the wetland adjacent to the stream . The majority of the wetland would not be affected by the freshwater hydrologic changes because it is open to and affected by the tides. There may be an effect in the upstream area where there is less tidal influence. It is not expected to be substantial considering the overall size of the wetland influenced by tides, the small reduction in the ground water level in the area, and the increase in Dungeness River flow. These factors suggest that the effects of Alternatives 2, 4, and 6 would be minimal.

Bell Creek Estuary

Bell Creek estuary is almost entirely open to salt water and is primarily affected by tidal and wave action. The small portion of the wetland at the mouth of Bell Creek is influenced by the creek and ground water. The Ecology 2003 model predicts that the average ground water level in the shallow aquifer in the Bell Creek estuary area would decline by less than 1 foot in Alternatives 2, 4, and 6. The Ecology 2003 model predicts that ground water input to Bell Creek would be reduced by less than 10 percent, or 0.2 cfs, in Alternatives 2, 4, and 6. The majority of the estuarine wetland would not be affected by freshwater hydrologic changes because it is open to and primarily affected by the tides. There may be an effect to the small area at the mouth of the stream but it would not be substantial considering the size of the entire wetland. That, combined with the low level of the reduction in ground water, suggests that the effect on the estuarine wetland would be minimal for all alternatives.

Lower Bell Creek Wetland

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

Alternative 2 – Full Plan Implementation

The Ecology 2003 model predicts that full pipelining would reduce the average ground water level in the shallow aquifer in the Lower Bell Creek wetland area by between 1 and 3 feet (Figure 5.4-1). The weighted average of decline in ground water level by acre is approximately 2 feet. The model predicts a reduction in the ground water input to Bell Creek of less than 10 percent or 0.2 cfs. There are also irrigation tailwater canals that flow through the wetland but they would not be altered.

The ground water reduction could result in a significant loss in source water and would reduce the length of time that the wetland is saturated and the size of the wetland. The volume of water in ponds and streams would be reduced, especially during the drier months. The altered water source would not significantly affect the forests or the farmed/grazed vegetation. It may affect emergent plants adjacent to the open water.

Sediment Removal and Nutrient and Toxin Removal: The current potential of the Lower Bell wetland to perform this function was rated moderate. Losing a large portion of the wetland's source of water is not likely to affect the ability to trap sediments, nutrients, or toxins unless there is a substantial change in the amount of emergent vegetation. However, the opportunity to perform this function may be reduced. The effect is expected to be minimal to medium depending on the change in emergent vegetation.

Production and Export: The current potential of the Lower Bell wetland to perform this function was rated moderate. The wetland would still produce organic material but the export would be limited by the flow of Bell and its tributary. The flow is expected to be reduced but it would still be able to transport organic material, at least at times. However, primary production in the fields may be reduced unless the fields are irrigated. The effect is expected to be medium.

General Habitat: The current potential for this function was rated moderate. The change in water source is expected to have minimal effect on the vegetation factor of habitat. The open water or streams may be smaller during the summer. This would reduce the potential for general habitat. The net effect on this function is expected to be medium.

Invertebrates and Amphibians: The current potential for this wetland to provide habitat was rated moderate. The net effect on this function is expected to be medium to high depending on the timing and amount of reduction in open or standing water in the summer.

Wetland Birds: The current potential for the wetland to provide bird habitat was rated moderate. The reduction in water may result in smaller ponds or streams. A loss in habitat for invertebrates and amphibians would reduce the primary food source for birds in open-water areas. A reduction in water supplied to the Lower Bell wetland may reduce the habitat for individuals/pairs of some bird species. A change in vegetation may change the bird species composition or distribution in this wetland area may change. The effect is judged to be medium.

Wetland Mammals: The current potential for this function was rated moderate. Open water is required for wetland mammal habitat. The reduction in water source may result in a reduction or a loss of habitat. The effect would be medium to high depending on the amount of open water loss.

Alternative 4 – Economic Efficiency

The length of canals to be piped would be reduced compared to Alternative 2. In particular, the canals south and southwest of Lower Bell Creek would not be piped (H-2 to H-9 and H-11 to H-16). Leakage from the canals in the local area provide recharge to the shallow aquifer that might affect water supply to Lower Bell wetland. While leakage from most of these canals is low, it adds up to 0.45 cfs for the area south of Bell Creek. The Ecology 2003 ground water model predicts a decline in the ground water level of the shallow aquifer of approximately 2 feet for the Lower Bell Creek wetland area in Alternative 4. Thus, while there may be small, localized differences, the overall effects are expected to be the same as in Alternative 2.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

This alternative was designed to reduce effects to high-value wetlands and streams, including Bell Creek below the fork. The fork is downstream from Lower Bell wetland. The Ecology 2003 ground water model predicts a decline in the ground water level of the shallow aquifer of approximately 2 feet for the Lower Bell Creek wetland area in Alternative 6. Thus, while there may be small, localized differences, the overall effects are expected to be the same as in Alternative 2.

<u>Lower Dungeness</u>

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

Alternative 2 – Full Plan Implementation

This wetland is ground water-fed and there is tailwater input to Meadowbrook Creek, which forms the eastern edge of the wetland. The tailwater flow is limited to the irrigation season and is estimated to be 0.54 cfs. A portion of this tailwater enters the creek in the wetland and a portion enters the creek below the wetland. The tailwater would be reduced by the installation of a re-regulating reservoir. The Ecology 2003 model predicts that full pipelining would reduce the average ground water level in the shallow aquifer in this wetland area by less than 1 foot (Figure 5.4-1).

The reduction in the shallow aquifer, combined with the reduction in tailwater input, would result in either a shorter time that the wetland is saturated or reduce the size of the wetland. This hydrologic alteration would not likely significantly affect the wetland vegetation because it is predominately forest or scrub-shrub along the creek, or farmed and grazed emergent species. There could be an effect on any emergent species adjacent to the stream.

Sediment and Nutrient and Toxin Removal: The potential of the Lower Dungeness wetland to perform these functions was rated moderate. Losing a portion of the wetland's source of water is not expected to change the vegetation and is not expected to affect the ability to remove nutrients or toxins. However, the opportunity to perform this function would likely be reduced. The effect is expected to be minimal.

Production and Export: The potential of the Lower Dungeness wetland to perform this function was rated moderate. The vegetative production and export to Meadowbrook Creek are expected to be minimally affected.

General Habitat: The potential of the Lower Dungeness wetland to perform this function was rated moderate due to the riparian areas. The effect of Alternative 2 is expected to be minimal.

Invertebrates and Amphibians, Wetland Birds and Mammals: The potential for the Lower Dungeness wetland to perform these functions was rated as low and any effect would be minimal.

<u>*Alternatives 4 and 6 – Economic Efficiency and Minimized Impact to High-Value Streams and Wetlands*</u>

The Ecology 2003 model predicts that an average decline in ground water level of the shallow aquifer would be less than 1 foot in Alternatives 4 and 6. This is the same as for Alternative 2 and the effects are expected to be similar.

<u>*Agnew Perched Wetland*</u>

Alternative 1 – No Action

Under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

Alternative 2 – Full Plan Implementation

This wetland is perched, primarily fed by surface and shallow subsurface water. A lowering of the ground water in the shallow aquifer is not expected to significantly affect the wetland's source of water. However, a perched wetland may be supplied through subsurface flow of leakage from nearby irrigation ditches. There are two irrigation ditches that cross the wetland but no tailwater feed. The two canals, A-24 and A-25, have minimal leakage (0.03 cfs). A-M3 is south and west of the wetland and may be in the basin that feeds the wetland. There is no information about the leakage of this canal. Piping these canals is the project action that may affect the source of water in the wetland.

Sediment Removal and Nutrient and Toxin Removal: The potential of this perched wetland to perform these functions was rated high. A wetland of this type does not have an outlet unless it is full and therefore sediment, nutrients, and toxins are trapped. Losing the irrigation leakage from the local canals is not likely to affect the ability to trap and remove sediment, nutrients, or toxins. The opportunity to perform these functions would be reduced during the irrigation months only. The effect is expected to be minimal.

Production and Export, General Habitat, Invertebrates and Amphibians, Wetland Birds and Mammals: The potential for the Agnew Perched wetland to perform these functions was rated as low and any effect would be minimal.

Alternative 4 – Economic Efficiency

The ditches that cross this wetland would not be piped in this alternative. Thus, any leakage that feeds this wetland would remain. The effects of Alternative 4 would be less than or the same as Alternative 2.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

In Alternative 6, a subset of projects shown in Alternative 2 would be implemented to reduce the effects to selected wetlands and streams. Siebert Creek was selected for reduced effects due to its fish habitat. Two irrigation canals in the Siebert Creek drainage (A-24 and A-25) are not piped in Alternative 6 and are partly in Agnew Perched Wetland. They each have an estimated leakage of 0.03 cfs. This is not expected to have a significant effect on the wetland size or function and the effects should be the same as in Alternative 2.

<u>*Wetlands Less Than 100 acres*</u>

Alternative 1 – No Action

For all wetlands under 100 acres, under Alternative 1, no project-related changes would be implemented. Existing plans that are unrelated to this proposal would occur (Table 3.2-1, Current Condition Actions). These include actions taken to reduce diversions as well as to limit water contamination. Changes in land use or irrigation application could also affect ground water. Some of these actions could reduce ground water or tailwater recharge of wetlands in the area.

These wetlands have been placed in two groups for discussion of the effects of Alternatives 2, 4, and 6: ground water-fed and perched.

<u>*Ground Water-Fed Wetlands Less Than 100 acres*</u>

The shallow aquifer is a major source to 51 percent of the wetlands smaller than 100 acres. They are primarily in the north and east part of the project area. There is also one larger (60 acres) and several smaller ground water-fed wetlands in the southwest part of the project area. The 60-acre wetland is the source of a tributary that feeds into Matriotti Creek.

Table 5.4-4 shows the difference in decline in ground water for the wetlands under 100 acres among Alternatives 2, 4, and 6. The Ecology 2003 model predicts that Alternative 4 could have the least effect on ground water level for a portion of the project wetlands that are smaller than 100 acres. The table shows that in Alternative 4, approximately 10 percent of the ground water-sourced wetlands smaller than 100 acres are in areas where the ground water is predicted to decline more than two feet. However, in Alternatives 2 and 6, approximately 27 and 26 percent respectively are in areas where the ground water is predicted to decline more than 2 feet.

The reduced impact in Alternative 4 is primarily explained by the changes that occur in the southwestern portion of the project area where a number of ditches remain unlined. The predicted decline in ground water in that area is less in Alternative 4 than in Alternative 2 (Figure 5.3-7). There are approximately 120 acres of ground water-sourced wetlands in this area, all with fewer than 100 acres. The reduced decline in ground water level in Alternative 4 may result in a difference in the change in wetland area or duration of saturation.

Table 5.4-4. Ground Water Level Decline in the Shallow Aquifer for Ground Water-Sourced Wetlands Under 100 Acres

Decline in Ground Water Level (feet)	Alternative (Acres)			Alternative (Percent of Acres)		
	2	**4**	**6**	**2**	**4**	**6**
Up to 1	310	337	317	60	66	62
>1 to 2	67	126	63	13	24	12
>2 to 3	39	43	41	8	8	8
>3 to 4	90	4	88	18	1	17
>4 to 5	8	4	5	2	1	1
>5 to 6	0	0	0	0	0	0
Total	**514**	**514**	**514**	**100**	**100**	**100**

Source: Ecology 2003 Ground Water Model, Steady-State Run

The largest ground water-fed wetland in this area is 60 acres and includes the origin of a tributary to Matriotti Creek. In Alternative 4, the ground water under this 60-acre wetland is predicted to decline by less than 2 feet while it is predicted to decline by more than 3 feet in Alternatives 2 and 6. In all three alternatives, there would likely be a decline in the wetland size or duration of saturation. The decline may be less severe in Alternative 4 although it would primarily show up in localized differences. There also may be a difference in the timing and duration of flow in the stream within the wetland. The effect to the functions is expected to be within the range of effects described below.

There is a 10-acre and a 7-acre wetland in the same area that show declines of 3 to 4 feet in Alternative 2 and of 2 to 3 feet in Alternative 4. All the other ground water-fed wetlands in the southwest area where the ground water level decline is less in Alternative 4 than in Alternative 2, are 5 acres or smaller and have a decline of greater than 1 foot in both alternatives. The effect to the functions is expected to be as described below.

Alternative 2 – Full Plan Implementation

The ground water-fed wetlands in the southwest part of the project are expected to be more affected by the proposed project than those in the northern part of the project. The 2003 ground water model predicts a decline in ground water level of the shallow aquifer of up to 7 feet in the southwest part of the project area. While a few of these wetlands have canals or tailwaters providing an additional source of water in the summer, the primary effect would be the reduction in ground water. The 60-acre wetland that is a source of a tributary that feeds into Matriotti Creek is in an area where the decline is predicted to be between 3 and 4 feet. This is expected to result in a significant loss in source water and would significantly reduce the length of time that the wetland is saturated and the size of the wetland. The volume of water in ponds and streams would be significantly reduced, especially during the drier months.

The wetlands in the northern and eastern parts of the project would be less affected because the ground water is expected to decline by less; most are located in the area where the decline is predicted to be less than one foot. Thus, there may be a loss of source water and the time of saturation and size of the wetland may be reduced. Any associated streams may also receive a reduced ground water contribution to their flow. The largest of the ground water-fed wetlands in the northern part of the project is the 81-acre estuarine wetland at the mouth of Meadowbrook Creek and adjacent to (east of) the Dungeness estuary wetland. The effect of reducing the amount of fresh water available to the wetland is expected to be minimal because it is influenced by tidal action and is in the area where ground water is predicted to decline by less than 1 foot.

Sediment Removal and Nutrient and Toxin Removal: Losing a major source of water may affect the ability to remove sediment, nutrients, or toxins in emergent areas. The degree of effect would depend on the magnitude of change of vegetation composition. A change in vegetation depends on the land management of the area. Many areas include managed vegetation, (e.g., farmed or grazed land) and would not be expected to change. The opportunity to perform these functions would likely be reduced as less water is transported through irrigation. The reduced ability to perform this function may be offset by lost opportunity. The effect is expected to be minimal to moderate depending on the change in vegetation and the change in surface water transported to the wetland.

Production and Export: Several of the ground water-fed wetlands have streams and the ability to export organic material. The wetlands would still produce organic material but the export would be limited by the flow of the associated creeks. The flow of these creeks may be lower but they would still be able to transport organic material at times. However, two of these wetlands are at the origins of creeks (Cassalary Creek and a tributary to Matriotti Creek). These may have significantly shorter (possibly no) periods of flow during which to export material. The effect is expected to be minimal in the wetlands without a stream, medium for those with streams that have at least periodic flows, and significant if the stream in the wetland is completely dewatered.

General Habitat: The potential for this function varies depending on the management, vegetation, and open water in the wetland. Most of the wetlands are farmed or grazed and have low potential for general habitat. The effect on general habitat for those wetlands would be minimal. The wetlands with streams or varied vegetation would have moderate potential for general habitat (none were noted as having high potential for general habitat). A reduction in the source of water could reduce the size of any open water pond or stream during the summer. The net effect on this function is expected to be medium.

Invertebrates and Amphibians: The potential and effects for this function would be the same as described for general habitat.

Wetland Birds: Most of these wetlands are not close to the coast and do not have open water. The potential for these wetlands to provide wetland bird habitat would be low. The wetlands with streams also have low potential for habitat because they are at the origin of the streams and the open water would be small. Because the potential for the function is low, the effects would be minimal. There are two exceptions to this. Meadowbrook Creek estuary wetland is adjacent to the Dungeness River estuary and open to salt water, providing habitat for birds. The habitat for wetland bird species would be minimally affected because the hydrologic regime is heavily influenced by the tides. The second exception is the narrow wetland associated with the lower mile of McDonald Creek that is close to the Strait of Juan de Fuca. It may provide habitat, including feeding, for wetland birds. The effect to this function is expected to be minimal.

Wetland Mammals: The potential for this function is low. Open water is required for wetland mammal habitat. Because the potential for the function is low, the effects would be minimal.

Alternatives 4 – Economic Efficiency

As described earlier, the 2003 model predicts a reduced decline in the ground water level for Alternative 4 in the southwest portion of the project where several ditches would remain unlined (Figure 5.3-7). The prediction for the rest of the project area is approximately the same as for Alternative 2 and the effects would be similar to Alternative 2.

Although the decline in the ground water in the southwest is predicted to be less than for Alternative 2, it is still large and is expected to affect the wetlands similarly. There would likely be less reduction on the wetland area or duration of saturation. Thus, while there would likely be differences in specific wetlands due to the variability of the land, the effects to the functions are expected to fall in the same range as for Alternative 2.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

The Ecology 2003 ground water model predicts the decline in the water level of the shallow aquifer in the area of the ground water-fed wetlands to be approximately the same as for Alternative 2. Therefore, the expected affects of Alternative 6 would be similar to Alternative 2.

Perched Wetlands Less Than 100 acres

Perched wetlands represent 49 percent of the wetlands less than 100 acres. They occur mostly in the southern and western sections of the project area. The subsurface flows that feed these wetlands generally would be supplied by precipitation, irrigation, and storm water in the wetland's contributing basin. A lowering of ground water in the shallow aquifer would not be expected to alter the source water for a perched wetland. However, water may be supplied through subsurface flow of leakage from ditches in the wetland or nearby.

Alternative 2 – Full Plan Implementation

If the water sources are reduced due to reduced irrigation ditch leakage and tailwater, the wetland water sources could be expected to change somewhat during the irrigation season. This would not affect water levels during other months. The continued use of irrigation for agriculture and landscape amenities would allow some of the source to remain in the area. These wetlands would be the least affected by changes in irrigation system conveyance losses because they do not depend on the shallow aquifer for their water.

Sediment Removal and Nutrient and Toxin Removal: Losing a major source of water may affect the ability to remove sediment, nutrients, or toxins in emergent areas. The degree of effect would depend on the magnitude of change of vegetation composition. A change in vegetation depends on the land management of the area, with many areas being managed. The opportunity to perform these functions would likely be reduced as less water is transported through irrigation. The reduced ability to perform this function may be offset by lost opportunity. The effect is expected to be minimal.

Production and Export: A few of the perched wetlands have streams and the ability to export organic material. The wetland would still produce organic material but the export would be limited by the flow of the associated creeks. The flow of these creeks is expected to be lower but they would still be able to transport organic material at times. If the streamflow is lowered enough, export may cease. The effect is expected to be minimal in the wetlands without a stream and medium to significant for those with streams.

General Habitat: The potential for this function varies depending on the management, vegetation, and open water in the wetland. Most of the wetlands are farmed or grazed and have low potential for general habitat. The effect on general habitat for those wetlands would be minimal because the potential to perform the function is low. An exception is the narrow perched wetland associated with the stream flowing to the Dungeness Spit (Woods Creek). It currently has a higher potential for general habitat than other perched wetlands due to the stream and proximity to the Strait of Juan de Fuca. The effect on its habitat is expected to be minimal.

Invertebrates and Amphibians: The potential and effects for this function would be the same as described for general habitat.

Wetland Birds: Most of these wetlands are not close to the coast and do not have open water. The potential for these wetlands to provide wetland bird habitat is low. Because the potential for the function is low, the effects would be minimal. An exception is the wetland associated with the stream flowing to the Dungeness Spit (Woods Creek). It may provide habitat, including feeding, for wetland birds. The effect to this function is expected to be minimal.

Wetland Mammals: The potential for this function is low. Open water is required for wetland mammal habitat. Because the potential for the function is low, the effects would be minimal.

5.4.3 Summary of Effects on Wetlands, All Action Alternatives

Direct and Cumulative Effects

Given a probable reduction in source water to wetlands, there may be direct adverse effects on functions of individual wetlands. Because the relationship between the ground water level changes and each wetland's hydrology is unknown, what follows is a worst-case analysis. In some cases there may be significant adverse effects to a particular large wetland's potential to perform a function. The effects that were rated as high are considered to be potentially significant. The effect on potential to perform functions in a particular wetland may not have been considered significant. However, when all the medium and low impacts are considered across all the wetlands (both large and small) together, the cumulative effect would <u>likely result in a significant adverse impact</u> to the wetland functions in the project area. The reduction in ground water and surface water is likely to result in a reduction in acreage of particular wetlands. The management of the wetlands is not proposed to change, but the wetland area is likely to be reduced. While the reduction may not be significant with regard to an individual wetland, when all are considered together, it could result in a significant effect on wetland acreage. Because the effect of the proposed reduction in irrigation conveyance leakage to the shallow aquifer cannot be isolated in the field from the effects of additional wells, changed land uses, and human alterations of wetlands, it is not possible to attribute loss of wetland function only to the implementation of this plan.

Indirect Effects on Wetland Qualification for Regulatory Protection

Recognizing the importance of maintaining and restoring the chemical, physical, and biological integrity of aquatic resources, several federal, state and local laws have been enacted to regulate the activities in wetlands. The laws are varied and may apply to specific activities or to certain types or sizes of wetlands. As described in Section 4.4, regulated wetlands are those areas delineated to be wetlands according to the 1987 Corps of Engineers Wetland Delineation Manual (Environmental Laboratory 1987). Generally, the wetlands in the project area are subject to regulation regardless of water source. For example, Clallam County would regulate a wetland whether it was historically natural or artificially augmented due to irrigation in the region. One exception is wetlands that were intentionally created, such as the irrigation ditches.

Alternatives 2, 4, and 6 are expected to reduce the shallow aquifer level and the surface water input to wetlands. The reduction in aquifer level may result in a reduction of ground water contribution to wetlands. This, when combined with a reduction in tailwater contribution to some wetlands, may be substantial enough to reduce the length of time that wetlands are saturated and/or the size of wetlands. If portions or all of the wetland become upland, those areas would no longer be regulated under current laws as wetland. Uplands are not usually regulated unless they provide special habitats for listed species. This jurisdictional change may allow development or a change in management of the affected areas.

The reduction or elimination of wetland source water would likely affect the potential for wetlands to perform certain functions. Other functions would continue to be performed even as upland areas. For example, several of the wetlands have moderate to high potential to provide habitat. With a reduction in wetland area they would still have the potential to provide some habitat functions as upland. The direct effect of the proposed project was therefore rated as medium. However, if the wetland is partially or totally converted to upland, it is no longer a regulated wetland. Development of the former wetland area would, in turn, significantly reduce the potential to provide habitat. The same would be true of the potential to perform other functions, such as reduction in peak flows.

5.5 Fish

5.5.1 Introduction

The primary effects of the proposed action or its alternatives on fish would occur during the summer/fall season. This is the season when water withdrawals for irrigation purposes would most likely affect aquatic habitats in the project area. Key aquatic habitat factors or conditions during this season that may affect fish and their habitat include:

- Water temperature (e.g., high temperatures can be lethal)
- Water quality (e.g., dissolved oxygen, contaminants)
- Water quantity (e.g., depth, velocity, and gradient)
- Refugia (e.g., pools, riffles, and shelter such as large woody debris) for resting, feeding, and escape from predators
- Access (e.g., between pools, to side channels, and to tributaries)

Under summer/fall low-flow conditions, increased flows may contribute to better salmonid (i.e., salmon and trout) habitat conditions for a number of reasons, including:

- There are fewer barriers (e.g., shallow riffles) to upstream migration of adults
- The size and extent of deep pools for holding/resting adults and for juvenile rearing increases
- Side channels may become more accessible for adults and juveniles
- More benthic habitat becomes available, which can contribute to primary productivity
- There is a greater opportunity for habitat diversity, which increases the opportunity for partitioning among species and their life stages

- Larger volumes of water provide higher resistance to changes in river water temperature from solar radiation or surface water originating from exposed areas, with the side benefit of greater potential dissolved oxygen levels in the cooler water
- Additional water provides more dilution of pollutants such as nitrates, turbidity, or other chemicals/materials
- Fish are less susceptible to predation and disease
- Competition is less density-dependent
- Three-dimensional space for juvenile fish to inhabit increases

However, minor increases or excessively large increases in flow may not provide some of these potentially beneficial conditions. For example, high flows may be accompanied with turbid waters or may decrease the available habitat due to high water velocities.

Low flows during the summer/fall spawning season can be the source of habitat loss, the impact of which cannot be seen until higher flows return. For example, if salmon are forced to establish redds in more vulnerable exposed areas because of severe low water conditions, higher flows at a later date could scour the redds, resulting in decreased success of spawning.

With the action alternatives, reduced flows might be expected in some of the tributaries and independent streams (see Section 5.3.1). Decreased flows in these water bodies could cause:

- The loss of available three-dimensional space in the water column
- Higher water temperatures because of the loss of ground water, which characteristically has lower water temperatures during the warmer low-water period
- Lower dissolved oxygen levels because of the higher water temperatures and less mixing (and thus less turbulence)

5.5.2 Change in Habitat Conditions and Water Flow by Alternative

Evaluation Approach

<u>Dungeness River</u>
To evaluate the environmental consequences of the alternatives on key fish species in the mainstem Dungeness River, existing conditions (i.e., Alternative 1 – No Action) were compared to the conditions that are projected under Alternatives 2, 4, and 6. The evaluations were concentrated on the late summer/fall low-flow season because this is the time when additional amounts of water would be maintained in the Dungeness River under all action alternatives (but with individual variations) and flow conditions may become critical to fish. August and September were identified as priority months for evaluation primarily because of the low-flow conditions that occur during this period and the presence of key life stages for important species of fish (Hiss and Lichatowich 1990).

The main approach for the evaluation was to compare habitat conditions among the alternatives for key fish species and life stages that would be present in the project area during August and September. Results of the surface and ground water analyses presented in Section 5.3 were used to establish flow conditions for these months during the modeled years of 1996 (considered representative of a low water year) and 1997 (considered a wet year). Habitat/flow relationships (Wampler and Hiss 1991, Hiss and Lichatowich 1990) developed through IFIM (see Appendix D.2 for a summary of the study) for the Dungeness

River were used to provide a means of comparison between alternative flows in the Dungeness River and the potential effects of those flows on fish habitat.

Although modeled flows from 1996 and 1997 were primarily used in the evaluation, it is recognized that lower flows during the late summer/fall period have occurred historically. In addition, instantaneous low flows are lower than mean monthly flow and therefore may be more limiting. These flow conditions can be considered "worst-case" and were also evaluated.

Tributaries and Independent Streams

IFIM studies have not been conducted on the tributaries or the independent streams. Therefore, the relationships between flow and fish habitat have not been determined. However, flow recommendations have been proposed for most of these streams. These recommendations were previously determined by Beecher and Caldwell (1997) using the "Toe-Width Method" (Beecher and Caldwell 1997). This method is primarily based on the geometry of the existing channel and does not directly consider existing or historic flows. Table 5.5-1 presents the recommended flows for the tributaries and independent streams for August and September based on this method. These values are an estimate of the streamflows proposed for spawning or rearing habitat for salmonids (Haring 1999).

Table 5.5-1. Streamflows Proposed for August and September in Tributaries and Independent Streams Based on the 'Toe-Width Method"

Stream Name (Study Location)	Proposed Instream Flow – August/September (cfs)
Siebert (Old Olympic Highway)	15
McDonald (Old Olympic Highway)	15
Matriotti (Lamar Lane)	5
Cassalary (Woodcock)	2
Gierin (Holland)	4
Bell (Schmuck)	4
Johnson (W. Sequim Bay)	5
Meadowbrook (Sequim – Dungeness Highway)	5

Source: Beecher and Caldwell (1997)

During the summer/fall season, chinook salmon and summer run chum salmon, both ESA-listed species, heavily use the river mainstem and its side channels. Adult pink salmon use the mainstem Dungeness River almost exclusively for spawning, except for the most downstream reach of Matriotti Creek and Hurd Creek.

Fish Species and Life Stages

Salmonids were considered the key fish species for evaluation. The reasons for selecting this general group of species are their significant economic value in sport, commercial, and tribal fisheries; sensitivity to habitat changes; and the presence of certain life stages during the summer/fall low-flow periods. In addition, several of these species are listed under the ESA.

Salmonids that would be present and their primary activities during the summer/fall low-flow period are summarized in Table 5.5-2. Appendix D.1 and Section 4.5.1 provide additional details about the life histories and distribution of key salmonid species in the project area.

Table 5.5-2. Key Salmonid Species that May be Found in the Project Area during the Summer/Fall Low-Flow Period

Species	Life Stage (s)	Primary Activities	Potential Habitat Used: Mainstem	Tributaries	Independent Streams	ESA-Listed
Chinook salmon	Adult	Holding, resting in pools, spawning	X	X		Yes
Summer run chum	Adult	Holding, resting in pools, spawning	X	X		Yes
Fall-run chum	Adult	Holding, resting in pools, spawning	X	X	X	No
Bull trout/char	Juvenile/Adult	Holding, resting, feeding	X	X	X	Yes
Coho salmon	Juveniles	Holding, resting, feeding	X	X	X	No
Pink salmon	Adults	Holding, resting in pools or riffles, spawning	X	X		No
Steelhead/rainbow	Juveniles	Holding, resting, feeding	X	X	X	No
	Adults (summer run)	Holding, resting in pools	X			
Coastal cutthroat	Juveniles/Adults	Holding, resting, feeding	X	X	X	No

Chinook salmon spawning was selected as a key indicator of flow/habitat relationships in the mainstem Dungeness River because this species is present during August and September and this life stage is considered sensitive to flow changes that may occur during these months.

The emphasis of the evaluations for the tributaries and independent streams was on "Toe-Width" for steelhead rearing, which is considered generally representative for August and September (Beecher and Caldwell 1997). The reader is referred to Haring (1999) where limitations of the "Toe-Width Method" are described. These limitations should be considered in the interpretation of the following evaluations.

Evaluation of Effects in the Dungeness River

Results of the IFIM study (Wampler and Hiss 1991) and the modeled data from August and September in 1996 and 1997 (see Section 5.3) were used to evaluate the environmental consequences of each alternative on fish resources for mainstem Dungeness River conditions.

Table 5.5-3 provides an example of representative data from the transient model results for August 1996 in relation to IFIM habitat conditions predicted for spawning chinook salmon at RM 2.3. (Appendix D.2 provides additional examples.) The table presents the:

- Average flow conditions for August 1996 and for each modeled alternative (modeled flows at RM 2.3 incorporate adjustments for upstream water withdrawals)
- Amount of increase for the modeled alternatives
- Percent of the optimum amount of chinook spawning habitat based on the IFIM study for August 1996 and each modeled alternative (optimum is assumed to be about 200 cfs for RM 2.3 based on Wampler and Hiss [1991])
- Percent increase in habitat for the modeled alternatives

August 1996 is highlighted because it represents a low-flow condition (estimated at 82 percent exceedance—see Appendix D.2) where the differences between the actual flows and potential increases in flow (as modeled for each alternative) were the largest of the 4 months considered (i.e., August and September in 1996 and 1997, respectively).

Figure 5.5-1 illustrates the same data from Table 5.5-3. Comparisons for other river miles, time intervals, and species are included in Appendix D.2.

As previously indicated, flows lower than the 1996 and 1997 values have historically occurred in the Dungeness River. In general, as flows decrease (between about 200 cfs and 0 cfs), any additional flow can provide additional habitat for chinook spawning. The actual amount of additional habitat depends on the shape of the curve (Figure 5.5-1). Under extreme low-flow events, the effects of additional flows on spawning area become even more critical.

Table 5.5-3. August 1996 Modeled River Flows and Relationship to Chinook Spawning Habitat

IFIM Reach [1/]	Alternative 1	Alternative 2	Alternative 4	Alternative 6
		River Flow (cfs) [2/]		
5	116.7	146.7	142.8	143.9
4	103.8	131.3	127.9	128.6
3	103.2	130.5	127.2	127.8
2	103.7	130.9	127.6	128.2
1	109.1	136.1	132.9	133.4
		Increase in River Flow (cfs)[3/]		
5	0.0	30.0	26.1	27.3
4	0.0	27.5	24.1	24.7
3	0.0	27.3	24.0	24.6
2	0.0	27.2	23.9	24.4
1	0.0	27.1	23.8	24.4
		Chinook Spawning Habitat (% of Optimum)		
5	0.0			
4	75	83	82	83
3	0.0			
2	70	84	83	84
1	0.0			
		Increase in Chinook Spawning Habitat (% of Optimum)		
5	0.0			
4	0.0	8	7	8
3	0.0			
2	0.0	14	13	14
1	0.0			

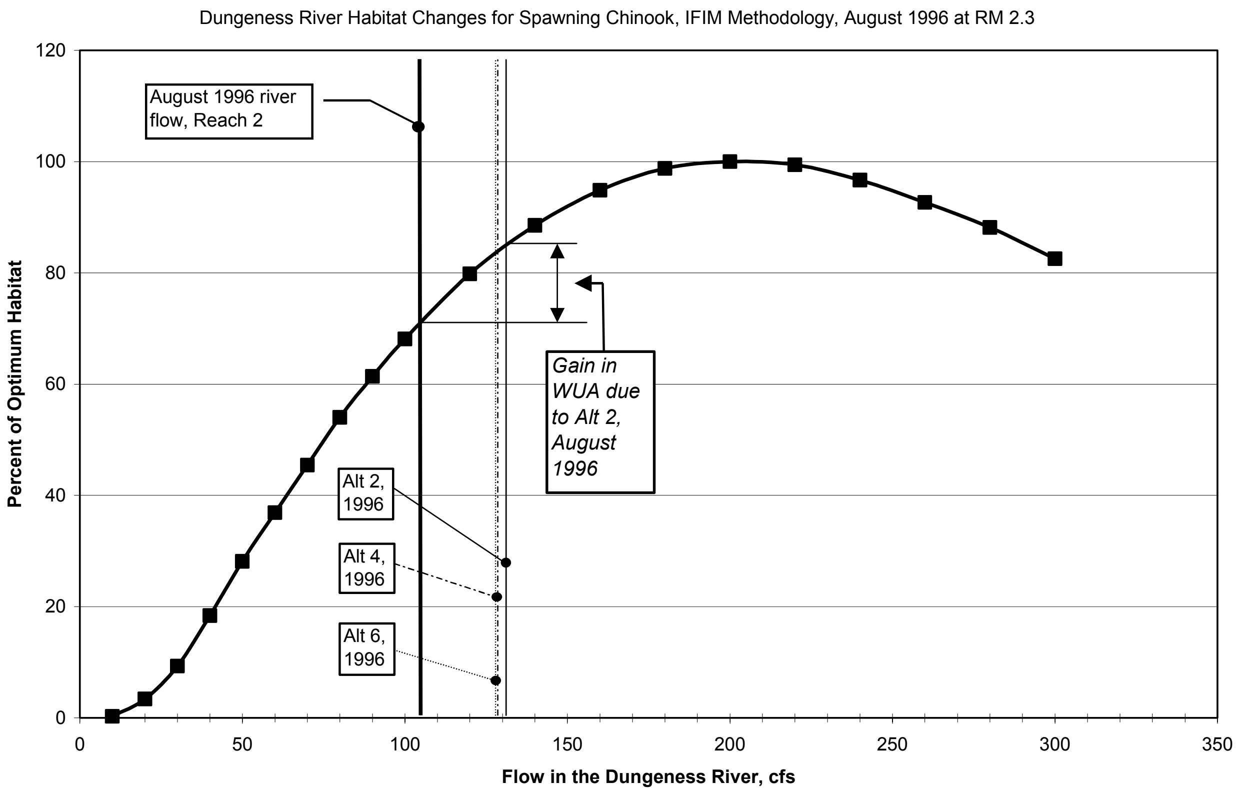
[1/] 1 RM 0 to 1.8
2 RM 1.8 to 2.5
3 RM 2.5 to 3.3
4 RM 3.3 to 6.4
5 RM 6.4 to 11.2

Adjustments in the model for upstream water withdrawals have been incorporated into the flows presented for each reach.

[2/] cfs - cubic feet per second; river flow is net of irrigation diversions and includes ground water contributions for each of the alternatives.

[3/] Increase in river flow by alternative is the difference between river flow with alternative implementation and the existing condition flow (Alternative 1). Change in river flow is based on actual diversions and the modeled leakage from Dungeness to the shallow aquifer.

Figure 5.5-1. August 1996 chinook spawning curve and habitat analysis (from Appendix D.2)



1/ Based on optimum weighted usable area from IFIM analysis (Wampler and Hiss 1991) of 31,393 at 200 cfs.

Evaluation of Effects in Tributaries and Independent Streams

The data from the IFIM study are only representative of mainstem Dungeness River conditions. No IFIM studies have been conducted for the tributaries or the independent streams in the project area. The relationships between flow and fish habitat have not been determined. Therefore, the results of the model studies (see Section 5.3) for August and September in 1996 and 1997 were used as indicators of the changes that might occur in the tributaries and independent streams. These changes are characterized by changes in ground water contribution, which was modeled, and changes in tailwater contribution, estimated on the ground. They are not characterized as absolute changes in flow because there is insufficient flow data on the smaller streams (see Tables 5.3-11 and 5.3-12). These changes were compared to the recommended flows developed from the "Toe-Width Method" (Beecher and Caldwell 1997). It was assumed that the recommended flows would represent favorable conditions for fish habitat and that flows less than those values would be less favorable.

5.5.3 Environmental Consequences of the Alternatives

The following describes the environmental consequences of the no action and action alternatives on key representative fish species. The comparisons are directed at the Dungeness River and on the tributaries or smaller independent streams in the project area.

Alternative 1 – No Action

No project–related changes would be implemented under this alternative. Reduction of Dungeness River flow due to irrigation withdrawals (including withdrawals to cover leakage) during the low-flow summer/fall season would continue during critical spawning and rearing times for species federally listed as threatened and for locally critical stocks as well (see Appendix D.1). This would constitute a significant adverse impact on species that use the mainstem Dungeness River during low-flow periods, including chinook salmon during spawning. In general, any flows lower than about 200 cfs would provide less than optimum habitat for chinook salmon spawning (see Figure 5.5-1 and Appendix D.2).

Under extreme low-flow conditions, any incremental additions to streamflow become even more important. The reason for this is that for any given additional amount, the relative percentage increase in habitat increases as flows decrease. For example, a 30 cfs increase at a flow of 40 cfs would provide a larger percentage increase in habitat than the same amount added at a flow of 180 cfs.

Under the modeled conditions for August and September 1996 and 1997, none of the contributions from ground water (Tables 5.3-11 and 5.3-12) for Alternative 1 would meet recommended flows for independent streams identified by the "Toe-Width Method" (Beecher and Caldwell 1997). Based on this, it is assumed that existing flows do not provide adequate habitat for steelhead rearing in these small streams. However, unquantified contributions from tailwater discharge or runoff could combine with the ground water contribution to provide flows nearer to the recommended flows.

Although flow conditions would generally be the same under Alternative 1, other actions such as implementation of the Clallam County Total Maximum Daily Load (TMDL) Cleanup Plan, the associated Clean Water Strategy (Hemplemen and Sargeant 2002), the Dungeness Bay TMDL (Sargeant 2002), and various salmon conservation and recovery efforts would be expected to improve conditions for salmonids in the project area (on a site-specific basis). Some of the potential for improved fish conditions could be offset by continuing urbanization, water quality degradation, and increasing water use due to ongoing and increasing ground water withdrawals from the shallow aquifer. The aquifer levels may continue to drop, and less ground water would be contributed to tributaries and independent streams.

Alternative 2 – Full Plan Implementation

Dungeness River

Based on Ecology 2003 model results (see Section 5.3.1), flows in the mainstem Dungeness River would have increased by about 11.2 to 36.4 cfs during the months of August and September in 1996 and 1997 (see Table 5.3-4) under Alternative 2. These flows consider the base flow, inflows from tributaries, and contributions or losses from ground water or runoff. Therefore, they are dependent on the conditions that existed during these months for 1996 and 1997.

Increased flows under Alternative 2 during the August 1996 would have resulted in improved habitat conditions (see Section 5.5.1) for spawning chinook salmon. In the example presented in Figure 5.5-1, spawning habitat for chinook salmon at the IFIM study site at RM 2.3 (Wampler and Hiss 1991) would have increased from about 75 percent of the optimum habitat to about 83 percent during August 1996, if Alternative 2 were implemented (Table 5.5-2). However, under conditions in August 1997, the increased flows would result in essentially no increase in spawning habitat (Appendix D.2) because the base flow is near the optimum habitat condition and there is essentially no change in the percent of optimum habitat in this area of the curve between the base flow and any incrementally higher flows.

Under conditions where habitat increases in relation to increased flow, most salmonid species inhabiting the mainstem would benefit significantly. This would be particularly apparent for adult Dungeness spring/summer chinook salmon and pink salmon, which use the mainstem during the late summer/fall season. The benefits would likely also apply to summer run chum salmon, but Wampler and Hiss (see Appendix D.1) did not evaluate this species in the IFIM study. It is also assumed that other salmonid species would significantly benefit, if they were present in the mainstem during this period (see Table 5.5-2 and Appendix D.1)

Higher flows would result in additional habitat where there is an upward trend (see Figure 5.5-1) in the IFIM habitat curves (i.e., habitat increases in a positive direction in response to flow—the steepest part of the habitat curve). At flows greater than optimum habitat conditions, any additional flows would not necessarily result in increased habitat, at least for chinook salmon spawning (Appendix D.2). Other species such as pink salmon, steelhead, and coho have similar flow to habitat relationships, with some curves leveling off, increasing, or some decreasing at higher flows (Wampler and Hiss 1991).

The habitat curve for chinook spawning in the Dungeness River is steepest between 30 cfs to 100 cfs, and shows positive habitat gain between 0 and 200 cfs. Therefore, the additional water provided to the mainstem Dungeness River by Alternative 2 would be most beneficial to salmonids in the lower-flow range (i.e., median flows or lower). Flows higher than the range of 180 to 220 cfs would not increase habitat for spawning chinook. However, these higher flows may improve other potential limiting factors by providing lower water temperatures, better water quality due to higher potential dilutions, additional refugia (e.g., deeper pools, additional backwater, and access to side channels), and higher benthic production.

<u>*Tributaries*</u>

Under Alternative 2, ground water contributions during August and September in 1996 and 1997 would have remained the same or decreased to over 30 percent, depending on which tributary is considered (Tables 5.3-11 and 5.3-12). For example, ground water contributions to Matriotti Creek would have decreased from about 0.5 up to 1.0 cfs or up to over 30 percent of the flow during August and September 1996-1997. In addition, tailwater contributions would also likely decrease (see Table 5.3-8). The result would be that differences between the recommended flows (Table 5.5-1) and flows under Alternative 2 would be even greater than under current conditions, and the trend would be away from conditions needed for steelhead rearing.

Decreases in mean flows in tributaries to the mainstem may result in significant effects on fish populations by decreasing conditions for rearing, spawning, or access, particularly for juvenile coho salmon or steelhead. This would be particularly apparent for Matriotti Creek where flow reductions (sometimes over 30 percent) would likely have significant negative effects on fish habitat and fish. Much of Matriotti Creek runs through actively farmed land with very narrow or no riparian habitat. Therefore, these effects might include warmer water temperatures due to minimal shading and less ground water input. The negative effects may also include restricted passage or access, lower abilities of the stream to dilute potential pollutants, and less available habitat. An estimate of these effects is not possible, however, because no IFIM or other habitat studies have been conducted in the tributaries.

Some small areas of refugia near the mouths of tributaries may expand, however, because some water from the higher river flows associated with Alternative 2 in the mainstem may backflow into the tributaries and provide cooler and more oxygenated water to the lower reaches of any mainstem tributaries. However, these conditions would be highly dependent on mainstem flow. From a water quality standpoint, as indicated in Section 5.3.6, reduction in tailwater flows may also have a positive benefit in reducing nutrient runoff in some of the tributaries.

Hurd Creek and Bear Creek were not modeled for ground water contributions. Hurd Creek is often dry above the hatchery under current conditions. Implementation of any of the action alternatives is unlikely to adversely affect this tributary. Bear Creek's headwaters are outside the project area, but the lower reaches may be adversely impacted by changes in the irrigation ditch leakage. Impacts on fish in Bear Creek are unlikely to be significant given the independent sources of water in this stream.

Independent Streams

Based on the changes that the modeling studies predicted for August and September in 1996 and 1997 (Tables 5.3-11 and 5.3-12), ground water contributions in Siebert, Johnson, and Gierin Creeks would remain about the same as existing conditions, or decrease slightly (e.g., decrease by 0.1 cfs in Gierin Creek – see Tables 5.3-8 and 5.3-11). As indicated in Alternative 1, flows under existing conditions are less than those recommended by Beecher and Caldwell (1997). No re-regulation reservoirs are planned for Johnson, Siebert, or Gierin Creeks. Therefore, there would no effects on salmonids due to tailwater reductions and salmonids would likely not be affected on these streams.

No significant changes in ground water contributions are predicted by the modeling efforts for McDonald Creek. The reason for this may be that McDonald Creek originates at higher elevations, so flows and Alternative 2 may not affect temperatures. In addition, no re-regulation reservoirs are planned, and therefore, there would be no effects from tailwater changes.

In Bell Creek, although ground water changes would likely be minor (no change to ± 0.1 cfs), tailwater reductions (Table 5.3-8) would likely cause significant effects on salmonids.

Ground water contributions to Cassalary Creek would decrease under Alternative 2, ranging from 0.2 to 0.3 cfs for the modeled years 1996 and 1997 (Table 5.3-11). In addition, tailwater contributions would also likely decrease. Combined, these would likely result in significant effects on salmonids in this stream.

Salmonids in Gierin Creek would not likely be significantly affected by changes in ground water contributions which would either not change or be slightly reduced (Table 5.3-11).

Meadowbrook Creek was not modeled for ground water contributions. However, possible reductions in tailwater contributions (Table 5.3-6) would likely result in significant effects on salmonids.

Alternative 4 – Economic Efficiency

Dungeness River

Under Alternative 4, the effects on salmonid species in the mainstem and side channels would be similar to those for Alternative 2, except there would be a slight reduction in the increased flow for the Dungeness River. For August and September in the modeled years 1996 and 1997, the increases would range from about 9.8 to 31.8 cfs, depending on the stream reach and the month (Table 5.3-4).

Results from the IFIM study (Wampler and Hiss 1991) indicate that the amount of water saved from diversion in Alternative 4 would provide significant positive benefits to fish habitat compared to existing conditions (Appendix D.2), although not to the level of Alternative 2 (see example in Figure 5.5-1). In the example for August 1996 (Table 5.5-1), this would result in a small reduction from the 8 percent increase in chinook spawning habitat (percent of optimum) for Alternative 2 to an increase of 7 percent for Alternative 4 in the upper IFIM study reach. Similarly, in the lower IFIM study reach, there would be small reductions from a 14 percent increase to a 13 percent increase between Alternatives 2 and 4, respectively.

Tributaries and Independent Streams

In the tributaries and independent streams, the effects would be similar, but slightly less than those found with Alternative 2. Some changes (as noted in the model years of 1996 and 1997 for August and September) would have been observed in specific streams such as Matriotti Creek where there would have been 0.5 to 0.8 cfs decrease in ground water discharge (Tables 5.3-11 and 5.3-12). Similar to Alternative 2, this decrease would likely have a significant effect on fish and their habitat.

The effects on fish in Bear and Hurd Creeks are assumed to be similar to Alternative 2.

The effects of Alternative 4 on Johnson, Bell, Gierin, Cassalary, Siebert, McDonald, and Meadowbrook Creeks are likely similar or nearly the same as Alternative 2. No significant changes would be anticipated in Johnson, Siebert, and McDonald Creeks. Tailwater reductions would likely negatively affect salmonids in Bell and Meadowbrook Creeks. In Cassalary Creek, flow decreases in ground water contributions and tailwater reductions could negatively affect salmonids. In Gierin Creek, there would be no reduction of tailwater discharge; however, there will be a reduction in groundwater contribution potentially affecting salmonids, though not significantly.

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

Alternative 6 is a subset of actions listed in Alternative 2. Alternative 6 was developed to reduce potential effects on Graysmarsh and Gierin, Siebert, and Bell Creeks. The irrigation ditches that feed the ground water affecting these streams would not be piped. See Appendix H, Figure H.2-1, for ditches already lined and to be lined in the vicinity of Gierin Creek.

Dungeness River

As Table 5.5-3 and Figure 5.5-1 indicate, conditions in the mainstem would be essentially the same as under Alternative 2, but with a slight reduction in flow (up to about 3 cfs). In the example for the modeled conditions in August 1966, the increase in chinook spawning habitat would be the same for both Alternatives 2 and 6, with increases of 14 percent and 8 percent for the IFIM study sites at RM 2.3 and 4.2, respectively (Table 5.5-3 and Figure 5.5-1). Therefore, under these conditions, habitat conditions would likely improve significantly over existing conditions. However, as in the analyses for the other action alternatives, increases at flows greater than about 180 to 220 cfs (e.g., August 1997 conditions) would not result in increases in spawning habitat for chinook salmon (Appendix D.2), but may improve other potential limiting factors such as lower water temperatures, better water quality due to higher potential dilutions, additional refugia (e.g., deeper pools, additional backwater, and access to side channels), and higher benthic production. Overall, the net reduction in irrigation withdrawals would likely provide significant positive benefits to salmonid habitat in the mainstem.

Although the 1996 and 1997 modeled flows represent a low water year and a wet year respectively, flows downstream of the USGS gauge at RM 11.8 would generally be lower than the 180 to 220 cfs range for optimum chinook spawning flows at RM 2.3. Also, the flow/habitat relationships for chinook spawning, under the 1996 and 1997 scenarios, focus on mean flows (see example in Figure 5.5-1 and Table 5.5-3) and not ranges of flow within a given month. Even though the 1996 and 1997 modeled flows are considered valuable tools for evaluation, daily or instantaneous flows are also important and are often more critical to fish species than mean flows. When the flow/chinook spawning habitat relationship (Figure 5.5-1) is considered, the lower the mainstem flow, the larger the relative percentage change (over existing conditions) in habitat for each cfs of flow in the river.

Tributaries

In the tributaries, the effects would be similar, but slightly less than those found with Alternative 2. Some changes (as noted in the model years of 1996 and 1997 for August and September) would have been observed in specific streams such as Matriotti Creek where there would have been a 0.5 to 0.7 cfs decrease in ground water discharge (Tables 5.3-11 and 5.3-12). Similar to Alternative 2, this decrease would be expected to have a significant effect on fish and their habitat. The effects of Alternative 6 on Hurd and Bear Creeks would likely be similar to Alternative 2.

Independent Streams

The effects of Alternative 6 on Johnson, Bell, Gierin, Cassalary, Siebert, McDonald, and Meadowbrook Creeks are likely similar or nearly the same as Alternative 2. No significant changes would be anticipated in Johnson, Siebert, and McDonald Creeks. Tailwater reductions would likely negatively affect salmonids in Meadowbrook Creek. In Cassalary Creek, tailwater reductions, as well as ground water reductions (Table 5.3-10), could negatively affect salmonids. In Gierin Creek and Bell Creek, there would likely be no significant effects on salmonids because there would be no significant tailwater reductions or ground water contributions (Tables 5.3-10 and 5.3-12) compared to existing conditions (Alternative 1).

Cumulative Effects, All Action Alternatives

The Water Users Association (2000) has reduced diversions from the Dungeness River over about the last 25 years by increasing on-farm efficiency and by reducing conveyance losses wherever possible. The diversions have dropped from a seasonal average of 126 cfs in 1979 when flood irrigation was used, to 53 cfs in 2000. This reduction in diversion has increased the streamflow in the Dungeness River and has increased fish habitat quality and quantity as a result. Further reductions in diversions, as proposed in any of the action alternatives, would provide additional streamflow and therefore likely maintain or improve salmonid habitat.

Table 5.5-4 summarizes the effects of each alternative on salmonids inhabiting the project area. Bull trout and cutthroat trout are not specifically addressed due to the limited amount of information available on these species. However, the consequences from each alternative on these two species would likely be similar (but not identical due to differences in life history requirements and habitat preferences) to the other salmonids that are described in greater detail.

The IFIM study (Wampler and Hiss 1991) indicates that, for chinook salmon in particular, further net reductions (Alternatives 2, 4, and 6) of diversion represent a significant improvement over current conditions, particularly at flows less than 180 cfs. While there are constraints with the IFIM methodology (Orsborn and Ralph 1994; see Appendix D.2), it

Table 5.5-4. Summary of Effects of Alternatives 2, 4, and 6 on Salmonids in the Project Area

		Alternative 1: Current Salmonid Presence[1/2/]	Effects of Alternative 2	Effects of Alternative 4	Effects of Alternative 6
Dungeness River and Side Channels		Chinook spawn to perhaps above RM 17.5 and inhabit up to RM 18.7; lower river pink spawn to about RM 6.5; summer chum to RM 9.0; fall chum to 11.8; coho and w-steelhead to RM 18.7	Significant positive effects to both listed and non-listed salmonids that inhabit the river mainstem, the side-channels, and the lower reaches of tributaries.	Essentially the same effects as Alternative 2, although positive effects might be slightly reduced compared to Alternative 2 because of small increases in net diversion.	Essentially the same effects as Alternative 2, although positive effects might be reduced compared to Alternative 2 because of small increases in net diversion. This could also affect side channel connectivity at low flows.
Tributaries to the Dungeness	**Matriotti**	Lower river pinks to RM 0.2 and also up a tributary; summer chum to at least RM 0.5; fall chum to at least RM 0.9; coho and w-steelhead (presumed) to RM 6.8	Likely will lose significant salmonid habitat (e.g., steelhead rearing areas) because of decreased ground water and tailwaters contributions; remaining water may be affected by high temperatures and low dissolved oxygen in low-flow periods. Higher water levels in the river may backflow into Matriotti and provide cool, oxygenated water to the lower reaches of this creek, which are often used by listed species.	Same effects as Alternative 2, although a slightly better supply of ground water might result in cooler water, compared to Alternative 2.	Same effects as Alternative 2.
	Hurd	Lower river pinks and summer chum to RM 0.5; coho and w-steelhead to at least 0.5	Flow of water from the hatchery may alleviate flow problems in the lower reaches, which are used by listed salmonid species. Upstream of the hatchery, the stream is generally dry during low-flow periods.	Same effects as Alternative 2	Same effects as Alternative 2.
	Bear	Coho and w-steelhead (presumed) to at least RM 1.0; fall chum to RM 0.2	Possible loss of salmonid habitat due to changes in irrigation ditch leakage. However, impacts are unlikely significant.	Same effects as Alternative 2.	Same effects as Alternative 2.

Table 5.5-4. Effects of Alternatives 2, 4, and 6 on Salmonid Inhabiting the Project Area

		Alternative 1: Current Salmonid Presence[1/]	Effects of Alternative 2	Effects of Alternative 4	Effects of Alternative 6
Independent Streams	Johnson	Coho, chum, and sea-run steelhead (presumed)	Small reductions in ground water are anticipated to be insignificant, but trending away from recommended flows.	Same effects as Alternative 2.	No effects
Independent Streams	Bell	Coho and w-steelhead (presumed) to at least RM 3.0; chum presence is unknown	Possible impacts to non-listed salmonid because of a reduction of tailwater and also some small, but reduced ground water contribution to flow during certain times.	Same effects as Alternative 2.	Fewer effects than Alternative 2 due to retained tailwater flow and some retained ground water flow.
Independent Streams	Gierin	Coho and w-steelhead (presumed) to RM 2.7; chum presence is unknown	Possible impacts to local non-listed salmonids, because of small ground water reduction.	Same effects as Alternative 2, although possibly little or no ground water reduction.	Few effects, especially since irrigation ditches affecting Graysmarsh will remain unlined.
Independent Streams	Cassalary	Coho and w-steelhead (presumed) to RM 2.9; chum presence is unknown	Possible adverse impacts to salmonids because of reduced tailwater and also ground water reduction.	Same effects as Alternative 2, although possibly less ground water reduction.	Same effects as Alternative 2.
Independent Streams	Cooper	Coho and perhaps w-steelhead to RM 0.8	Insufficient data to determine impacts to non-listed salmonids.	Insufficient data to determine impacts to these non-listed salmonid.	Insufficient data to determine impacts to these non-listed salmonid.
Independent Streams	Meadowbrook	Coho and w-steelhead (presumed) to RM 2.4	Possible adverse impacts to salmonids because of reduced tailwater; ground water effects were not specifically modeled on this stream.	Same effects as Alternative 2.	Same effects as Alternative 2.

Table 5.5-4. Effects of Alternatives 2, 4, and 6 on Salmonid Inhabiting the Project Area

		Alternative 1: Current Salmonid Presence[1/]	Effects of Alternative 2	Effects of Alternative 4	Effects of Alternative 6
Independent Streams (continued)	McDonald	Pinks are anecdotally present; coho and w-steelhead perhaps to at least RM 5.1 and perhaps to 9.0	No effects to salmonids because no changes in ground water contributions and no re-regulation reservoirs; however, this creek originates in the higher elevations so flows and temperatures may be adequate. Tailwater discharge would not be reduced because no re-regulation reservoirs are planned. However, large numbers of smolts (coho, winter steelhead, and cutthroat) may be affected by reduced flow.	Same effects as Alternative 2.	Same effects as Alternative 2.
	Siebert	Coho and w-steelhead (presumed) to RM 8.5; fall chum to RM 1.4	Possible minor effects on salmonids from reduced ground water contribution; tailwater discharge would not be reduced because no re-regulation reservoirs are planned.	No significant effects on salmonids.	Same effects as Alternative 2.

[1/] Current fish presence is adapted from Haring (1999), and is limited to observations without including historical or potential habitat; "w-steelhead" indicates winter steelhead.
[2/] Cutthroat and bull trout are not specifically addressed in this table, but would be expected to have roughly similar responses to the various alternatives as other salmonids.

provides an indication of the relative importance of additional increases in the late season flow for chinook salmon and other species (Hiss and Lichatowich 1990). In addition, increased streamflow would increase the ability of the Dungeness River to dilute pollutants, to maintain lower temperatures during critical summer/fall low-flow periods and to provide mainstem migration without barriers due to low flows.

Improvement in mainstem Dungeness River fish habitat with further net reductions must be balanced with potentially negative cumulative effects on fish that primarily use the tributaries. Any reductions in ground water contributions to these small streams would reduce the habitat quality for fish and would further reduce flows below those recommended by Beecher and Caldwell (1997). For the tributaries, the modeled results for August and September 1996 and 1997 indicate that significant negative effects would occur (Table 5.3-11) and affect fish. In contrast, the relatively minor changes in the independent streams would not likely result in any significant effects on fish, except in Cassalary Creek where reductions in ground water and tailwater flows could significantly negatively affect salmonids.

Streamflow is only one of the many factors that affect salmonid fish production. As indicated previously, other factors such as water quality, refugia, water temperature, and others combine to affect overall production. These other factors have been or will be assessed in the Dungeness River project area. It is likely that other measures besides streamflow have and will be implemented to improve conditions for salmonids in this area, particularly for those species listed under the ESA. Key examples include activities involving establishment and implementation of TMDLs, structural additions to the river channel, habitat restoration (Dungeness River Restoration Work Group 1997) and others. Therefore, the cumulative effects of the proposed actions and these other activities should be beneficial to salmonid populations.

5.5.4 Discussion of Streamflow with Respect to Other Limiting Factors

Although correlations between streamflow and habitat can be made, the same correlation cannot be made between habitat and actual numbers of fish; too many other factors affect actual numbers. For example, if a 25 percent increase in habitat can be demonstrated using IFIM or other means when additional flows are added to a given stream system, this does not necessarily indicate that there will be 25 percent more salmonids in that habitat.

It should also be noted that throughout this analysis, the key factor evaluated was streamflow and its relation to habitat. Although streamflow is a major consideration in salmon recovery measures, other interrelated and interdependent factors affect fish and their habitat (Haring 1999). For example, human activities including diking, bridge and road constrictions, removal of log jams and large woody debris, forest and agricultural land management, as well as water withdrawals have affected salmonid production in the Dungeness River (Orsborn and Ralph 1994). Similarly, conditions in the estuarine and marine environments (e.g., climate, harvest, predation, and others) can affect overall population numbers for anadromous salmonids.

In the Dungeness River, the Dungeness River Restoration Work Group (1997) has specifically identified seven different approaches (often referred to as the “Seven Pillars of River Restoration”) for improving conditions for salmonids. As such, the analyses in this EIS were focused on the proposed action, which examined two of these (i.e., conservation of streamflows and low-flow conditions). The other restoration measures will be examined in other actions and will likely also include additional considerations of streamflows and low-flow conditions due to their interrelationship with other factors that affect salmonid habitat.

Increases in streamflow do help to alleviate some, but not all, of the bottlenecks or limiting factors affecting salmonid production. For example, increases in flow under the proposed action will not only increase habitat (particularly at critical low flows), but they will likely help to provide better water quality; reduce the potential of high water temperatures; provide more favorable conditions for upstream passage and access to side-channels or tributaries; increase the potential for benthic production; expand the volume and extent of pools and riffles; and provide other refugia for holding, resting, or rearing. Therefore, Alternative 2 and, to a lesser extent, the other action alternatives, would likely provide significant benefits in the restoration of salmonids in the Dungeness River. It would also likely result in significant negative effects on tributaries such as Matriotti Creek, there will likely be little or no significant effect on the independent streams except Cassalary Creek.

5.5.5 Other Wildlife

Implementation of any of the action alternatives or Alternative 1 would have no effect on bald eagles or their habitat; would not impact peregrine falcons, harlequin ducks, or their habitat; and would not significantly influence merlins, purple martins, osprey, great blue herons, or their habitat. No large mature trees would be removed as a result of implementation of this plan, though some small trees and shrubs are routinely removed during system maintenance and would also be removed prior to pipelining. Piping the irrigation mains and laterals is associated with normal ongoing agricultural practices. Construction activities would not begin until mid-September or October, after the critical breeding period for bald eagles, harlequin ducks, and great blue herons (Watson and Rodrick 2001, Lewis and Kraege 1999, Quinn and Milner 1999).

Alternative 1 – No Action

Under Alternative 1, there would be no impact to wetland/riparian-dependent wildlife species or special status species.

Alternative 2 – Full Plan Implementation

Implementation of Alternative 2 would likely reduce wetland/riparian habitat (see Section 5.4), possibly displacing individuals of some freshwater wetland-dependent species (Table 4.5-4). Waterfowl species in the project area often feed in the wetlands and farmland at night.

Though there may be a reduction in wetland/riparian habitat under plan implementation, the farmland, bay, and estuary will continue to provide abundant habitat for nighttime roosting and feeding. A decrease in wetland habitat would influence wetland-breeding species more than species that only winter in the area. The Pied-bill grebe, American bittern, blue-winged teal, and cinnamon teal have relatively large home ranges (Johnson and O'Neil 2000) and individuals of these species may be displaced as a result of Alternative 2 implementation.

Alternative 4 – Economic Efficiency

Implementation of Alternative 4 would likely reduce wetland/riparian habitat, to a lesser extent than under Alternative 2 (see Section 5.4). This reduction in habitat may displace individuals of some freshwater wetland-dependent species (Table 4.5-5).

Alternative 6 – Minimized Impact to High-Value Streams and Wetlands

Implementation of Alternative 6 would likely reduce wetland/riparian habitat, to a lesser extent than Alternative 2 (see Section 5.4). This reduction in habitat may displace individuals of some freshwater wetland-dependent species (Table 4.5-5).

5.6 Built Environment

5.6.1 Land Use

Under Alternative 1, land use conversion from agriculture to rural residential can be expected to continue. Implementation of the Conservation Plan with any of the proposed action alternatives would have no direct impact on land use. If the trend of installing exempt wells to provide water for new rural residences continues, then under full implementation of the Conservation Plan, wells might need to be drilled to deeper levels to provide adequate water than the average depth now needed. This situation does not preclude the further development of rural residences by itself. However, the cumulative impact of the implementation of the Conservation Plan taken together with other shallow aquifer withdrawals may be more important. Please see Section 5.3.3, Water Supply, for a full discussion.

5.6.2 Public Services and Utilities

Implementation of the Conservation Plan with any of the proposed action alternatives would have no impact on public services except for water supply. Please see Section 5.3.3, Water Supply, for a full discussion.

5.6.3 Recreation

Implementation of the Conservation Plan with any of the proposed action alternatives would have no impact on recreation opportunities in the area. Very little recreation depending on the small creeks and wetlands would be adversely affected by such implementation. Hunters of waterfowl may see a species change in areas where less open water is available because some coastal marshes may become more saline, but waterfowl will persist in the overall project area.

5.6.4 Agricultural Crops

There would be no impact to the extent of farmland or type of crops grown under any of the action alternatives analyzed. If Alternative 1 is chosen and no action is taken to further reduce diversions from the Dungeness River, the WUA may be found out of compliance with the 4(d) rules for protection of the federally listed threatened species in the Dungeness River and some or all of the irrigation diversion system could be closed down. This would end most irrigated agriculture in the planning area and would also result in adverse impacts from the action alternatives on the small streams and wetlands in the area.

5.6.5 Aesthetics

Open irrigation ditches are considered an attractive element of the rural landscape in the Sequim-Dungeness area. Under Alternative 1, they would be periodically dredged or cleaned to remove vegetation and would be gradually replaced by pipes where other funding opportunities, especially for public health reasons (control of fecal coliform pollution especially), arose. Under Alternatives 2, 4, and 6, many of the open ditches would be replaced by pipes, reducing the number of such features in the landscape. Though individual landowners who have come to view the ditches as “creeks” might be disappointed to lose the water feature near their residence, the overall impact to the area’s rural character would be insignificant.

5.6.6 Public Safety

Open irrigation ditches near roads and highways can create a public safety hazard. Under Alternative 1, a few ditches would be replaced by pipes and the hazard would be reduced. However, most ditches would remain open, providing an ongoing pollution pathway, especially for fecal coliform. Under Alternative 2, virtually all ditches along roads would be replaced by pipes, substantially reducing this hazard. Under Alternatives 4 and 6, fewer ditches would be replaced but the overall hazard would be reduced. Because the hazard represented by open ditches is a relatively minor component of public safety, none of the alternatives would have a significant positive impact on improving public safety. Also, the potential hazard involved in current herbicide use, though reduced under all action alternatives, is also a minor component of public safety.

6. Mitigation

6.1 Introduction

Under Washington law (WAC 197-11-768), mitigation is defined as:

- Avoiding the impact altogether by not taking a certain action or parts of an action;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation, by using appropriate technology, or by taking affirmative steps to avoid or reduce impacts;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment;
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;
- Compensating for the impact by replacing, enhancing, or providing substitute resources or environments; and/or
- Monitoring the impact and taking appropriate corrective measures.

Ecology must take into account the overall proposal impacts of the project. While SEPA requires that adverse impacts be identified and an EIS prepared even if the overall impact of the proposal is positive (WAC 197-11-330), it does not require mitigation for each adverse impact, particularly if such mitigation measures would reduce the overall proposal effectiveness or if the impact is outside the capability of the applicant or the agency to mitigate (WAC 197-11-060).

6.2 Factors Affecting the Hydrology of the Planning Area

Several factors are affecting the extent to which the implementation of the Conservation Plan may impact shallow aquifer water levels and patterns of ground water distribution in the planning area. The long-term effects of reduced conveyance loss are difficult to separate from those caused by other actions, such as changes in land use, agricultural practices, additional wells drilled to the shallow aquifer, and past deliberate alterations of streams and wetlands. This can complicate both the determination of appropriate mitigation measures and their effectiveness.

6.2.1 Land Use

Many farms have been taken out of agricultural production, subdivided, and then had parcels sold for residential development. This change in land use reduces the amount of water being conveyed across the landscape and potentially lost through open ditches and other system inefficiencies. It also reduces the amount of water actually applied to the land as irrigation water, where the excess is lost to the aquifer. Commercially irrigated acreage has been reduced from as much as 14,000 acres in the 1950s (Eckert 1998) to less than 6,000 acres at present (WUA 2001).

Rural residential development and urbanization has also resulted in an increase in impervious surfaces (roads, roofs, parking lots). Impervious surfaces eliminate rainwater percolation into the aquifer at their location, thereby reducing aquifer recharge and increasing runoff during rain events that may go directly to a creek or to salt water and never enter the aquifer.

Agricultural Practices: The way water is used on areas still farmed has also changed significantly over the last 30 years. Where flood irrigation was common in the early 1970s, all members of the WUA now use sprinkler or drip irrigation systems. This has reduced the deep percolation return to the aquifer from wasteful on-farm irrigation practices.

On remaining farmed acreage, there has been some change away from water-intensive crops, such as irrigated pasture for dairy cattle, to one requiring much less water (e.g., lavender). This change reduces not only the deep percolation return to the aquifer but also reduces conveyance losses as less water is demanded by the farmer.

Even with improved infrastructure, many streams and wetlands will continue to receive tailwaters after the construction of all the proposed projects in the Conservation Plan. To ensure that enough water can be delivered to the farthest users, the irrigation systems in the planning area were constructed to divert more water form the river than can actually be used on the fields. This water in excess of what ultimately is used on the fields is pushed through the system and flows to creeks or wetlands at the end of the system. While there are several re-regulating reservoirs planned to reduce this loss of tailwaters, not all tailwaters can be practically controlled and there will still be some returns to creeks and wetlands.

6.2.2 Well Development

The number of wells in the planning area has jumped from approximately 200 in 1970 to over 4,000 wells in 2000 (Clallam County Wells Database). Many of these wells were drilled under the statutory exemption from permitting (Chapter 90.44.050, Revised Code of Washington), so less information is available for them than for wells with permits or certificates.

6.2.3 Human Alteration of Wetlands and Streams

At the time of settlement and well into the 20th century, wetlands (“swamps”) were viewed as prime farmland if drained. The wetlands that were not forested were much easier to farm than lands that had to be laboriously cleared by hand. Therefore, there was a concentration of effort by early farmers to dike and drain wetlands and to channelize creeks in order to use the soil for agricultural production. The largest, most important wetlands in the area all underwent extensive alteration from their natural state, with as much commercially productive use being made of them as possible (Eckert 1998). Tide gates were installed and, to an extent, are still maintained on creeks that block the passage of salt waters into the previously estuarine marshes. Evidence indicates that at least 115 acres of Graysmarsh were once saltmarsh that provided estuarine rearing habitat for salmonids (Haring 1999).

All these factors, taken together, make the environmental effects of the implementation of the Conservation Plan more difficult to quantify. They also complicate the possible effectiveness of any proposed mitigation, given the altered condition of the wetlands, the existing and ongoing decreases in the shallow aquifer levels, and other present and future changes occurring in land and water use independent of the Conservation Plan implementation.

6.3 Summary of Adverse Impacts

In Chapter 5, significant adverse impacts to certain elements of the environment were identified for Alternative 1 (No Action); Alternative 2, Full Plan Implementation (the proposed action); Alternative 4, Economic Efficiency; and Alternative 6, Minimized Impact to High-Value Streams and Wetlands (the wetlands and small streams protection action). These impacts are described below.

Alternative 1 (No Action):

- Reduced streamflow in the Dungeness River will continue to adversely impact **federally listed and locally critical stocks of salmonid fish species**.

Alternatives 2, 4, and 6:

All action alternatives show probable significant adverse impacts.

- Reduction in ground water recharge and aquifer levels may adversely impact **water supplies**, especially for shallow wells. Each of the action alternatives shows probable significant adverse impacts, at least in localized areas.
- Reduction in ground water recharge and tailwater discharge from the irrigation system may adversely impact, in a cumulative sense, **wetlands** in the project area, and may adversely impact certain specific wetland functions for some of the larger wetlands.

6.4 Possible Mitigation

This section examines possible mitigation measures and includes those that have been recommended by stakeholders and members of the public prior to and after the publication of the Conservation Plan. This section speaks to mitigation measures that could be included in a decision that includes any of the action alternatives (2, 4, and 6).

6.4.1 Mitigation Provided by the Conservation Plan

The Conservation Plan was designed and proposed as a large mitigation plan for the ongoing adverse impacts of diverting water from the Dungeness River. It produces very substantial environmental benefits for the Dungeness River aquatic system by restoring water to the river, most critically during low flows when salmon are most needful of the water. These substantial benefits compensate for and offset the environmental impacts to artificially maintained wetlands, streams, and aquifers that have in the past received water from leakage and discharge associated with the irrigation system.

6.4.2 Other Mitigation Measures

Water Supplied from Irrigation System

Mitigation might be provided by diverting water from the irrigation system directly for artificial support of selected wetlands that may have the greatest biological significance. Any mitigation proposed that would use Dungeness River water, directly or indirectly, for impacts on small streams and wetlands would remove mitigation water from the Dungeness River. This mitigation water has been secured at substantial cost, and removing it adversely impacts the river's populations of threatened and critical salmonid species, especially during critical low-flow periods. If mitigation is not supplied, then these artificially enhanced wetlands would revert to a seasonal hydrology similar to what existed prior to their artificial enhancement. In the case of the Gierin Creek wetland, which is under private ownership, the owner has the capability of restoring a large portion of the wetland to its prior hydrology by removing the tide gate that restricts the entry of tidally fluctuating salt water and re-meandering the stream (see Appendix H.1 for WDFW recommendations).

A diversion for wetland support purposes would require adding a beneficial purpose of use to the existing water rights. This is a lengthy process; it can take years to complete the approval of the change applications. The approval of such applications is also not ensured.

Deliberate Allowance of Water Loss

The potential exists for maintaining some level of artificial water supply to wetlands and aquifers through deliberate inefficiency in the irrigation system. This mitigation has a number of significant drawbacks. The level of the continued inefficiency required to maintain aquifers and wetlands at artificial levels would be very high, and would substantially reduce the flows needed to benefit threatened species of salmon, which is especially important during critical low-flow periods. The deliberate diversion of conservation savings from the river to artificially support wetlands or surrounding areas could also create liability under the Endangered Species Act by possibly causing the "take" of listed fish species through adverse impacts to their habitat.

Provide Pumped Ground Water

It is possible that ground water may be pumped to support wetlands and small streams. There is considerable evidence that there is hydraulic continuity with the Dungeness River, at least with the shallow aquifer if not with the lower aquifers. The ultimate source of water for all the aquifers in the Dungeness River area is the Dungeness watershed. Changes in the aquifers, including ongoing drawdowns for other permitted ground water uses, may adversely impact the Dungeness River or other surface water bodies through the effects of hydraulic continuity. While the impact may be less obvious and less immediate, development of ground water to supply wetlands and streams would have potential adverse impacts on the river and salmonids.

Import Water from Another Basin

The economic and environmental costs of importing water from another basin make the importation of water from another basin unreasonable. Because it is unreasonable it cannot be considered as a mitigation measure.

Artificial Storage of High Flows

It has been proposed in the Conservation Plan that the possibility of aquifer recharge during winter high flows be considered (Montgomery Water Group, Inc. 1999). The DQ Plan (Ecology 1994) suggested that studies be conducted of the feasibility of off-channel reservoirs to divert and store winter high flows for subsequent release during low-flow periods (Recommendation C.3.1).

Storage of high flows, whether in surface reservoirs or as artificial aquifer recharge, has potential to reduce the impacts to wetlands and small streams resulting from lowered shallow aquifer levels.

Reduction of high flows on the Dungeness River with any on-channel reservoirs could reduce the river's carrying capacity for the large particles (cobbles, gravels) essential for fish habitat; this approach was not recommended under the DQ Plan. Small off-channel storage projects, especially those targeted at reducing stormwater runoff from developed areas, would probably not have a significant impact on sediment movement in the river.

Other off-channel storage projects would also probably not significantly affect sediment movement and river habitat. Artificial aquifer recharge through infiltration from deliberately unlined small surface storage reservoirs could be accomplished by adding such reservoirs to the existing irrigation system and filling them during high-flow periods.

This mitigation measure would require studies, engineering, permitting, and environmental analysis. It would also require new construction of facilities, assuming that they proved to be feasible and permissible. The cost of such a mitigation measure would likely be prohibitive and out of proportion to the level of adverse impact. This is particularly true when the Conservation Plan proposal as a whole is recognized as having a significant positive impact on the environment, specifically on the critically low streamflows in the Dungeness River.

Deepening Wells

It may be possible to mitigate effects on some or most of the impacted wells by deepening the wells. The feasibility of such mitigation would depend on the particular circumstances of the well in question.

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Appendix Table of Contents

Appendix A

Completed Projects in the Project Area

- A.1 Non-structural Plan Elements Completed
- A.2 Structural Elements Completed Since 1997

Appendix A.1

Non-Structural Plan Elements Completed

Appendix A.1

Non-Structural Plan Elements Completed

The Dungeness Water Users Association Comprehensive Water Conservation Plan (Conservation Plan) called for significant non-structural changes to be made in the way the Association (WUA) manages its water resource. Those changes are summarized below:

- Combine irrigation districts and companies;
- Implement a drought response plan;
- Improve maintenance on existing open canals by brushing and removing trees;
- Maintain existing program of water measurement and expand;
- Designate one individual from the irrigation entities to coordinate water conservation activities.

By the time the Plan was complete, three irrigation entities (Sequim Prairie, Independent, and Eureka Companies) had combined into a single company, reducing the total number of companies from 9 to 7. As of the writing of this EIS, Mr. Mike Jeldness has been designated the individual from the irrigation entities to coordinate water conservation activities.

Included in this Appendix are the currently accepted Rules and Regulations of the Sequim-Dungeness Valley Agricultural Water Users Association. These rules illustrate the maintenance approach and also contain a Drought Response Plan. Adoption of these rules by the irrigation entities, and their subsequent enforcement on water users, is the best illustration of the intent of the WUA to implement the non-structural projects recommended. It should be noted that the rules also contain and confirm previous non-structural water conservation measures, such as the prohibition of flood irrigation, the limitation of water use to "beneficial use" as defined under the water right, and the denial of irrigation water for recreational or aesthetic ponds.

Appendix A.2

Structural Elements Completed since 1997

Appendix A.2

Completed Pipelining Projects in the Planning Area

Of the total of 61.7 miles of main irrigation canals, 5.4 miles were piped prior to 1997, and of the 111 miles of laterals, 29.3 miles were piped prior to 1997 (Table 2-2, Montgomery Water Group, Inc. 1999). This represents a total of 34.7 miles or 20 percent of the total system. These pipes were installed to improve conveyance efficiency by eliminating leakage and evapotranspiration through vegetation that accumulates in the open ditches. From 1997 to 2001, 17 additional miles of open ditches have been replaced with pipe, an additional 10 percent of the system. Table A2-1 summarizes the laterals that have been at least partially piped from 1997 to 2001 by irrigation entity, and Figure A2-1 shows the location of laterals and mains where pipes have been installed.

Under Alternative 2, 774,770 feet (147 miles) of ditch will be lined. Under Alternative 4, 402,627 feet (76 miles) of ditch will be lined. Under Alternative 6, 695,288 feet (132 miles) of ditch will be lined.

Table A2-1. Pipelined Projects Completed between 1997 and 2001.

Agnew District		Clallam Company		Cline District		Dungeness Company		Eureka Company		Highland District		Independent Company		Sequim-Prairie Company	
ID	length (ft)	ID	length (ft)	ID	length (ft)	ID	length (ft)	ID	length (ft)	ID	length (ft)	ID	length (ft)	ID	length (ft)
A-4	2,222	C-3	7,969	M-7	2,404	DC-1	3,141	New Lateral	194	H-1	1,923	New Lateral	1,800	SP-3	3,356
A-7	1,105	C-3	1,525	M-4	614	DC-1	3,021			H-1	1,191	New Lateral	646	New Lateral	1,010
A-7	424	C-3	5,274	M-4	204	M-4	83			H-16	1,524	M-1	4,272	SPM-2	2,204
A-7	597	C-3	1,622			M-4	83			H-16	2,385	I-4	298		
A-8	4,129					M-4	295								
A-11	1,182					DC-5	9,821								
A-12	407					DC-1	4,408								
A-15	2,040														
A-17	1,056														
A-17	1,737														
M-3	658														
M-3	1,767														
A-27	672														
A-29	460														
A-22	2,291														
A-18	602														
M-2	554														
A-37	550														
A-37	1,216														
M-1	2,149														
A-38	707														
A-18	518														
A-18	375														
A-18	1,903														
Total:	**29,321**		**16,390**		**3,222**		**20,852**		**194**		**7,023**		**7,016**		**6,570**

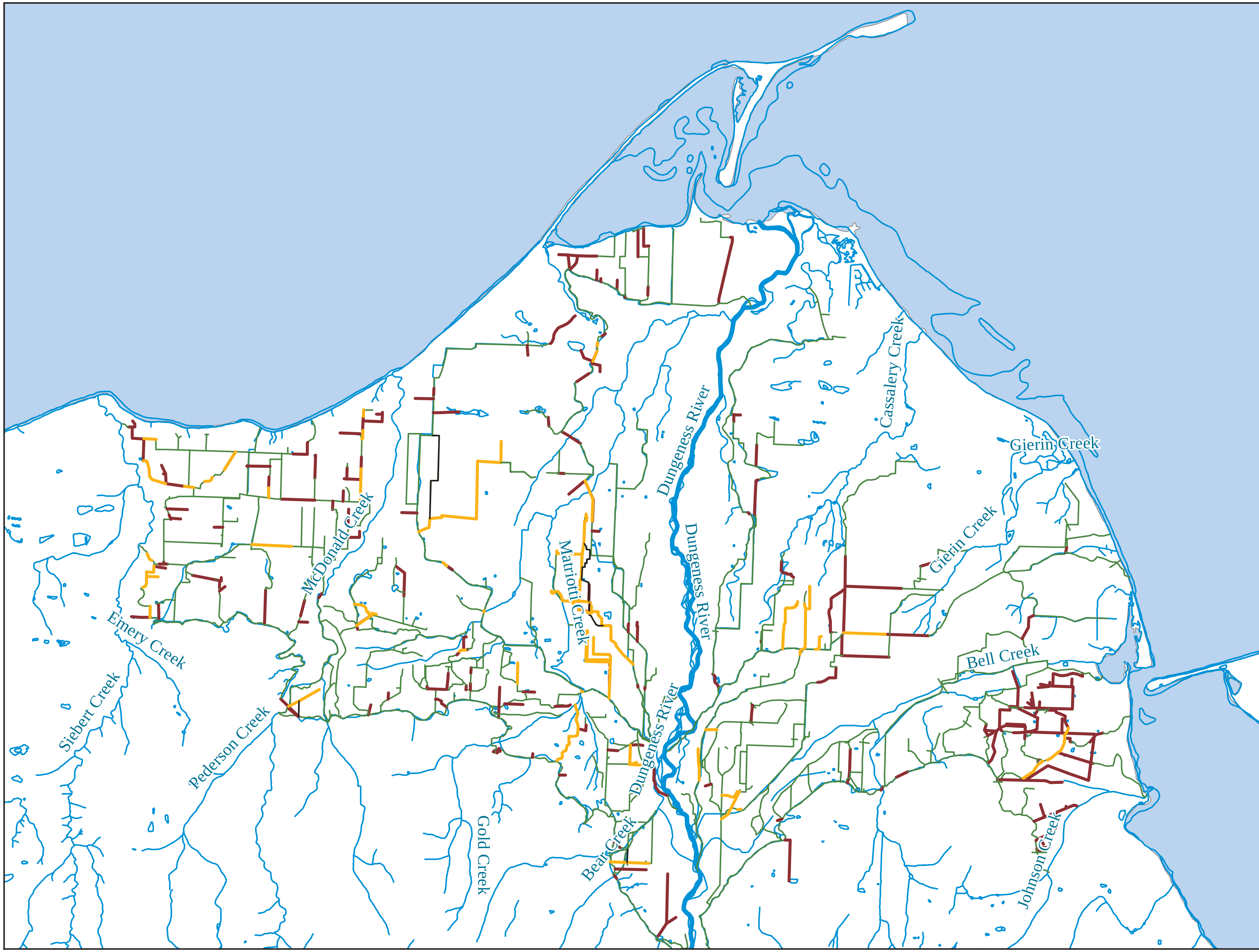

Figure A2-1
Pipelined Projects

Irrigation Ditches
Piped Lateral/Main - Completed Before 1997
Piped Lateral/Main - Completed After 1997
Abandoned Lateral
Streams

Location Map

FOSTER WHEELER
FOSTER WHEELER ENVIRONMENTAL CORPORATION

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Appendix B

Ecology 2003 Ground Water Model

- B.1 Ground Water Model Summary
- B.2 Ground Water Model Results

Appendix B.1

Ground Water Model Summary

Appendix B.1

Ground Water Model Summary

CONTENTS

1.0 INTRODUCTION

Tetra Tech FW, Inc. (TtFWI), formerly known as Foster Wheeler Environmental Corporation, developed a regional groundwater flow model of the Sequim-Dungeness area for use as a tool in analyzing the impacts of the Dungeness River Water Users Association Comprehensive Water Conservation Plan[1] (Conservation Plan) alternatives. This groundwater model will also serve as a tool for the current 2514 watershed planning effort, 2496 salmon recovery management, the Comprehensive Irrigation District Management Plan (CIDMP) process, and for Clallam County's ongoing planning work. The ground water model was developed for the Washington Department of Ecology (Ecology) using the MODFLOW model and the Ground Water Vistas pre- and post-processing software. Steady-state and transient (monthly) models were developed for the period from December 1995 to September 1997, corresponding to the study period for the U.S. Geological Survey (USGS) Hydrogeologic Assessment of the Sequim-Dungeness Area[2] (Thomas Study). The creation of the ground water model (referred to as the Ecology 2003 model) consisted of the following key activities:

- Review of existing data
- Model input development (which consisted of developing credible and documented model inputs based upon resolution of conflicting data and by completing the analyses required to generate an appropriate regional data sets)
- Model development and construction (steady-state and transient)
- Model calibration (steady-state and transient)
- Completion of a sensitivity analysis (with specific focus on hydraulic conductivity, specific yield and Dungeness River interaction with the shallow aquifer)

This document summarizes important background information (including the components of the groundwater flow system) and discusses the model development and construction, model calibration, provides a summary of the sensitivity analysis and includes an assessment of the Environmental Impact Statement (EIS) alternatives. This report is meant as a summary document that focuses on the major aspects of the groundwater model construction. The Groundwater Model Report (in preparation) will provide additional detail on the data review, model input development process, model construction and model calibration efforts.

2.0 BACKGROUND INFORMATION

2.1 Groundwater Flow System

The Sequim-Dungeness area is underlain by unconsolidated glacial and fluvial deposits that thicken from a veneer in the south study area to more than 2,400 ft at the northern boundary. Within the unconsolidated deposits, the Thomas Study delineated three aquifers separated by two

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[1] Dungeness River Water Users Association Comprehensive Water Conservation Plan, Prepared by Montgomery Water Group, Inc. Kirkland, Washington for the Washington State Department of Ecology, 1999.

[2] Blakemore E. Thomas, Layna A. Goodman, Theresa D. Olsen, 1999. Hydrogeologic Assessment of the Sequim-Dungeness Area, Clallam County, Washington. USGS Water Resources Investigation Report 99-4048. Prepared in cooperation with the Clallam County Department of Community Development and the Washington State Department of Ecology.

confining units. Bedrock formations that form the Olympic Mountain foothills in the southern portion of the study area also extend beneath the unconsolidated sediments.

2.1.1 Hydrogeologic Units

The Thomas Study delineated seven hydrogeologic units for unconsolidated deposits and bedrock. The seven hydrogeologic units are summarized below from youngest to oldest units (i.e., from ground surface down to bedrock):

- Unit 1 – Shallow aquifer. The shallow aquifer is generally about 120 feet thick and consists of various deposits including alluvium, older alluvium, Everson glaciomarine drift, Everson sand, Vashon recessional ice-contact and outwash deposits, Vashon till and Vashon advance outwash (Jones 1996). Deposits are discontinuous and observed in complex relationships, with overall thickness ranging from 10-360 feet. The coarsest deposits are centrally located in the area and associated with Dungeness River fluvial deposition.

- Unit 2 – Upper confining bed. The upper confining bed is generally about 80 feet thick and consists of silt and clay deposits. It contains locally discontinuous lenses of water bearing sand and gravel, and ranges in thickness from 5 to more than 175 feet.

- Unit 3 – Intermediate aquifer. The middle aquifer is generally 50 feet thick and consists pre-Vashon outwash deposits of sand, sand-and-gravel lenses, and some thin lenses of silt and clay. This unit is present throughout most of the model area and occurs most consistently where the unconsolidated deposits are thickest, but is observed locally to be absent. Where present, the thickness of unit 3 ranges from about 5 to 105 feet (Jones 1996).

- Unit 4 – Lower confining bed. The lower confining bed is generally about 100 feet thick and consists of till and interbedded clay, silt and fine-grained sand. It may contain locally discontinuous lenses of water-bearing sand and ranges in thickness from 5 to 190 feet.

- Unit 5 – Lower aquifer. The lower aquifer is generally 80 feet thick and consists of sand with thin lenses of sand and gravel, silt and clay. Few wells are completed in this aquifer; therefore, limited data is available for this unit.

- Unit 6 – Undifferentiated unconsolidated deposits. The undifferentiated unconsolidated deposits that underlie the lower aquifer are thin across the southern part of the study area but thicken to over 1,000 feet thick at the northern boundary of the study area. Few wells are completed in these deposits, consequently individual aquifers and confining units cannot yet be distinguished within this layer.

- Unit 7 – Bedrock. Bedrock generally underlies the unconsolidated deposits and is considered the base of the groundwater system (Jones 1996). It consists of sedimentary and volcanic rocks that are exposed at the southern boundary of the study area. Wells completed in bedrock yield relatively small quantities of water.

The vertical distribution of hydrogeologic units are shown on cross sections of Figures 17a-k in the Thomas Study. To extend the area of model coverage beyond that of the Thomas Study, three additional stratigraphic cross sections were created by TtFWI. As a part of this process, over 800 well logs from the Department of Ecology database were reviewed and evaluated. Since field verification activities were outside the scope of this effort, well locations were verified by cross-referencing street address information (where provided in the well log) with the online mapping database MapQuest. Comparison of well logs between the Thomas Study and the Department of Ecology was in most cases not possible due to the use of different well naming conventions. In some cases, well log material descriptions were not sufficient to make a geologic unit determination and therefore could not be used.

2.1.2 Groundwater Flow

Groundwater in the shallow aquifer (unit 1) flows generally northward, originating at the contact with bedrock of the Olympic Mountain foothills and discharges to the Strait of Juan de Fuca.

The middle aquifer (unit 3) receives subsurface inflow from bedrock along with downward flow from the shallow aquifer, particularly where the Dungeness River exits the foothills, to generate horizontal groundwater flow to the north. Flow conditions in the lower aquifer (unit 5) generally mimic flow in the middle aquifer, although insufficient monitoring points are available in the lower aquifer to develop a potentiometric surface (Thomas Study).

Groundwater flow in the unconsolidated, undifferentiated sediments (unit 6) is considered similar to the lower aquifer, based upon limited well data. Flow in the basalt and sedimentary bedrock (unit 7) is largely undocumented and can be assumed to occur from high elevations to low.

3.0 GROUNDWATER MODEL DEVELOPMENT

3.1 Model Boundary and Grid

The Ecology 2003 ground water model study area is bounded to the north by the Strait of Juan de Fuca, to the south by the 48th parallel, to the west by Morse Creek and to the east by the ground water divide between Johnson Creek and Jimmy-Come-Lately Creek. The model grid was developed in State Plane North NAD83 coordinates and generally consists of one-quarter-mile by one-quarter-mile grid cells. Two areas of interest, the Dungeness River corridor and Graysmarsh, were modeled with higher resolution grid cells (one-quarter-mile by one-eight-mile).

The complex stratigraphy of the Sequim-Dungeness Area is summarized in Section 2.1.1 and discussed in detail in the Thomas Study. The stratigraphy was modeled with seven layers in the vertical direction, defined as follows:

- Layer 1: Represents unit 1, the shallow aquifer, in areas where unit 1 is present. In other areas layer 1 represents bedrock
- Layer 2: Represents unit 2, the upper confining unit, in areas where unit 2 is present. In other areas layer 2 represents bedrock.
- Layer 3: Represents unit 3, the middle aquifer, in areas where unit 3 is present. In other areas layer 3 represents bedrock.
- Layer 4: Represents unit 4, the lower confining unit, in areas where unit 4 is present. In other areas layer 4 represents bedrock.
- Layer 5: Represents unit 5, the lower aquifer, in areas where unit 5 is present. In other areas layer 5 represents bedrock.
- Layer 6: Represents unit 6, undifferentiated unconsolidated deposits, in areas where unit 6 is present. In other areas Layer 6 represents bedrock.
- Layer 7: Represents unit 7, bedrock underlying the undifferentiated unconsolidated deposits units.

The layer elevations specified in the model were based on information obtained from the Thomas Study, a review of available well logs, the Geologic Survey of Canada (GSC), and the USGS Digital Elevation Model (DEM) for the Sequim-Dungeness area. The Thomas Study covered the area delineated by the shoreline to the north, Miller Peninsula to the east, approximately the 1000-foot contour line to the south, and Siebert Creek to the west. The Thomas Study was the primary source of stratigraphic information inside this area. Three cross-sections (as discussed in Section 2.1.1) were developed from an analysis of available well logs to supplement stratigraphic information for areas between Morse and Siebert Creeks, between Siebert and McDonald Creeks, and east of Johnson Creek. Offshore layer elevations were estimated based on bathymetry and thickness of unconsolidated sediments data obtained from the GSC[3]. Table 1 summarizes the methods used to develop elevations for each model layer.

Interpolated elevations for layers 1 through 7 were quality control checked to eliminate crossing layers and ensure a minimum layer thickness of 10 feet. Model layer cross-sections were compared against the Thomas Study hydrogeologic cross-sections as a quality control measure.

3.2 Model Study Period

The steady-state model was developed to represent average annual conditions during the study period from December 1995 to September 1997. A transient model was based on the calibrated steady-state model to evaluate the monthly fluctuations in ground water elevations and streamflows. The transient model required input of monthly parameters for each of the 22 months simulated during the study period. Each month is represented in the model as a stress period and inputs remain constant within each stress period. The methods used to develop model inputs, referred to as properties and boundary conditions, are summarized in the following sections for the steady-state and transient models.

3.3 Steady-State Model Properties

Hydrogeologic properties required for the steady-state model include hydraulic conductivity and average annual ground water recharge. These properties were applied to each model grid cell using the Ground Water Vistas software according to the methods described in the following sections.

3.3.1 Hydraulic Conductivity

The hydraulic conductivity values were chosen for the current modeling effort based on the best calibration fit to groundwater elevations and water budget within an observed range of measured values and literature values. This methodology was also employed by Drost (1983) during the development of his steady-state model. The selection of higher conductivity values results in a better calibration fit and representation of water levels and water budgets in the aquifer layers with the current modeling procedures, computations, and stratigraphic representation.

[3] GSC, 2000. Mosher, D.C. and Johnson, S.Y. (eds.), Rathwell, G.J., Kung, R.B., and Rhea, S.B. (compilers). Neotectonics of the eastern Juan de Fuca Strait: a digital geological and geophysical atlas. Geologic Survey of Canada Open File Report 3931.

Table 1. Model Layer Geometry

Layer	Source and Method
1	Top elevations were interpolated for each model grid cell from the USGS DEM data in upland areas and GSC data for bathymetry in offshore areas. Bottom elevations were interpolated from data from the Thomas Study unit 1 bottom elevations, unit 1 bottom elevations from the well log analysis, and GSC unconsolidated sediment thickness.
2	Bottom elevation was interpolated from data from the Thomas Study unit 2 bottom elevations, unit 2 bottom elevations from the well log analysis, and GSC unconsolidated sediment thickness.
3	Bottom elevation was interpolated from data from the Thomas Study unit 3 bottom elevations, unit 3 bottom elevations from the well log analysis, and GSC unconsolidated sediment thickness.
4	Bottom elevation was interpolated from data from the Thomas Study unit 4 bottom elevations, unit 4 bottom elevations from the well log analysis, and GSC unconsolidated sediment thickness.
5	Unit 5 was assumed to have a uniform thickness of 100 feet based on previous model studies[4]. The bottom elevations were set by subtracting 100 feet from the unit 4 bottom elevations.
6	Bottom elevations in upland areas were interpolated from bedrock elevations from the Thomas Study. Bedrock elevations in offshore areas were developed by subtracting the GSC thickness of unconsolidated sediments above bedrock from the GSC bathymetry data.
7	Layer 7 was assumed to have a uniform bottom elevation of –3,200 feet to represent a portion of the underlying bedrock.

General Methodology for Determination of Initial Horizontal and Vertical Hydraulic Conductivity Values (All Layers)

Initial Horizontal hydraulic conductivities for layers 1 through 6 were specified using the following procedure:

- Layer bottom elevations were compared to bedrock elevations from the Thomas Study for each model grid cell.
- Grid cells where the layer bottom elevation was less than the bedrock elevation were flagged to indicate that the cell represented bedrock rather than an unconsolidated hydrogeologic layer.
- For each layer selected, horizontal hydraulic conductivity values for the grid cells representing the corresponding hydrogeologic layer (layers 2 through 6) were established based on the ranges in Table 1 of the Thomas Study.

[4] Dungeness River Water Users Association Water Conservation Plan, Prepared by Montgomery Water Group, Inc. Kirkland, WA for the Washington State Department of Ecology, August 1998, Chapter 7 and Drost, B.W., Impact of Changes in Land Use on the Ground-Water System in the Sequim-Dungeness Peninsula, Clallam County, Washington. USGS Water Resources Investigations Report 83-4094, Tacoma, Washington, 1983.

- Horizontal hydraulic conductivity in the flagged bedrock cells were set.

Vertical hydraulic conductivities were specified in each layer by indicating the ratio of the horizontal hydraulic conductivity to the vertical hydraulic conductivity. Ground Water Vistas automatically calculated the leakance associated with the specified ratio for each layer.

During the model calibration, the hydraulic conductivity values and anisotropy ratios were varied within a reasonable range (based upon the Thomas Study, Puget Sound RASA Study and other literature values) during the steady state model calibration to achieve the optimum model performance. The final horizontal hydraulic conductivity values and anisotropy ratios each layer for the calibrated model are presented in Section 4.1.2.

Layer 1 (Shallow Aquifer) Horizontal Hydraulic Conductivity
Horizontal hydraulic conductivities were specified in each model grid cell in units of feet per day based primarily on information from the Thomas Study. Layer 1 hydraulic conductivity values were set in the model by importing the Thomas Study horizontal hydraulic conductivity zone shape file (Figure 26 in Thomas Study) into Ground Water Vistas.

Horizontal hydraulic conductivity in areas outside the Thomas Study area were set based on the well log review, specific capacity analysis (where data were available and those hydraulic conductivity ranges specified in Table 1 of the Thomas Study.

Layers 2 and 4 (Confining(Aquitard)) Layers: Horizontal and Vertical Hydraulic Conductivity Values
A range of horizontal hydraulic conductivity values was developed for layers 2 and 4 based on combined information from the Thomas Study[5] and from stratigraphic cross-sections developed by TtFWI from well logs and specific capacity data outside the Thomas Study area. During the steady-state model calibration, horizontal hydraulic conductivity values were varied within the defined range of reasonable values for each layer and established the combination of horizontal conductivity values that resulted in the best fit to measured calibration targets and estimates of water budget fluxes from the Thomas Study and Drost's 1983 study[6].

The horizontal hydraulic conductivity values chosen for layers 2 and 4 as a result of the steady-state calibration are shown in Table 2.

Table 2. Horizontal Hydraulic Conductivity Values for Layers 2 and 4

Layer 2 & 4 K_H (ft/day)	Thomas Study and TtFWI Cross-Section K_H (ft/day)
20	6.3 – 200, Median 24

Vertical hydraulic conductivity values for each layer were assigned in the groundwater model by assigning an anisotropy ratio, the ratio of K_H to K_V. The ratios that resulted in the best fit to model calibration targets and the overall flux estimates for the water budget are shown in Table 3 for layers 2 and 4.

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[5] Blakemore E. Thomas, Layna A. Goodman, Theresa D. Olsen, 1999. Hydrogeologic Assessment of the Sequim-Dungeness Area, Clallam County, Washington. USGS Water-Resources Investigation Report 99-4048.
[6]Drost, B.W., 1983. Impact of Changes in Land Use on the Ground-water System in theSequim-Dungeness Peninsula, Clallam County, Washington, Water Resources Investigation Report 83-4094.

Table 3. Vertical Hydraulic Conductivity Values for Layers 2 and 4

Layer 2 & 4 K_v: K_H ratio	Resulting K_V (ft/day)	Puget Sound RASA Study Kv (ft/day) values for glacial till[7]
Layer 2: 125	0.16	0.0002 – 53.0 ft/day
Layer 4: 75	0.27	0.0002 – 53.0 ft/day

As can been seen from Table 3, the vertical hydraulic conductivity values are at the upper end of the range of accepted values, though by no means the highest published conductivity values. This finding is in keeping with results from the Puget Sound RASA Study[7] which notes that "interglacial deposits present along the Strait of Juan de Fuca in parts of Clallam County generally are coarse grained (Washington Department of Ecology, 1978); the close proximity to the source of the deposits, the Olympic Mountains, can account for the coarseness of these deposits." Therefore, the hydraulic conductivities observed in the study area may be higher than in other areas further from the depositional source. The Puget Sound RASA Study also presents a range of values for vertical hydraulic conductivities for till of 0.0002 ft/day to 53.0 ft/day, but notes that these values may be influenced by some horizontal conductivity components during testing. The values for Layers 2 and 4 used in the model calibration of 0.16 ft/day and 0.27 ft/day are well within this range. In addition, the vertical conductivity values are within the range cited within available literature of 0.00005 ft/day (Drost 1983) to 1.0 ft/day (Johnson, 1963).

Bedrock Hydraulic Conductivity
Bedrock horizontal hydraulic conductivity values were specified in areas of layer 1 where layer 1 is not present due to bedrock outcropping. These areas were identified using the well log analysis and the geologic maps[8] for the area.

3.3.2 Recharge

The Ecology 2003 model recharge to ground water in the Sequim-Dungeness area consists of four main components: precipitation recharge, irrigation recharge, well return recharge, and wastewater application recharge. Each of the four components were specified for each model grid cell and summed to obtain the total recharge for each model grid cell. The components were developed as follows:

- Precipitation Recharge: Precipitation recharge was based on the Deep Percolation Model (DPM) annual-average precipitation recharge estimates for the study period shown in Figure 29 in the Thomas Study. The DPM precipitation recharge was developed using a series of regression equations for estimating precipitation recharge from soil type, land surface slope and annual average precipitation (Table 5 in the Thomas Study). These equations were applied to the model area outside the Thomas Study using Geographic Information Systems (GIS) along with the soil group coverage for the area to develop a

[7] USGS, 1998, Hydrogeologic Framework of the Puget Sound Aquifer System, Washington and British Columbia, Regional Aquifer System Analysis, Professional Paper 1424-D

[8] Schasse, Henry W., Wegmenn, Karl W. December 2000. Geologic Map of the Carlsborg 7.5-Minute Quadrangle, Clallam County, Washington. State Department of Natural Resources Open File Report 2000-7.
Schasse, Henry W., Logan, Robert L. June 1998. Geologic Map of the Sequim 7.5-Minute Quadrangle, Clallam County, Washington. State Department of Natural Resources Open File Report 98-7.

complete GIS coverage of precipitation recharge. The GIS shape file for precipitation recharge was applied to the model grid using a weighted area average to specify values in each model grid cell.

- Irrigation Recharge: Average annual irrigation recharge was also obtained from the DPM results from the Thomas Study (Figure 33). The shape file for the average annual irrigation recharge was obtained from USGS and applied to the model grid using a weighted area average. The irrigation recharge includes recharge due to ditch leakage and recharge due to infiltration of unconsumed field irrigation.

- Well Return Recharge: A portion of the water pumped from wells was assumed to return to the ground water as well return recharge from sources such as septic systems and domestic irrigation. Pumping rates were applied to the wells in the study area as described in Section 3.4.4. Wells were assigned to the nearest model grid cell and those wells that were inside areas identified as sewered areas were flagged. All other wells were assigned well return rates equal to 70 percent (domestic, public, and dairy usage) or 33 percent (irrigation, golf, stock, and industrial usage) of the estimated pumping rate. The return rates were summed for each model grid cell.

- Wastewater Application Recharge: The Sunland Water District applies treated wastewater to a 30-acre area at T30NR3W Section 5 at a rate of approximately 30 inches per year[9]. The wastewater application rate of 30 inches per year over a 30-acre area was converted to the corresponding applied volume per year. This volume per year was applied over a single 20-acre (1/4 mile by 1/8 mile) grid cell at a rate of 0.0103 feet per day.

The four recharge components were summed up for each model grid cell using an Excel spreadsheet and applied to the steady-state model using Ground Water Vistas.

While the Dungeness River leakage also constitutes a component of recharge, in the Ecology 2003 model it is treated separately from the components of recharge identified above. The interaction between the aquifer and Dungeness River was modeled using the MODFLOW Streamflow-Routing Package (Stream Package). This Stream Package performs an accounting of both surface flow in the river and flux between the river and ground water. Additional information on the Dungeness River and stream package is discussed in Section 3.4.6.

3.4 Steady-State Boundary Conditions

3.4.1 Southern Constant Head Boundary

A constant head boundary was developed for the southern model boundary to provide a source for ground water flow from the upland areas. The head values applied to each model grid cell on the southern boundary were developed using a relationship between the ground water elevation in several wells near the boundary and the ground surface at each well. A regression equation for static water elevation versus ground surface elevation was developed using information from available well logs. The regression equation was used to apply heads to the southern boundary based on ground surface elevation in each model grid cell along the boundary. Because the regression equation was valid for ground water heads up to approximately 1,600 feet, the maximum head along the southern boundary was set equal to 1,600 feet.

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[9] Rongey/Associates, 1992. Hydrological Investigation, Sunland Comprehensive Wastewater System Plan, February 1992.

3.4.2 Offshore Drains in Strait of Juan de Fuca

The ground water model included a portion of the offshore areas in the Strait of Juan de Fuca to the north. This area was included to extend the model away from the upland areas of interest and allow for ground water to flow out of the model area into the strait. The offshore areas were modeled as drain boundary conditions in the ground water model. Drains allow ground water to pass out of the model as a function of the head specified in the drain boundary condition, a drain conductance, and the ground water head in the surrounding cells.

A drain boundary condition was set in each cell in the offshore area in layer 1. The heads specified in the drain cells were developed using an equivalent freshwater head method[10] for adjusting the saltwater heads in the strait to an equivalent freshwater head. The depth of saltwater above each layer 1 offshore grid cell was found using the GSC bathymetry data (top of layer 1). These depths were converted to the equivalent freshwater depth using the ratio of the densities of saltwater in the area and freshwater. For each model grid cell, the equivalent freshwater depth was added to the elevation of the top of layer 1 to determine the equivalent freshwater head for each offshore drain boundary condition. The hydraulic conductivities were set in each drain boundary condition according to the layer 1 hydraulic conductivity.

3.4.3 No Flow Boundary

Model grid cells outside the area of interest, areas to the west of Morse Creek and east of Sequim Bay and the ground water divide between Johnson Creek and Jimmy-Come-Lately Creek, were specified as no flow cells. These cells are visible in the model grid, but are not included in the model calculations and do not require input parameters.

3.4.4 Well Pumping

Several well databases for the study area were reconciled and combined to form as comprehensive a list of wells and pumping information as possible. A well database obtained from Clallam County was used as the master list, due primarily to the fact that the database contained well identification numbers in the Township, Section, Range (TRS) format. Additional databases were obtained from the Thomas Study Appendix A, the Washington Department of Health (DOH), and Ecology. The Ecology well database was compared to the other databases which resulted in very little overlap due to the different well naming conventions used by the database owners. As a result, the Ecology database could not be used for well pumping information. Pacific Ground water Group (PGG) provided a table of 1996 recorded pumping rates for select wells in a memo to Foster Wheeler Environmental (now TtFWI)[11]. The databases were combined using the following process:

- The Thomas Study Appendix A wells were compared to the master list. If the well identification numbers matched, the additional information from the Thomas Study list was added to the master list (well depth, GPS location, well usage code).
- The DOH Group A and B well database was compared to the master list. The DOH database did not use the TRS well identification format, so comparisons were made based

[10] Drost, B.W., D.M. Ely, and W.E. Lum, II USGS, 1999. Conceptual Model and Numerical Simulation of the Ground-Water-Flow System in the Unconsolidated Sediments of Thurston County, Washington. USGS Water Resources Investigations Report 99-4165, Tacoma, Washington, 1999.

[11] PGG, Data Orientation Memo to Foster Wheeler Environmental Corporation, August 7, 2002. Table 1. Recorded Pumping Rates.

on approximate location and well owner name. If an obvious match was located, the DOH well information was added to the master list entry. If no obvious match was made, the DOH well was added as a new well in the master list.

- Recorded pumping data for 1996 for those wells in Table 1 of the PGG Data Orientation Memo were added to the master list.
- The master list was cleaned up by removing duplicate wells, those installed after September 30, 1997, wells listed in the Thomas Study Appendix A as "U" for unused, wells listed in the Clallam County notes as abandoned, grouted, discontinued, dry, oil well, salt water, and possible duplicate, and monitoring wells.

After completing the master well list for the study period, steady state pumping rates were applied to each well in the list according to the following process:

- Recorded 1996 pumping rates for the wells in Table 1 of the PGG Data Orientation Memo were applied to those wells.
- Pumping rates for the DOH Group A and B wells were applied according to the number of connections times an assumed rate of 350 gallons per day (gpd) for each connection.
- The remaining wells were assumed to have a single connection and a pumping rate of 350 gpd.
- Pumping rates were converted to ft^3/day for input to the model via Ground Water Vistas and summed for each model grid cell.

The wells were assigned to model grid cells according to their location and to a model layer according to the well depth recorded in the master list. The well depths were compared to the model layer elevations and a model layer was assigned to each well in the master list. The model layer assignments were further refined by reassigning wells from layers 2 and 4 (the confining layers) that fell within 20 feet of an aquifer layer to the next nearest aquifer layer.

3.4.5 Streams Modeled as Drains

The tributaries of the lower Dungeness River and independent creeks are also interconnected with the ground water flow regime (Drost 1983, Thomas Study). Gains and losses resulting from discharge of ground water into the streams or loss of water to the shallow aquifer were measured on October 7, 1997 by the USGS (Thomas Study). Based upon these instream measurements and field observations, the total estimated average annual discharge to the small tributaries and independent streams, included in the EIS study area, was estimated to be 25 cfs. With the exception of Bear Creek, in which a loss to ground water was measured; all other creeks received ground water discharge during the period of measurement.

Based upon the information above, nine streams in the model study area were modeled using the drain boundary condition to evaluate the ground water contribution to the streams. The streams modeled as drains are, from west to east, Morse Creek, Bagley Creek, Siebert Creek, McDonald Creek, Matriotti Creek, Cassalary Creek, Gierin Creek, Bell Creek, and Johnson Creek. The streambed conductivities were set to initial values and varied during model calibration within a reasonable range to calibrate the ground water contribution to the streams. The final conductivities are provided in the discussion of model calibration parameters in Section 4.1.2.

3.4.6 Dungeness River Stream Package

The interaction between the aquifer and Dungeness River was modeled using the MODFLOW Stream Package. The stream package compares local ground water elevations to the water surface elevation in the river and determines the amount and direction of flow between the river and the ground water. In addition, the stream package performs an accounting of both surface flow in the river and flux between the river and ground water.

The Dungeness River downstream of USGS gage #12048000 was divided into model cells based on the location of the river. Each Dungeness River model cell represents a "reach" in the model. In the model, reaches are grouped into segments, which begin and end with either an inflow from a tributary or an outflow from a diversion in the river. Watershed runoff values were calculated based on the average annual precipitation and recharge data from the Thomas Study and included as tributary inflows to the river at locations determined by topographic analysis. Diversions from the river for irrigation purposes were based on the information in Table 6 of the Thomas Study. The inflow at the upstream end of the modeled portion of the Dungeness River was based on the average annual river flow recorded at the USGS gage #12048000.

The stream package requires input of parameters for each river reach including channel width, length, bed elevation, bed hydraulic conductivity, bed thickness, and roughness. These parameters were specified as follows:

- Channel Width: The channel width for each model reach was developed from 60 Dungeness River cross sections obtained from the U.S. Bureau of Reclamation (BOR)[12]. Rating curves were developed for each river cross-section to determine river flow as correlated to depth. For each cross-section an equivalent rectangular channel was chosen that had approximately the same rating curve for the flow range during the study period as the measured cross-section. The widths of the equivalent rectangular channels were applied to the nearby model river reaches.
- Channel Length: The channel length was set based on the length of the model cell for each river reach.
- Bed Elevation: The riverbed elevations were obtained from the USGS DEM contour map.
- Bed Hydraulic Conductivity: The hydraulic conductivity of the riverbed was specified based on information in the recent USGS study of Dungeness River ground water/surface water interactions[13].
- Bed Thickness: The riverbed was assumed to have a thickness of 5 feet.
- Roughness: A typical Manning's n roughness coefficient of 0.025 was assumed[14].

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[12] Bountry et al, 2002. United States Department of the Interior, Bureau of Reclamation. Physical Processes, Human Impacts, and Restoration Issues of the Lower Dungeness River. Water Resources Services Division, Sedimentation and River Hydraulics Group, May 2002.

[13] Simonds W.F. and K.A. Sinclair, 2002. Surface Water-Ground Water Interactions Along the Lower Dungeness River and Vertical Hydraulic Conductivity of Streambed Sediments, Clallam County, Washington, September 1999-July 2001. USGS Water Resources Investigations Report 02-4161, Washington State Department of Ecology Report 02-03-027.

[14] Chow, Ven Te, Open Channel Hydraulics, McGraw Hill Book Company, New York, New York, 1959.

3.5 Transient Model Properties

The steady-state model properties were modified to develop the monthly transient ground water model. Hydraulic conductivity remains constant over time and the steady-state values were copied to each of the model's monthly stress periods for the transient model. Recharge changes over time and the steady-state recharge inputs were prorated to represent monthly conditions in the transient model as described below in Section 3.5.1. The MODFLOW model conducts a storage computation as part of the transient model and requires input of storage coefficients that are not required for the steady-state model. These storage coefficients were developed as described in this section (Section 3.5.2).

3.5.1 Recharge

The four steady-state recharge components described in Section 3.3.3 were prorated individually on a monthly basis to develop monthly recharge for the transient model. The four-recharge components were then summed on a monthly basis to estimate total monthly recharge for each stress period for input to the model via Ground Water Vistas. Precipitation recharge was varied monthly based on the average monthly variation during the study period from six local USGS precipitation monitoring sites. Irrigation recharge was varied monthly based on monthly outtakes for each irrigation district or company according to Thomas Study Table 6. Well return recharge and wastewater application recharge were varied according to the same monthly patterns as well pumping rates as described in Section 3.4.4.

3.5.2 Storage Coefficients

The transient model uses three storage parameters in calculation of transient ground water storage: storativity, specific storage, and porosity. A literature review was conducted to develop a range of reasonable values for these parameters[15]. The mid-range value for each parameter was specified prior to the transient model calibration and the storage coefficients were modified during calibration to achieve the optimum model calibration. The storage coefficients from the calibrated transient model are summarized in the discussion of the calibration in 4.2.2 and in the discussion of sensitivity analysis results (Section 5.1.2).

3.6 Transient Boundary Conditions

Several of the steady-state boundary conditions described in Section 2.4 were assumed to remain constant throughout the study period, including the constant head boundary along the southern model boundary, the offshore drain elevations in the Strait of Juan de Fuca, the no flow cells along the model boundary, and the stream characteristics for the streams modeled as drains. Well pumping rates and inputs to the Dungeness River stream package were varied on a monthly basis for the transient model as described in the following sections.

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[15] Sources included:
Thomas Study;
Drost, B.W. 1983;
Freeze, R. Allan, and Cherry, John A., Ground Water, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1979.;
Sinclair, Kirk. 2002, A Comparison of Horizontal Hydraulic Conductivity Values Derived from Aquifer Test and Well Specific-Capacity Data for the Sequim-Dungeness Area. Washington Department of Ecology Report. Publication No. 02-03-017, April 2002.

3.6.1 Well Pumping

The average annual well pumping rates specified in the steady-state model were prorated on a monthly basis to represent monthly pumping rates. The pumping rates were varied on a monthly basis according to the well usage. Domestic and public wells were assumed to vary according to the measured monthly variation reported by the City of Sequim for the study period. Wells for industrial and fish usage were assumed to have a constant pumping rate and wells for dairy and stock usage were assumed to have a nearly constant pumping rate over the year. Wells for irrigation and golf course usage were assumed to vary according to the monthly variation in irrigation outtakes reported by the Dungeness River Water Users Association. The monthly pumping rates were assigned to each stress period in the model using Ground Water Vistas.

3.6.2 Dungeness River Stream Package

The river inflow at the upstream end was varied for each stress period according to recorded monthly streamflows at the USGS gage site. The steady-state runoff inputs to the river were varied monthly according to measured monthly variation in precipitation at six precipitation measurement sites. Diversion outflows from the river by irrigation districts and companies were varied using values from Thomas Study Table 6. All other parameters in the stream package remained the same as for the steady-state condition.

4.0 Groundwater Model Calibration

The first step in model calibration consisted of calibrating the steady-state model to measured ground water elevations, river flows, and ground water contributions to streamflow during the study period. Following completion of the steady-state model calibration, the steady state model was expanded to include 22 monthly stress periods to create the transient model. The transient model was populated with the monthly properties and boundary conditions and calibrated to measured ground water elevations, river flows, and ground water contributions to streamflow during the study period. The following sections describe the calibration targets, changes made to model parameters during calibration, and the calibration results for steady-state and transient conditions, respectively.

4.1 Steady State Calibration

Before beginning the steady-state model calibration, the model was tested and checked to make sure the model performed stable, reasonable computations. Initial runs showed a series of dry cells representing areas where the model was not able to reach a converged solution during the iterative computation process. These dry cells were primarily along the steep faces of the foothills where layer 1 thins. After further testing, the model was stabilized to eliminate non-converging dry cells by thickening layer 1 in the foothills. Hydraulic conductivities for the thickened layer 1 areas were adjusted by a weighted average of the layer 1 and layer 2 hydraulic conductivities to effectively model the actual hydrogeologic layers despite the thickening layer 1 in the model. With this adjustment, the steady-state model reached a converged, stable solution with no dry cells.

4.1.1 Steady-State Calibration Targets

Calibration targets, or measured ground water elevations, were imported into Ground Water Vistas for comparison to modeled ground water elevation. The steady-state targets were developed from a ground water monitoring database obtained from Clallam County. The measured ground water elevations were sorted by date to eliminate measurements made outside the study period from December 1995 to September 1997. The remaining measurements were averaged over the study period at each location and imported into Ground Water Vistas. The approximately 70 steady-state calibration targets were distributed across the study area and over a 710-foot elevation range.

4.1.2 Steady-State Calibration Parameters

During the steady-state calibration, model parameters including hydraulic conductivities, and bed conductivities for streams modeled as drains and for the Dungeness River were varied within reasonable limits to improve the comparison between model-predicted ground water elevations and target elevations. In addition, the parameters were optimized to achieve a satisfactory overall water balance for the model area.

The final hydraulic conductivities selected for the calibrated steady-state model are shown in Table 4.

Table 4. Calibrated Hydraulic Conductivity Values

Layer	Horizontal Hydraulic Conductivity (ft/day)	Hydraulic Conductivity for Bedrock Portions of Layer (ft/day)	Ratio of Horizontal to Vertical Hydraulic Conductivity
1	10 to 250	0.80	125
2	20	0.80	125
3	60	0.34	75
4	20	0.34	75
5	35	0.34	75
6	20	0.34	75
7	0.34	0.34	1

All of the final hydraulic conductivities are well within the ranges in the Thomas Study Table 1. The ratios of horizontal to vertical hydraulic conductivity are within ranges presented in literature for the area, including the Puget Sound Regional Aquifer System Analysis[16], and values used in previous modeling efforts[17]. The higher ratios for the shallow aquifer (layer 1) and upper confining layer (layer 2) were chosen due to model sensitivity to the ratio and a better fit for the overall water budget with higher ratios in these layers. A higher ratio for layer 1 is not unreasonable due to the complex stratigraphy within the shallow aquifer.

Streambed hydraulic conductivities were varied for both the streams modeled as drain boundary conditions and the Dungeness River stream package reaches. The final streambed hydraulic conductivities for the nine streams modeled as drains ranged from 0.01 to 10 ft/day. The Dungeness River bed hydraulic conductivities ranged from 0.01 to 29 ft/day along the length of the river. Dungeness River bed hydraulic conductivities calculated in a recent Thomas Study ranged from 1 to 29 ft/day along the length of the river[18].

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[16] Vaccaro, J.J., A.J. Hansen, Jr., M.A. Jones, 1998. Hydrogeologic Framework of the Puget Sound Aquifer System, Washington and British Columbia, Regional Aquifer-System Analysis – Puget-Willamette Lowland. USGS Professional Paper 1424-D, 1998.

[17] PGG, 2002 and Drost. B.W., 1983.

[18] Simonds, W.F., and K.A. Sinclair, 2002. Surface Water-Ground Water Interactions Along the Lower Dungeness River and Vertical Hydraulic Conductivity of Streambed Sediments, Clallam County, Washington, September 1999-July 2001. USGS Water Resources Investigations Report 02-4161, Washington State Department of Ecology Report 02-03-027.

4.1.3 Steady-State Calibration Results

Ground Water Vistas performs a series of statistical analyses on the model predicted ground water elevations and the imported calibration target elevations. These calibration statistics provide a means of evaluating how well the model was calibrated. Ground Water Vistas calculates many statistics, including the following:

- Residual (ft): The difference between the model predicted ground water elevation and the target elevation at a target location.
- Residual Mean (ft): The mean value of all of the residuals.
- Residual Standard Deviation (ft): The standard deviation of all of the residuals.
- Residual Standard Deviation/Range (%): The residual standard deviation divided by the elevation range of the target elevations.

The calibration statistics for the steady-state model are summarized in Table 3.

Table 5. Steady-State Model Calibration Statistics

Residual Mean	-1.0 ft
Residual Standard Deviation	26.8 ft
Residual Standard Deviation/Range	3.8%

Ground Water Vistas recommends the residual standard deviation divided by the target range should be "less than 10 to 15 percent for a good calibration[19]". The steady-state model residual standard deviation divided by the target range is 3.8 percent, well below the recommended range, indicating good agreement of the model with calibration targets.

4.2 Transient Calibration

The transient model was developed based on the calibrated steady-state model. Initial test runs showed that the model reached a stable, converged solution with no dry cells. The transient model is sensitive to the initial heads specified for the model simulation. The initial heads for the transient model calibration were developed by an iterative process. First, the final ground water heads for the steady-state model were set as the initial heads at the beginning of the transient model in stress period 1, December 1995. The model was run for 12 stress periods, or months, ending with November 1996. The resulting ground water heads for November were in turn set as the initial heads for stress period 1, December 1995, and the model was run again. This process was repeated until the resulting heads were within 0.2 feet, or 2 inches, of the initial starting heads. The resulting ground water heads were used as the initial heads for the full 22-month transient calibration run from December 1995 to September 1997. This process allowed the variation in recharge, well pumping, and the Dungeness River parameters to "warm up" the model to reflect starting heads typical of December rather than the average annual heads resulting from the steady-state model.

4.2.1 Transient Calibration Targets

Transient calibration targets were imported into Ground Water Vistas for comparison to modeled ground water elevation. The targets were identified by sorting the Clallam County ground water monitoring database by date to eliminate measurements made outside the study period from

[19] Ground Water Vistas Version 3.37, Electronic Manual description of Computing Calibration Statistics

December 1995 to September 1997. The remaining measurements imported into Ground Water Vistas along with the date of measurement and location. The approximately 60 transient calibration targets were spread over the study area and over a 712-foot elevation range.

4.2.2 Transient Calibration Parameters

The transient model calibration was optimized by adjusting the storage coefficients for each model layer to achieve the best fit to the overall water balance and calibration targets. The final storage coefficients for the transient model are summarized in Table 4.

Table 6. Transient Model Storage Coefficients

	Non-Bedrock Areas			Bedrock Areas		
Layer	Storativity	Specific Yield	Porosity (%)	Storativity	Specific Yield (S_y)	Porosity (%)
1	NA	0.25	0.3	NA	NA	0.05
2	0.001	NA	0.4	0.00005	NA	0.05
3	0.005	NA	0.3	0.00005	NA	0.05
4	0.001	NA	0.4	0.00005	NA	0.05
5	0.005	NA	0.3	0.00005	NA	0.05
6	0.005	NA	0.3	0.00005	NA	0.05
7	0.00005	NA	0.05	0.00005	NA	0.05

4.2.3 Transient Calibration Results

Ground Water Vistas calculates a series of calibration statistics for the transient model using the same methods as for the steady-state model. The calibration statistics for the transient model are summarized in Table 5.

Table 7. Transient Model Calibration Statistics

Residual Mean	-.17 ft
Residual Standard Deviation	21.8 ft
Residual Standard Deviation/Range	3.1%

Ground Water Vistas recommends the residual standard deviation divided by the target range should be "less than 10 to 15 percent for a good calibration[20]". The transient model residual standard deviation divided by the target range is 3.1 percent, well below the recommended range, and less than that for the steady-state model. The calibration statistics for the transient model are slightly improved over those for the steady state model, likely due to increased confidence in the calibration targets used for the transient calibration. The targets imported into the steady-state model were averaged over the study period and the transient target measurements were compared to model predicted elevations for the same month as the measurements were made.

5.0 Sensitivity Analysis

A sensitivity analysis was performed to evaluate the impact of key parameters on the Ecology 2003 groundwater model (steady state and transient calibration). Key parameters which were

[20] Ground Water Vistas Version 3.37, Electronic Manual description of Computing Calibration Statistics

varied as a part of this sensitivity analysis were hydraulic conductivity and specific yield (i.e., the storage coefficient for the shallow aquifer (layer 1)). As a part of the sensitivity analysis, the interaction between the Dungeness River and shallow aquifer was also further investigated and evaluated. Results from the sensitivity analysis for the main parameters of concern (hydraulic conductivity and specific yield) are discussed in this section. Results of the sensitivity analysis with respect to Dungeness River interaction with the shallow aquifer will be discussed in the Groundwater Model Report.

5.1 Horizontal Hydraulic Conductivity Analysis

The steady-state calibration of the groundwater model reached for the EIS relies principally on parameter values presented in the hydrogeologic assessment report of Thomas Study. In the case of hydraulic conductivity, the original model calibration (referred to within this section as "Cal17") varied horizontal hydraulic conductivity values within the range of Table 1 in the Thomas Study. With respect to the horizontal hydraulic conductivities of the aquitards (represented by model layers 2 and 4), the final calibration established values at 20 ft/day for these layers (at the low end of range in Table 1 Thomas Study). While the horizontal hydraulic conductivity of 20 ft/day is higher than often observed for an aquitard, the application of an anisotropy ratio (i.e., the ratio of horizontal to vertical hydraulic conductivity) was used to provide much lower vertical hydraulic conductivities to limit vertical flow. Specifically, the model calculated low vertical hydraulic conductivities from the selection of an anisotropy of 125 for layers 1 and 2. An anisotropy ratio of 75 was applied for layers 3 to 6. Using these anisotropy ratios, vertical hydraulic conductivities applied for the EIS steady-state calibration were 0.16 ft/day for the layer 2 aquitard and 0.27 ft/day for the layer 4 aquitard.

An alternate approach for representing the aquitards in layers 2 and 4 is to select a lower range for horizontal hydraulic conductivities and apply a smaller horizontal to vertical anisotropy. To assess the model sensitivity to this approach, a sensitivity calibration was conducted whereby horizontal hydraulic conductivities for the aquitards were limited to a range from 1 to 3 ft/day (as opposed to the original Cal17 model in which horizontal hydraulic conductivities for layer 2 and 4 were set at 20 ft/day).

This sensitivity calibration is referred to hereafter by its file root name of "Cal24". Initial changes for Cal24 included setting horizontal hydraulic conductivities in layers 2 and 4 to 1 ft/day and adjusting the anisotropy ratio between 125 (for layer 2) and 100 (for layer 4). The lower horizontal hydraulic conductivity and applied anisotropy ratios resulted in a vertical hydraulic conductivity values for layers 2 and 4 of between 0.008 to 01 ft/day.

Principal parameter changes between Cal17 and Cal24 are summarized in Table 8. Additional parameter changes for Cal24 are described below (and are also summarized in Table 8):

- River hydraulic conductivities were reset to initial values of Simonds and Sinclair (2002), and then lowered in the northern peninsula as calibration progress to reduce losses from the river in that area. These changes eliminated the values that had been doubled in vicinity of Sequim for Cal17 (river reaches 2 and 3) and restored the first part of reach 1 that had been "shut down" by extremely low values due to high hydraulic heads computed for the narrow river drainage.
- Bedrock hydraulic conductivities were lowered.
- Slight anisotropy was added for bedrock
- Layer 5 and 6 hydraulic conductivities were increased
- A low anisotropy zone was added for model rows 1 through 6 for layers 2 and 4 to simulate an extension of the model area further north and provide for greater communication of

lower layers with the Strait of Juan de Fuca. This modification resolved a condition of excessively high heads computed for lower layers of the model due to the inability in the model for deeper groundwater to discharge to the sea.

Table 8. Parameter comparison for steady-state calibration (Cal17) and sensitivity calibration (Cal24)

Parameter	Cal 17	Cal 24
Unconsolidated Sediments Hydraulic Conductivity (Kh) (ft/day)		
Layer 1	2.5 - 400	1 - 250
Layer 2	20	1
Layer 3	60	65
Layer 4	20	1
Layer 5	35	40
Layer 6	20	65
Bedrock Kh Values (ft/day)		
Layer 1	0.8	0.65
Layer 2	0.8	0.15
Layer 3	0.34	0.1
Layer 4	0.34	0.04
Layer 5	0.34	0.04
Layer 6	0.34	0.04
Layer 7	0.34	0.01
Anisotropy (Kh:Kv)		
Layer 1	125	10
Layer 2	125	125
Layer 3	75	10
Layer 4	75	100
Layer 5	75	10
Layer 6	75	25
Layer 7 (bedrock)	1	1
Bedrock (layers 1 to 6)	1	2
Rows 1 to 6 in Layers 2 and 4	125. 75	2
Dungeness River Vertical Hydraulic Conductivities (Kv) as factor of Simonds and Sinclair (2002) Values		
Reach 1	0.001 to 1	1
Reach 2	2	1
Reach 3	2	1 to 0.3
Reach 4	1	1 to 0.3
Reach 5	1	1

Concordant with other changes in the sensitivity calibration, conductance values for drains that represent streams were adjusted to allow the model to compute observed groundwater-to-stream discharge rates. Gains and losses in the Dungeness River were monitored to achieve a target overall loss in the range of 12 to 15 cfs.

Statistical analyses for calibration, which compare the model predicted groundwater elevations with calibration target elevations, are presented below for both Cal17 and Cal24.

Table 9. Steady State Model Calibration Statistics

Calibration Statistic	Cal17	Cal24
Residual Mean	-1.0 ft	-2.19 ft
Residual Standard Deviation	26.8 ft	20.3 ft
Residual Standard Deviation/Range	3.8%	2.9%

As an overall indicator, the calibration statistics show Cal24 to be a moderately better fit to observations than Cal17. The slight residual high is indicated for Cal24 results primarily from layer 1 near the northern extent of the Dungeness River.

5.2 Specific Yield Analysis

The transient model for the Cal24 sensitivity analysis was also completed. The primary sensitivity for the transient model is calibration of specific yield. Specific yield values ranging from 0.02 to 0.19 were applied. A specific yield value of 0.19 selected as the best fit for Cal24.

5.3 Overall Comparison of Cal17 to Cal24 Results

EIS alternatives run for both Cal17 and Cal24 provide a comparison of the different calibrations. Steady-state decreases in hydraulic head from Alternative 1 to Alternative 2 were produced for both Cal 17 and Cal24 and then compared against each other. These results are summarized in Table 10. The maximum difference of –3.9 ft occurs in the Sequim Prairie area, but decreases sharply outward. A similar but smaller area of difference occurs west of the Dungeness River. Another area of difference is present near the mouth of Bell Creek. No significant differences occur to the north of Bell Creek and east of the Dungeness River (north of Sequim Prairie). Overall, the degree and extent of differences for Alternative 2 under Cal17 and Cal24 are small. Table 10 shows that more than 86% of the terrestrial model cells have less than a 1 ft difference, and only 1.71% have more than a 3 ft difference.

Table 10. Comparison of Alternative 2 reductions in hydraulic heads for steady state calibration (Cal17) and sensitivity calibration (Cal24)

Differences in head for Alternative 2: Cal17 minus Cal24	Difference (ft)	Number of Terrestrial Model Cells	Percent of Terrestrial Model Cells
Minimum	0.77	--	--
Maximum	-3.90	--	--
Average	-0.23	--	--
<-1.0 ft	--	2,579	87%
-2.0 to -1.0 ft	--	181	6%
-3.0 to -2.0 ft	--	165	6%
-4.0 to -3.0 ft	--	51	2%
Total	--	2,976	100%

The small differences observed between Alternative 2 responses for Cal17 and Cal24 may represent the combined influence of hydraulic conductivity differences and changes to riverbed values for the Dungeness River. Adjustments to Dungeness River hydraulic conductivity values for the riverbed may have provided significantly greater buffering for reductions in aquifer recharge under Cal17 than under Cal24. Because the river bed conductivity values were twice the value under Cal17, a lowering of the water table in vicinity of the river would allow significantly greater river losses to compensate for reduced recharge.

6.0 EIS Alternative Analysis methodology

The calibrated steady-state and transient models were used to evaluate the impacts of Alternatives 1, 2, 4, and 6. The modifications made to the model input parameters for each alternative are described in the following section. A discussion of the major differences between this ground water modeling effort and previous efforts is provided in Section 4.3.

6.1 Development of Model Inputs for Alternatives

Alternative 1 represents the no action, or existing conditions scenario and serves as a base case for evaluating the impacts of Alternatives 2, 4, and 6. The existing conditions were modeled using the steady-state and transient models as calibrated for the period from December 1995 to September 1997.

Alternatives 2, 4, and 6 involve reducing irrigation recharge by a combination of lining and piping irrigation ditches. These alternatives were modeled by decreasing the irrigation component of recharge for each alternative according to the location of the improvements to the irrigation system. Recharge consists of four components: precipitation recharge, irrigation recharge, well return recharge, and wastewater application recharge. The irrigation recharge is the combined recharge due to ditch leakage and unconsumed field irrigation. The ditch leakage component of irrigation recharge varies depending on the configuration of ditches piped or lined in each alternative.

The irrigation recharge coverage obtained from the Deep Percolation Model (DPM) from the Thomas Study included both recharge due to ditch leakage and unconsumed field irrigation. Foster Wheeler Environmental developed a simple method for determining the portion of ditch leakage that would be removed for each alternative. The method involved overlaying the DPM average annual irrigation recharge (combined ditch leakage and unconsumed field irrigation recharge) onto the irrigation ditches to be piped/lined for each alternative. The DPM specifies an irrigation recharge value for each of its one-eighth-mile-by-one-eighth-mile cells, a resolution approximately four times greater than the one-quarter-mile by one-quarter-mile ground water model grid. For each alternative, the irrigation recharge in any DPM cell containing an irrigation ditch that is to be piped/lined was set to zero. The resulting recharge assigned to the DPM cells was overlaid onto the ground water model grid and irrigation recharge values were applied to the ground water model grid cells on a weighted area average basis. This procedure was repeated for each alternative.

The updated average annual irrigation recharge values for each alternative were combined with the average annual precipitation recharge, wastewater application recharge, and well return recharge to develop total average annual recharge for each alternative for the steady-state model. The steady-state irrigation recharge for each alternative was varied according to the same procedure used to develop the existing conditions monthly irrigation recharge for the transient calibration. The transient recharge was developed for each alternative by summing the updated monthly irrigation recharge for each alternative with the monthly precipitation recharge, well return recharge, and wastewater application recharge.

Eight model runs were conducted, steady-state and transient simulations for each of Alternatives 1, 2, 4, and 6.

6.2 Model Results

The model results for the EIS alternatives are provided and discussed in the EIS.

6.3 Comparison of Ecology 2003 Model Results to Previous Ecology 1999 Model Results

A previous model study conducted by PGG (referred to as the Ecology 1999 model) evaluated the impacts of Alternatives 1 and 2 and predicted declines in ground water levels of up to 30 feet in the shallow aquifer with implementation of Alternative 2. The alternative analysis conducted by TtFWI predicted declines in ground water levels of up to 7 feet in the shallow aquifer with implementation of Alternative 2. The difference between the modeling results obtained from the previous and current models can be attributed to the following major differences in model implementation:

- TtFWI developed a method for estimating the changes in irrigation recharge due to implementation of the EIS alternatives. A portion of the irrigation recharge due to ditch leakage was removed for each alternative, but the recharge due to unconsumed field irrigation was left largely unchanged. The method used by TtFWI results in a conservative, but refined estimate of the impacts to ground water levels with implementation of the EIS alternatives.
- The ground water model developed by TtFWI reached a stable, converged solution with no dry cells for all steady-state and transient model simulations. The model was successfully calibrated for steady-state and transient conditions. A limited calibration was achieved in the previous model by PGG, but up to 11 dry cells remained at the end of the limited calibration process. This means that as the model ran its simulations, it inaccurately predicted a complete lack of ground water in some grid cells. This caused the model results to be unreliable in the immediate vicinity of those cells.

Additional refinements to the TtFWI model over the previous model included:

- The complete flow system stratigraphy was developed south of the Thomas Study area to the foothills of the Olympic Mountains (48th parallel) and boundary conditions were extended to the west (Morse Creek), east (Schoolhouse point), and north into the Strait of Juan de Fuca. Increasing the modeled area increased confidence in the results by moving boundary conditions further away from the areas of interest.
- Ground water flow from bedrock into the southern portion of the study area was incorporated.
- Ground water flow within the deep undifferentiated unconsolidated deposits overlying the bedrock was incorporated by modeling layers 6 and 7.
- The model grid resolution was increased in areas of interest (along the Dungeness River) and in the vicinity of Graysmarsh.
- The MODFLOW Streamflow-Routing Package was implemented to more completely model the interaction between the shallow aquifer and Dungeness River. (The stream package compares local ground water elevations to the water surface elevation in the river and determines the amount and direction of flow between the river and the ground water. In addition, the stream package performs an accounting of both surface flows in the river and flux between the river and ground water).

- A transient model was developed based on the calibrated steady-state model to evaluate the impacts of the EIS alternatives and other development scenarios on a monthly basis. The transient model allowed for evaluation of impacts during critical low-flow months and analysis of seasonal trends in the ground water system.

Appendix B.2

Ground Water Model Results

Appendix B.2

Ground Water Model Results

The tables contained in this appendix provide the detailed results of the Ecology 2003 ground water model runs for each of the four EIS alternatives:

Table B-1	Monthly Groundwater Contribution to Streams, Alternative 1 (Base Conditions) for December, 1995 through September, 1997)
Table B-2	Monthly Groundwater Contribution to Streams, Alternative 2 for December, 1995 through September, 1997)
Table B-3	Monthly Groundwater Contribution to Streams, Alternative 4 for December, 1995 through September, 1997)
Table B-4	Monthly Groundwater Contribution to Streams, Alternative 6 for December, 1995 through September, 1997)

Table B2-1
Ground Water Contribution to Streams
Transient Model Results
Existing Condition (Alternative 1)

		Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96	Nov-96	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97			
Original Model Output																										
	ft^3/day[1/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**			
Morse	5	-140920.8	-141566.8	-141550.5	-140003.3	-140568.4	-140463.7	-139720.8	-139256.0	-138780.5	-139730.2	-139909.5	-140621.4	-142182.6	-141694.0	-140178.1	-140349.7	-140011.0	-139887.3	-140143.5	-139228.4	-139089.9	-139501.8			
Bagley	3	-255115.2	-257007.1	-258164.5	-255729.4	-255512.5	-255160.9	-253410.6	-251296.0	-248922.0	-249404.9	-250049.5	-251974.8	-256713.5	-258679.1	-256877.2	-256112.3	-254947.0	-253933.0	-253839.9	-251803.4	-250207.3	-250035.3			
Siebert	10	-285846.5	-287125.0	-287354.7	-284842.5	-285648.0	-285512.7	-284271.8	-283345.4	-282313.9	-283705.3	-284061.4	-285395.5	-288425.4	-288126.1	-285752.4	-285865.7	-285212.5	-284900.1	-285274.9	-283703.4	-283262.5	-283776.6			
McDonald	4	-203336.7	-203841.4	-204156.5	-203547.2	-203525.3	-203496.7	-203128.6	-202657.4	-202118.9	-202176.6	-202272.9	-202721.8	-203923.3	-204432.1	-203964.6	-203713.9	-203402.4	-203173.1	-203194.4	-202716.4	-202337.1	-202218.2			
Matriotti	2	-250355.4	-255880.2	-257225.1	-235731.3	-228463.6	-237182.1	-242101.2	-240537.8	-228527.1	-232504.9	-231816.7	-242864.2	-268933.1	-271093.7	-252992.2	-241439.4	-239853.2	-251909.3	-264854.8	-261391.8	-258768.8	-254424.2			
Cassalery	6	-326837.6	-330836.0	-332251.6	-320942.9	-318202.9	-315445.5	-308697.1	-301268.4	-292954.6	-293883.9	-294876.8	-299661.3	-313081.2	-317214.5	-309719.1	-306059.7	-301538.9	-298282.2	-298462.7	-292418.0	-288189.4	-288306.6			
Gierin	8	-72515.2	-73011.9	-73252.4	-72037.2	-71834.6	-71731.0	-71136.5	-70488.0	-69701.5	-69762.7	-69909.5	-70400.1	-71938.3	-72479.6	-71531.1	-71101.3	-70587.0	-70136.2	-69962.9	-69189.8	-68569.1	-68373.2			
Bell	7	-210005.0	-211954.8	-212005.1	-206892.2	-208853.3	-210496.7	-210104.0	-209312.8	-200868.3	-203393.5	-203683.4	-206009.0	-210526.7	-210327.5	-204795.4	-202144.6	-199572.6	-197806.5	-197712.0	-194218.3	-191911.8	-191773.1			
Johnson	9	-57899.2	-58296.8	-58584.9	-58262.4	-58240.3	-58189.0	-57882.9	-57464.8	-56957.3	-56907.3	-56916.4	-57170.8	-58669.2	-58368.9	-58134.2	-58007.1	-57788.6	-57565.6	-57484.5	-57067.5	-56681.3	-56523.0			
Model Output for FEIS																										
	cfs[2/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	average	ss run	
Morse	5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	102%
Bagley	3	3.0	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.7	109%
Siebert	10	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	103%
McDonald	4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.4	2.3	103%
Matriotti	2	2.9	3.0	3.0	2.7	2.6	2.7	2.8	2.8	2.6	2.7	2.7	2.8	3.1	3.1	2.9	2.8	2.8	2.9	3.1	3.0	3.0	2.9	2.9	3.4	84%
Cassalery	6	3.8	3.8	3.8	3.7	3.7	3.7	3.6	3.5	3.4	3.4	3.4	3.5	3.6	3.7	3.6	3.5	3.5	3.5	3.5	3.4	3.3	3.3	3.6	3.6	99%
Gierin	8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	100%
Bell	7	2.4	2.5	2.5	2.4	2.4	2.4	2.4	2.4	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.2	2.2	2.2	2.4	2.4	97%
Johnson	9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	113%
																								20.484	20.624	99%

[1/] Original model output is in cubic feet per day. Sign convention in original model output is opposite to convention used in FEIS and by USGS.

[2/] Groundwater Contribution to Surface Water: Sign Convention from USGS (1999):

Positive number = groundwater is discharging (entering) creek [i.e. GAINING CREEK)

Negative number = surface water body is losing water to groundwater [i.e., LOSING CREEK]

Table B2-2
Ground Water Contribution to Streams
Alternative 2 Simulation
Transient Model Results

		Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96	Nov-96	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97			
Original Model Output																										
	ft³/day[1/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**			
Morse	5	-140767.6	-141413.9	-141398.6	-139849.9	-140415.6	-140311.6	-139568.3	-139105.6	-138630.7	-139581.0	-139759.9	-140473.3	-142035.6	-141547.4	-140031.6	-140203.9	-139865.7	-139742.7	-139999.7	-139084.9	-138947.1	-139359.8			
Bagley	3	-253424.8	-255321.9	-256482.7	-254055.5	-253841.9	-253495.3	-251752.0	-249646.6	-247281.2	-247767.4	-248415.9	-250345.5	-255092.2	-257065.6	-255270.8	-254513.7	-253356.1	-252349.7	-252264.1	-250235.1	-248646.4	-248481.7			
Siebert	10	-283414.7	-284712.9	-284960.9	-282465.9	-283277.1	-283140.9	-281886.6	-280963.2	-279954.3	-281325.7	-281666.6	-282983.9	-286006.1	-285726.6	-283372.9	-283513.7	-282884.6	-282598.0	-282988.2	-281445.8	-281026.6	-281548.2			
McDonald	4	-200693.7	-201225.9	-201571.9	-200989.9	-200967.2	-200921.9	-200519.2	-199999.1	-199380.1	-199438.0	-199542.7	-200000.5	-201219.6	-201767.6	-201333.0	-201115.0	-200805.7	-200549.3	-200536.7	-200021.8	-199599.6	-199487.3			
Matriotti	2	-212581.6	-218297.0	-220216.7	-200476.9	-193086.7	-194158.0	-190009.0	-181194.1	-167251.7	-165817.3	-163925.0	-171887.9	-195290.6	-201528.9	-189066.2	-181893.6	-179059.9	-183855.7	-190332.5	-183497.3	-176884.7	-171839.2			
Cassalery	6	-306815.8	-310847.2	-312434.0	-301883.5	-299069.8	-295749.5	-288201.5	-279731.0	-270933.4	-270853.7	-270989.5	-275091.5	-288431.8	-292712.3	-285492.0	-282256.0	-278002.6	-274812.4	-274775.9	-268815.0	-264313.0	-263844.0			
Gierin	8	**-67993.4**	-68435.9	-68686.4	-67831.5	-67606.9	-67339.8	-66665.5	-65848.2	-64943.4	-64918.8	-65005.7	-65494.9	-66852.9	-67396.8	-66806.8	-66464.9	-65987.2	-65541.7	-65387.4	-64639.4	-64025.3	-63865.4			
Bell	7	-200462.0	-202544.5	-202760.8	-197761.6	-199623.7	-201141.3	-200574.0	-199596.2	-197738.2	-197575.2	-196633.5	-198296.6	-203629.6	-202973.2	-197432.9	-195078.0	-194414.0	-195666.4	-198174.3	-196842.1	-196551.5	-195116.1			
Johnson	**9**	**-57381.9**	**-57781.8**	**-58071.4**	**-57751.8**	**-57731.8**	**-57682.9**	**-57379.2**	**-56963.7**	**-56458.7**	**-56411.0**	**-56420.9**	**-56677.1**	**-57922.3**	**-57880.9**	**-57648.3**	**-57523.2**	**-57307.0**	**-57086.2**	**-57007.4**	**-56592.6**	**-56208.8**	**-56052.8**			
Model Output for FEIS																										
	cfs[2/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**average**	**ss run**	
Morse	5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	102%
Bagley	3	2.9	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.7	110%
Siebert	10	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	103%
McDonald	4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	103%
Matriotti	2	2.5	2.5	2.5	2.3	2.2	2.2	2.2	2.1	1.9	1.9	1.9	2.0	2.3	2.3	2.2	2.1	2.1	2.1	2.2	2.1	2.0	2.0	2.2	2.1	105%
Cassalery	6	3.6	3.6	3.6	3.5	3.5	3.4	3.3	3.2	3.1	3.1	3.1	3.2	3.3	3.4	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.1	3.3	3.1	105%
Gierin	8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.7	105%
Bell	7	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	101%
Johnson	9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	113%
																								19.328	18.460	105%

[1/] Original model output is in cubic feet per day. Sign convention in original model output is opposite to convention used in FEIS and by USGS.

[2/] Groundwater Contribution to Surface Water: Sign Convention from USGS (1999):
Positive number = groundwater is discharging (entering) creek [i.e. GAINING CREEK)
Negative number = surface water body is losing water to groundwater [i.e., LOSING CREEK]

Table B2-3
Ground Water Contribution to Streams
Alternative 4 Simulation
Transient Model Results

		Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96	Nov-96	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97			
Original Model Output																										
	ft^3/day[1/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**			
Morse	5	-140822.7	-141469	-141453.7	-139905.2	-140470.8	-140366.7	-139623.4	-139160.7	-138685.7	-139635.8	-139814.6	-140527.8	-142089.9	-141601.7	-140085.9	-140258.1	-139919.9	-139796.8	-140053.6	-139138.8	-139000.9	-139413.4			
Bagley	3	-254101.4	-255993.7	-257151.7	-254721.9	-254506.1	-254157.5	-252412.4	-250305.2	-247938.1	-248422.7	-249069.6	-250997.8	-255743	-257715	-255918.7	-255160.1	-254000.9	-252993.1	-252906	-250875.7	-249285.7	-249119.6			
Siebert	10	-284763.5	-286039.2	-286285.3	-283818.5	-284639	-284525.4	-283292.6	-282364.2	-281304.6	-282671.9	-283022.7	-284345.3	-287371.7	-287086.5	-284726.6	-284884.7	-284279.3	-283999.9	-284401.9	-282861.2	-282394.2	-282891.1			
McDonald	4	-202061.4	-202564	-202907.7	-202375.9	-202389.3	-202400.4	-202052.6	-201580.6	-200933.4	-200970.3	-201065.8	-201489.1	-202662.7	-203186.4	-202733.6	-202544.1	-202286.4	-202074.4	-202104.2	-201642.7	-201184.2	-201025.4			
Matriotti	2	-224397.4	-229944.3	-231713.5	-212783.6	-214454.7	-217537.8	-210677.5	-199409.9	-183904	-179577.8	-179628.6	-187337.6	-204261.1	-212184.1	-200274.8	-200935.7	-204757.8	-207302.2	-212009.5	-205732.8	-193212	-179841.1			
Cassalery	6	-309522	-313498.7	-315034.7	-304960.1	-302798.8	-299987.2	-292925.7	-284859.6	-275905.4	-275745.7	-275553	-279610.4	-292627.8	-296617	-289166.4	-286258.5	-282554.1	-279637.7	-279957.9	-274375.6	-269990.9	-269076.9			
Gierin	8	-68772.96	-69199.29	-69435.46	-68639.16	-68520.99	-68365.46	-67804.31	-67096.06	-66255.24	-66254.56	-66295.13	-66730.88	-68033.19	-68524.04	-67889.32	-67575.18	-67178.68	-66813.72	-66742.05	-66105.92	-65555.11	-65367.69			
Bell	7	-202365.3	-203715.9	-204796.5	-202311.9	-204245.2	-206347.1	-205778.2	-204270.4	-198897.4	-198022.7	-197611.4	-198546	-203462.4	-203778.3	-198800.9	-198706	-199647.9	-200827	-203050.5	-201854.4	-197741.2	-194712.3			
Johnson	9	-57455.09	-57854.91	-58144.52	-57824.94	-57804.88	-57756.03	-57452.46	-57036.97	-56531.94	-56484.15	-56494.06	-56750.24	-58037.31	-57953.7	-57720.95	-57595.84	-57379.53	-57158.63	-57079.73	-56664.93	-56281.03	-56124.82			
Model Output for FEIS																										
	cfs[2/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**average**	**ss run**	
Morse	5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	102%
Bagley	3	2.9	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.7	109%
Siebert	10	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	103%
McDonald	4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	103%
Matriotti	2	2.6	2.7	2.7	2.5	2.5	2.5	2.4	2.3	2.1	2.1	2.1	2.2	2.4	2.5	2.3	2.3	2.4	2.4	2.5	2.4	2.2	2.1	2.4	2.3	101%
Cassalery	6	3.6	3.6	3.6	3.5	3.5	3.5	3.4	3.3	3.2	3.2	3.2	3.2	3.4	3.4	3.3	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.3	3.2	105%
Gierin	8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	104%
Bell	7	2.3	2.4	2.4	2.3	2.4	2.4	2.4	2.4	2.3	2.3	2.3	2.3	2.4	2.4	2.3	2.3	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.3	101%
Johnson	9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	0.7	0.6	113%
																								19.654	18.903	104%

[1/] Original model output is in cubic feet per day. Sign convention in original model output is opposite to convention used in FEIS and by USGS.

[2/] Groundwater Contribution to Surface Water: Sign Convention from USGS (1999):

Positive number = groundwater is discharging (entering) creek [i.e. GAINING CREEK)

Negative number = surface water body is losing water to groundwater [i.e., LOSING CREEK]

Table B2-4
Ground Water Contribution to Streams
Alternative 6 Simulation
Transient Model Results

		Dec-95	Jan-96	Feb-96	Mar-96	Apr-96	May-96	Jun-96	Jul-96	Aug-96	Sep-96	Oct-96	Nov-96	Dec-96	Jan-97	Feb-97	Mar-97	Apr-97	May-97	Jun-97	Jul-97	Aug-97	Sep-97			
Original Model Output																										
	ft^3/day[1/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**			
Morse	5	-140816.2	-141463.1	-141447.9	-139900.6	-140466.9	-140362.8	-139620.4	-139155.3	-138680	-139633	-139812.2	-140525.8	-142086.2	-141599.8	-140084.6	-140258.1	-139920.2	-139797.8	-140054.7	-139139.4	-139001.9	-139415.7			
Bagley	3	-253965.7	-255863.4	-257025.5	-254595.6	-254385.5	-254042.2	-252297.3	-250185.1	-247814.1	-248304.8	-248957.7	-250890.5	-255640	-257616.4	-255824	-255070.7	-253915	-252911.6	-252829.5	-250794.3	-249204	-249042.5			
Siebert	10	-284127.5	-285421	-285659.5	-283161.3	-283977.8	-283853.1	-282614.3	-281684.3	-280693.8	-282084.6	-282435.2	-283764.1	-286802.5	-286515.3	-284154.3	-284285.9	-283652.5	-283365.8	-283767.5	-282215.6	-281816.3	-282352.4			
McDonald	4	-200955.9	-201488	-201833.7	-201251.1	-201228.4	-201183.2	-200780.5	-200259.6	-199640.2	-199699.4	-199805.1	-200263.9	-201483.4	-202032	-201598.1	-201381	-201072.4	-200816.8	-200805.1	-200290.4	-199869	-199758.2			
Matriotti	2	-214713.5	-220440.1	-222366.9	-202559	-195157.1	-196229	-191969.3	-183144.4	-169179.1	-167758.8	-165881.9	-173882.8	-197313.6	-203568	-191071.6	-183891.5	-181063	-185856.1	-192342.8	-185495	-178870.2	-173836.6			
Cassalery	6	-308577	-312572.8	-314131.5	-303533.8	-300724.8	-297428.8	-289911.3	-281468.7	-272588.6	-272560.1	-272781.5	-277078.9	-290467.5	-294772.6	-287560.9	-284335.4	-280103	-276859.7	-276877.8	-270911.6	-266454	-266031.3			
Gierin	8	-69042.41	-69464.44	-69695.2	-68813.92	-68645.59	-68510.3	-67980.55	-67329.78	-66592.62	-66695.94	-66855.35	-67361.03	-68709.08	-69220.02	-68585.66	-68191.38	-67735.15	-67384.59	-67335.09	-66704.66	-66244.83	-66201.51			
Bell	7	-202350.2	-204399.1	-204536.9	-199520.3	-201572	-203286.2	-202941.7	-202175.8	-200481.4	-200219.9	-199135.6	-200715.6	-205911	-205097.1	-199478.2	-197095.3	-196572.9	-198097.6	-200840.1	-199707.7	-199620.8	-198081.3			
Johnson	9	-57470.69	-57871.96	-58163.76	-57844.71	-57826.93	-57780.15	-57477.14	-57061.66	-56556.55	-56510.22	-56521.91	-56779.72	-58069.96	-57984.69	-57753.15	-57629.62	-57414.28	-57194.28	-57116.64	-56701.43	-56317.25	-56162.26			
Model Output for FEIS																										
	cfs[2/]	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**average**	**ss run**	
Morse	5	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	102%
Bagley	3	2.9	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	3.0	3.0	3.0	3.0	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.7	110%
Siebert	10	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.2	103%
McDonald	4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.2	103%
Matriotti	2	2.5	2.6	2.6	2.3	2.3	2.3	2.2	2.1	2.0	1.9	1.9	2.0	2.3	2.4	2.2	2.1	2.1	2.2	2.2	2.1	2.1	2.0	2.2	2.1	105%
Cassalery	6	3.6	3.6	3.6	3.5	3.5	3.4	3.4	3.3	3.2	3.2	3.2	3.2	3.4	3.4	3.3	3.3	3.2	3.2	3.2	3.1	3.1	3.1	3.3	3.2	105%
Gierin	8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	103%
Bell	7	2.3	2.4	2.4	2.3	2.3	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	101%
Johnson	9	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.6	113%
																								19.439	18.617	104%

[1/] Original model output is in cubic feet per day. Sign convention in original model output is opposite to convention used in FEIS and by USGS.

[2/] Groundwater Contribution to Surface Water: Sign Convention from USGS (1999):

Positive number = groundwater is discharging (entering) creek [i.e. GAINING CREEK)

Negative number = surface water body is losing water to groundwater [i.e., LOSING CREEK]

Appendix C

Wetlands

Appendix C

Wetlands

In 1995, Clallam County developed a Geographic Information System- (GIS-) based procedure to inventory and to characterize functions of wetlands in the County (CCDCD 1995). The County assessment included the determination of several hydrologic functions for wetlands based on landscape position and hydrology. The Clallam County assessment did not account for management practices within a wetland, but looked at whether there is potential for a function to be performed and whether it can potentially provide value to the region. For example, two large wetlands with the same hydrology type, one farmed and one with more natural and varied vegetation, would both have the same functional rating. Each of these wetlands, while being managed differently and probably performing some functions differently, is recognized as having the potential to provide equivalent functions for the region. The County assessment procedure recognizes long-term potential and value to the region.

The Clallam County database contains 11 hydrologic types; 6 of these characterize the wetlands in the project area. The hydrologic type describes the source and outflow of water, which has implications for the hydrologic, biologic, and biogeochemical functions (Clallam County Web site: Wetland Function Maps).

Table C-1 shows the hydrologic types found in the project area and the associated functions.

Table C-1. Functions Provided by Wetland Hydrologic Type in the Project Area (Source: Clallam County Critical Area Code C.C.C. 27.12.210)

Hydrology Type	Source/Outflow	Flood Storage	Flood Desynchronization	Stream flow maintenance	Ground Water Recharge	Temperature Maintenance	Sediment /Bacteria Removal	Nutrient Removal Opportunity	Toxicant Removal Opportunity	Seawater Intrusion Prevention	Drinking Water	Water Availability for Migratory Waterfowl	Water Availability for Other Wildlife
1	Runoff, perched water table/stream	L	L	L	N	L	L	L	L	N	L	L	L
2	Runoff, perched water table/can initiate stream when full	L	H	H	N	H	H	H	H	N	H	H	H
3	Runoff, perched water table/none	L	L	N	L	L	H	L	L	N	L	H	H
4	Aquifer/ground water	L	L	L	H	H	L	H*	H	N	H	H	H
5	Aquifer/stream	L	H	H	N	H	H	H	H	N**	H	H	H
6	Aquifer/stream; tidally influenced	L	L	H	L	H	L	H*	H	H	H	L	H

H = High Functional Value; L = Performs this function to a limited degree; N = Does not perform this function; * = Highest functional value in Sequim Bay area; ** = High if associated with wetland hydrology.

The wetlands over 100 acres have the following hydrology types and would have the associated Clallam County functional assessment as listed above. Table C-2 shows wetlands larger than 100 acres in the project area and their hydrology types. Table C-3 is the Dungeness Water Conservation Plan Wetlands Functional Assessment. For a map of project area wetlands, refer to Figure 4.4-5 in the EIS.

Table C-2. Description of Project Area Wetlands

Wetland	Wetland ID #	Size (acres)	Hydrology Type
Graysmarsh	SB0803	405	5
Cassalary Creek	SB0901	329	5
Matriotti Creek	DL1202	268	5
Dungeness Estuary	DL1001	227	6
Bell Creek Estuary	SB0701	136	6
Lower Bell Creek	SB0702	115	5
Lower Dungeness	DL1004	103	5
Agnew Perched	MS0719	103	2

Source: Clallam County Wetland Attribute Table (updated July 2002), available on-line: http://www.clallam.net/Maps/assets/applets/Wetland_Attribute_Table.pdf

The system used in Clallam County also characterizes and assesses wetland landscape functions (Clallam County Critical Area Code (CCC 27.12.210). This is also based on the 1995 study of wetland functions (CCDCD 1995).

See EIS Figure 4.4-5 for a map of wetlands in Clallam County showing wetlands by hydrology type. Figure 3.3-2 in the EIS shows the location of wetlands with respect to the location of irrigation canals.

Table C-3. Dungeness Water Conservation Plan Wetlands Functional Assessment

Dungeness Water Conservation Plan Wetlands Functional Assessment

Listed below are the variables used to assess potential to perform wetland functions. This was used to determine the potential of the wetlands greater than 100 acres to perform wetland functions. The + or - in the chart shows which variables apply to which functions. For example, to determine a wetlands potential to provide general habitat, the condition of the buffer, type of vegetation, interspersion of open water within the wetland, whether there were large trees, and whether there was development in the general area of the wetland (within 1 km) was considered. The potential of the wetland to perform the function was assigned a rating of high, moderate or low based on professional judgement.

	Potential for:					Habitat Suitability					
VARIABLE	**Removing Sediments**	**Removing Nutrients, Toxics (1)**	**Reducing Peak Flows and Erosion (1)**	**Recharg-ing Ground-water**	**Produc-tion and Export**	**General Habitat**	**Inverte-brates and Amphib-ians (1)**	**Anadro-mous Fish**	**Resident Fish**	**Birds**	**Mammals**
Outlet constraint	+	+	+								
Areas of herbaceous vegetation	+	+			+						+
Area of wetland that is vegetated	+	+			+						
Presence of clay or organic soils		+									
Presence of organic soils					+						
Size of area inundated or flooded	+	+									
Area of wetland compared to contributing basin			+								
Area of wetland with forest or shrub vegetation			+								
Presence of sand, gravel soils				+							
Size of buffer that is undeveloped						+	+			+	+
Number of vegetative strata						+	+			+	
Interspersion of vegetative classes						+	+			+	
Interspersion of areas of open water and vegetation						+	+	+	+		
Large trees in the wetland						+					
Development within 1 km of wetland						-	-				-
Channels with permanent water							+	+	+		+
Variety of water regimes						+	+	+	+	+	
Area of open water							+	+	+	+	+
Vegetation around stream/open water						+		+	+		
% Flow through culverts								-	-		
Size of wetland										+	
Wetland close to salt water estuary, lake, open field, mudflats										+	
Suitable habitat for invertebrates								+	+	+	
Suitable habitat for amphibians										+	
Wooded area with closed canopy										-	
Permanent open water											+
Vegetated riparian corridors to other habitat											+
Habitat suitability for fish										+	+
Known presence								+	+	+	+

+ (plus sign) indicates that as the variable increases, the potential for the function increases.

- (minus sign) indicates that as the variable increases, the potential for the function decreases.

1) Two functions were combined due to similarity in variables and effects.

Appendix D

Fish

- D.1 Salmonid Fish Resources
- D.2 IFIM Study Summary

Appendix D.1

Salmonid Fish Resources

Appendix D.1
Salmonid Fish Resources of the Dungeness River Watershed

Introduction
Important salmonid fish species that occur in the project area (Goin 1998, Orsborn and Ralph 1994, McHenry et al. 1996) include:

- chinook salmon (*Oncorhynchus tshawytscha*)
- pink salmon(*O. gorbuscha*)
- coho salmon (*O. kisutch*)
- chum salmon (*O. keta*)
- char including bull trout (*Salvelinus confluentus*) and Dolly Varden (*S. malma malma*)
- steelhead/rainbow trout (*O. mykiss*)
- coastal cutthroat trout (*O. clarki*)

These species have varied life histories, but most migrate upstream as adults to spawn in the summer and fall (salmon) or late winter and spring (trout). Juveniles outmigrate in the spring and summer. The various species use different portions of the project area, with nearly all using the mainstem Dungeness River at some point and some also using specific tributaries. The Dungeness project area has some anadromous species that are considered healthy. However, others are less healthy and three are listed under the Endangered Species Act (ESA) as threatened. A measure of the condition of the various species is indicated by the number escaping to spawn in the system.

Fish habitat in the Dungeness River project area can be broadly categorized into five types of watercourses:

- mainstem Dungeness River
- side channels of the Dungeness
- tributaries to the Dungeness
- the irrigation system
- independent streams that flow to marine waters

These watercourses each provide habitat in varying degrees of quality that affects habitat for fish and other aquatic organisms.

This appendix briefly describes life histories and known distributions of important salmonid fish species in the project area. A large portion of the information presented on limiting factors is derived from a recent report by Haring (1999). Additional details on the life histories, habitat conditions, maps depicting species distributions in the Dungeness watershed, and factors limiting fish production also can be found in Haring (1999).

Life Histories and General Distribution
In general, anadromous salmonids grow to maturity in the ocean and then return to their natal freshwater streams to spawn. Eggs are deposited and fertilized in appropriately sized gravel

substrate. Both male and female salmon species die within weeks after spawning, but trout may survive spawn one or more times. Eggs incubate for a period of one to several months before hatching into “alevins.” The eggs remain in the substrate and embryos feed from a yolk sac for a period ranging from weeks to months. Once this food source is consumed, the young salmon emerge from the gravel as “fry” and begin feeding on food items drifting in the water. This period of freshwater “rearing” lasts from a few days to several years, after which the juveniles “smolt” and are physiologically ready for their migration to the ocean.

Steelhead/rainbow trout, cutthroat trout, and char, such as bull trout/Dolly Varden, differ from the other salmonids in that a few adults may survive spawning to return to spawn again. These species may have other life cycle forms that do not migrate to the ocean, but instead migrate within the freshwater system to rear in lakes or other streams and rivers.

Chinook Salmon

Chinook salmon in the Dungeness River are spring/summer fish, which refers to the season when adults enter the river to spawn.

Adult spring/summer chinook salmon are especially vulnerable to predation because they migrate into the river in May and remain there until they are ready to spawn in at least mid-August. This “holding period” increases risks for survival when summer flows decline and the depth of pools decreases. Another effect of decreased flows is the potential for barriers to adult passage at shallow riffles (Wampler and Hiss 1991).

Chum Salmon

In the Dungeness project area, chum salmon commonly occur as two distinct stocks known as summer and fall run. Summer run chum salmon generally spawn from June to early September, and are usually larger, older, and spawn in the mainstem of streams. Fall chum salmon spawn later and often use smaller spring-fed waters higher in the watershed because of the moderated (hence, higher) temperatures compared to those in the mainstem. Fry emerge in March and April (Haring 1999). Fry of both summer and fall stocks have been thought to promptly migrate directly to the ocean with little or no residence time in freshwater. However, in a literature review by Johnson et al. (1997), chum in Washington State were found to reside in freshwater for as long as a month; juvenile residence times in freshwater longer than a month have also been reported in the mainstems of the Skagit and Nooksack Rivers.

Chum juveniles live in the estuarine environment before going to sea for 3 to 4 years (Salo 1991). In the review of studies by Johnson et al. (1997), the period of time spent in estuaries was found to be more important to chum than for other salmonids, and this interval is the most critical period of their life history. Since the most critical factor for survival is fish size, the timing of chum smoltification and entry into the estuaries is seasonally coincidental with plankton abundance. The fry are preyed upon by juvenile coho in freshwater, and by cutthroat trout and sea birds in estuaries.

Summer run chum salmon are thought to enter the Dungeness River in August to spawn in the main channel from September into October. These fish are the most western of the summer run chum salmon in Puget Sound and the Strait of Juan de Fuca. The summer run chum in the

Dungeness River are a component of the Hood Canal Summer Chum Evolutionarily Significant Unit (ESU) and were listed under the ESA on March 24, 1999, as threatened.

Char: Bull Trout/Dolly Varden

Bull trout and Dolly Varden are closely related to Arctic char, and both reside in the project area as discussed below. The following description of their biology is derived from reviews in Brown (1994), Goetz (1994), and McPhail and Baxter (1996).

Bull trout and Dolly Varden are genetically distinguishable, but they closely resemble each other in appearance and have comparable life histories. Consequently, they are often discussed together although only the bull trout is listed as threatened under the ESA. Char differ from other salmonids in that they prefer significantly colder water for spawning and rearing, often at higher altitudes, and they spend much more time incubating in the gravel before emergence (at least 220 days versus roughly 120 days for other salmonids) because of the cold temperatures. This life history makes them more susceptible to fish passage problems because of the greater migratory distance, and also exposes them to more sediment scouring over longer periods.

Bull trout populations are characterized as having one of four diverse life histories, the first three of which undergo migrations: anadromous, adfluvial (mature in lakes and spawn in tributaries where juveniles mature for 1 to 3 years), fluvial (similar to adfluvial, but spend their lives in streams or rivers instead of lakes), and resident bull trout which stay in their high, small streams for their entire lives. Bull trout typically spawn in the fall after water temperatures drop, and the eggs hatch in late winter or early spring. Fry remain close to the substrate after emergence and then migrate after several weeks. Low water temperatures are strongly preferred by juveniles (Dunham et al. 1999). A bull trout recovery plan is currently under development by the U.S. Fish and Wildlife Service (USFWS).

Coho Salmon

Wild, naturally spawning coho adults arrive at their rivers of origin in late summer and fall and spawn in the fall. They migrate upstream once temperatures decrease and the flow and rainfall increase. The combination of these conditions helps them reach very small, low-order tributaries (Sandercock 1991). The period required for egg incubation is temperature dependent; the period is longer at low temperatures, and also depends to a lesser extent on dissolved oxygen. In one Olympic Peninsula stream, this period was about 167 days from December to emergence in May (Sandercock 1991).

The life history of coho salmon differs from other salmon in that they have a uniformly longer freshwater phase as juveniles—about 18 months. Coho fry may occupy backwaters, side channels, and even small creeks too small for adults. The fry typically reside in pools and establish territories; streams with wood, stones, and other complex structures will support more fry. Juveniles prefer slower-moving streams with large areas of slack water. When water temperatures begin to decline in the late summer and early fall, many juveniles move from the larger streams to the smaller creeks to overwinter, and it is ground water seepage into the small tributaries that may be the main attractant (Sandercock 1991). After winter, coho juveniles may migrate to salt water in May, having spent just over a year in fresh water after emergence. They spend about one year at sea before returning to spawn (Sandercock 1991).

Pink Salmon

Pink salmon have the least complex and unvaried life history of any Pacific salmon. Nearly all pink salmon stocks have a 2-year life cycle.

Relatively small waterfalls or rapids, which other salmon can often negotiate, will bar pink salmon from progressing upstream. Pink salmon will spawn over a wide range of temperatures. However, they select spawning areas based on two variables: water depth and current velocity. Consequently, their preferred spawning beds are often riffles with clean gravel, or between pools and riffles in shallow water, and not deep water such as pools nor over muddy or silted streambeds. Pink salmon are susceptible to pre-spawning mortality because of drought or other low-flow conditions that are often associated with higher water temperatures or reduced dissolved oxygen levels. After pink salmon fry emerge in the spring, they migrate quickly to the ocean and return to spawn 18 months later.

The Washington State Salmon and Steelhead Stock Inventory (SASSI) (WDFW and Western Washington Treaty Indian Tribes 2000) identifies three pink stocks in Water Resources Inventory Area (WRIA) 18, two of which are in the project area—Upper Dungeness River pinks and Lower Dungeness River pinks. These two stocks have distinct spawning distribution and run-timing differences.

Upper Dungeness River pinks spawn primarily in the Dungeness River (from approximately 1.0 mile below the hatchery rack [RM 9.8]) upstream to the impassable falls at RM 18.7), Grey Wolf River, Gold Creek, and Canyon Creek. This stock enters the Dungeness River from mid-July to mid-August, with spawning through August until mid-September. Lower Dungeness River pink spawning occurs primarily in the Dungeness River (to RM 6.0, with most of the spawning downstream of RM 3.0), Matriotti Creek (to RM 0.2), Beebe Creek (to RM 0.6), and in Hurd Creek (to the hatchery rack at RM 0.5). Studies indicate that lower Dungeness pinks enter the river from August through early October, with spawning from mid-September through late October. The earlier returns remain in pools in the lower river until they are ready to spawn (Ray Johnson, cited in Haring 1999). Because both stocks spawn during the low-flow period of late summer, they will generally be found in whichever streams or side channels are accessible, given the flow conditions (Haring 1999).

Although there is general separation of the majority of spawners of the two Dungeness River pink stocks, there is overlap in the central portion of the river (RM 3.0-9.0), where there is a mixture of lower and upper pink stock spawning. Fish in this area also have an intermediate spawning timing (R. Johnson, cited in Haring 1999). The difference in timing is not surprising, and is actually to be expected, because the water temperature differences in the upper and lower Dungeness are substantial (Haring 1999).

The timing of downstream juvenile pink outmigration in the Dungeness appears to coincide with that of all other streams in Puget Sound, with early marine residence in April and early May during spring plankton blooms and increasing food abundance in the marine environment (Haring 1999).

Cutthroat Trout

Coastal cutthroat trout is one of four subspecies of cutthroat trout that are native to the western part of the state. There are four life history forms that are similar to the char life history forms described above: anadromous (sea-run), fluvial, adfluvial, and resident fish which typically reside in headwaters. All forms can potentially live in a single watershed (WDFW and Western Washington Treaty Tribes 2000). All four forms share the common characteristic of spawning in small streams. Unlike salmon, the anadromous form can migrate repeatedly between salt water and fresh water. The anadromous form prefers to spawn in riffles near pools.

Two river entry forms of upstream migrating anadromous adults are seen in Puget Sound. These are early and late forms, depending on the size of the river. Cutthroat trout returning to rivers with larger summer flows are usually early entry and enter from August through October. Fish returning to small streams with lower summer flows return from November through March when the flows are higher. Adult cutthroat trout that survive spawning return to marine waters in late March and early April.

Cutthroat trout fry emerge from the spawning gravels between March and June. They move quickly to low velocity water at the edges of streams and remain there to feed. During the winter, they move to log jams and overhanging banks. They will remain for about a year in small streams and then migrate over longer distances. Cutthroat trout will often remain in fresh water for 2 to 4 years – sometimes 6 – before migrating to salt water in the spring. Typically, they will spend several months in estuaries or fairly close to shore before migrating back to fresh water for their first spawning.

The SASSI (WDFW and Western Washington Treaty Tribes 2000) identifies three coastal cutthroat stocks in the Strait of Juan de Fuca, one of which is in the project area. The cutthroat in all watercourses in the project area are considered to be members of the Eastern Strait stock. These fish have been documented in the Dungeness and Gray Wolf Rivers, and in Johnson, Bell, Gierin, Cassalary, McDonald, Siebert, and Bagley Creeks as well as several unnamed independent streams.

Anadromous coastal cutthroat trout in the Eastern Strait complex are mostly late-entry, but early-entry cutthroat may also be present in the Dungeness River system. The spawning period for cutthroat trout is largely unknown, but is thought to be from January to April for both forms. Resident cutthroat may be present throughout the basin.

Rainbow Trout and Steelhead

Rainbow trout are residents in fresh water throughout their life spans and do not migrate to salt water. Rainbow trout tolerate a wide range of temperatures and salinity and may be found throughout the Dungeness drainage. This species is often raised in hatcheries for stocking into freshwater bodies for recreational fishing.

The sea-run form of rainbow trout is known as steelhead. Both summer and winter run steelhead are present in the Dungeness River.

Rainbow trout and steelhead spawn in the spring in Washington, depending on the temperature and location, although there can be spawning activity in the fall. Adult fish require moving water in a stream to spawn. Their eggs hatch in about 50 days, depending on the water temperature (Wydoski and Whitney 1979). Scott and Crossman (1973) have described the preferred habitat of rainbow trout as small to moderately large shallow rivers, of the pool-riffle type, with moderate flow and gravel bottoms. Rainbow trout remain in freshwater throughout their life span, whereas steelhead migrate to salt water in the spring after 1 or 2 years of freshwater rearing. They return to spawn in 1 to 3 years. Entry into the river system varies between summer run fish that enter the river in late spring through summer and winter run fish that enter the river in late fall through early spring.

Appendix D.2

IFIM Study Summary

Appendix D.2
Comparison of Dungeness River IFIM Study Results with EIS Alternatives

A study of the Dungeness River using Instream Flow Incremental Methodology (IFIM) was reported by Wampler and Hiss (1991) and summarized by Hiss and Lichatowitch (1990). This methodology, which is practiced nationwide (Bovee et al. 1998), was originally developed around 1980 to provide predictions about the amount of habitat available to life stages of fish at various stream flows. The Dungeness River IFIM study was conducted by the U.S. Fish and Wildlife Service (USFWS) in cooperation with the Washington Departments of Fisheries, Wildlife, and Ecology, in response to the need of the Dungeness River Management Team (DRMT) to determine a relationship between the river's discharge and habitat for anadromous fish. Field data for this study were collected in 1988 and 1989.

An IFIM study utilizes field measurements, hydraulic simulation, and fish habitat criteria curves to establish a flow versus habitat relationship (see Bovee et al. 1998 for a complete description of the methodology). The output of IFIM consists of predictions of weighted usable area per 1,000-foot length of stream or river for a given discharge for each life stage of the species of interest. Hence, weighted usable area can be considered as the surface area of a stream in square feet which is potentially usable by a particular life stage of a species. Higher values of weighted usable area indicate that more useful habitat is potentially available. Once the relationship between flow and habitat is established by IFIM, the percentage of increased habitat available per unit increase in river discharge can be estimated. IFIM does not, however, provide a relationship between habitat and numbers of fish because the interaction of other habitat variables such as temperature, predation, or water quality makes the determination of that relationship very complex and difficult to understand.

The original intent of the IFIM study on the Dungeness River reported by Wampler and Hiss (1991) was to model the river from River Mile (RM) 1.8 to 11.0. To model this length of the river, two representative reaches were selected. One reach extended from RM 1.8 to 2.5, and the other reach extended from RM 3.3 to 6.4. These reaches represent distinct habitat and morphology of the river; the lower reach has a relatively low gradient and a single channel, and the upper reach has a moderate gradient and frequent channel braiding is present.

Complications because of multiple water withdrawal points, islands, and side channels were found upstream of RM 6.4, so the study was restricted to that upstream limit. No explanations for not including the area downstream of RM 1.8 were provided in Wampler and Hiss (1991); however, this location is just downstream of the confluence of Matriotti Creek and the Dungeness River. Tidal influence, storm surges, and delta shaping forces are limited to the lower 0.8 mile (Bountry et al. 2002). Pools sufficiently deep for nesting or holding by adult salmon were found below RM 1.8 by Orsborne and Ralph (1994), and a dozen adult chinook were observed in such a pool by these authors in October of 1994. An explanation for the gap in the middle of the study area between RM 2.5 and 3.3 also was not provided, but may reflect that this reach is intermediate between the more braided upper segment and the more concentrated single channel segment below RM 2.5.

The data for the Dungeness study were collected in 1988 and 1989 at two sites (at RM 2.3 and 4.2) that typified the conditions of the lower and upper study reaches. The habitat in the upper reach was complex because side channels were present and they had to be modeled individually, but depths and velocities were collected at verticals along multiple transects at both locations at high (June 1988), medium (July), and low (September) flows. These data were then combined with the fish habitat suitability curves that were based on the preference by different life stages of each species for certain depths and water velocities. The dominant and subdominant substrate types were also recorded on separate trips.

Results of the study were presented in part by graphs depicting the predicted weighted usable areas at different river flows for the upper study sites (Figures 19 and 20 in Wampler and Hiss [1991]) and lower study sites (Figures 21 and 22) for spawning, juvenile, and adult life stages of chinook, pink, Dolly Varden, steelhead, and coho. The predicted weighted usable area for spawning chinook at both study sites distinctly increases with river discharge from zero to the optimum (the maximum weighted usable area) at about 180 cfs (RM 2.3) and 220 cfs (RM 4.2).

The modeled Dungeness discharges for each EIS alternative were compared based on information provided in Wampler and Hiss (1991). To combine this information, the Dungeness River was divided into reaches comparable to those outlined by Wampler and Hiss (1991) and the discharges in the low-flow months of August and September were modeled in those reaches. See Section 5.3.1 and Figure 5.3-2 in Chapter 5 of this FEIS for a more complete description of this method and a map of the study reaches.

We compared the data from USGS Gage #12048000 (located upstream of irrigation diversions) from the low-flow months of the modeled years of 1996 and 1997 against exceedance tables prepared from data derived from the Conservation Plan (Montgomery Water Group, Inc. 1999).

Table D.2-1 shows the relationship between actual gauged flow above all irrigation diversions in the Dungeness River and the longer term averaged flow exceedances. August 1996, for example, shows a mean monthly flow of 180 cfs. For the month of August at that location, mean monthly flows are larger than 180 cfs 82 percent of the time. The right-hand side of the table gives the 10, 50, and 90 percent exceedance values for the months of August and September over the period of historic measurement. The larger the exceedance percentage, the less frequent that low-flow event is.

Table D.2-1. Comparison of Monthly Mean Flows with Monthly Flow Exceedences at USGS Gage #12048000

Month and Year		Monthly Mean Flow, USGS Gage #12048000 (*Approximate Exceedence Levels*)	Monthly Flow Exceedences (1999)		
			90%	50%	10%
August	1996	188 (*82%*)	175	262	412
"	1997	276 (*45%*)			
September	1996	130 (*75%*)	112	167	274
"	1997	261 (*15%*)			

Source: Data was downloaded from USGS website.
Note: Approximate exceedences were estimated by graphing the Comprehensive Plan (Montgomery Water Group, Inc. 1999) data.

Comparisons of the chinook spawning weighted usable area between years, months, and alternatives are detailed in Table D.2-2 and illustrated in Figures D.2-1 and D.2-2. These comparisons provide examples from two specific study sites and illustrate the changes that would occur under each alternative at specific locations. They are based on flows modeled at those locations and, therefore, incorporate adjustments for upstream diversion withdrawals. The 2 years chosen by Thomas et al. 1999 for modeling (1996 –1997) represent a relatively dry year (1996) and an average year (1997). They do not include an extreme low-flow year. When flows after diversions are less than 100 cfs, as occurs in extremely dry years, we would expect a larger percentage improvement in chinook spawning habitat from the action alternatives. However, the changes in the river are complex because the river is in hydraulic continuity with the shallow aquifer; therefore, this discussion is based only on the years for which modeling data was available.

At the lower river study site at RM 2.3, the chinook spawning weighted usable area (Figure D.2-1) increases about 14 percent in the low water year of 1996, to 85 percent of optimum, with the water savings of Alternative 2, and increases slightly less with Alternatives 4 and 6. The weighted usable area in the wet year of 1997 remained near 100 percent of optimum with all four alternatives. A similar pattern occurred at this site in September 1997, with a 6 percent increase in weighted usable area with Alternatives 2, 4, and 6. In September, the weighted usable area for chinook spawning habitat was similar for all of the alternatives (Table D.2-2).

At the upper river study site at RM 4.2 (Figure D.2-2), Alternative 2 resulted in a 8 percent gain in chinook spawning over Alternative 1 during the low-water year of 1996, but Alternatives 4 and 6 resulted in less gain. In 1997, Alternatives 2, 4, and 6 resulted in a near 100 percent weighted usable area although the "no effect" first alternative was at 97 percent. In September, a 4 percent gain in potential habitat, to 79 percent of optimum habitat, was gained by Alternatives 2, 4 and 6.

It is important to recognize that the 1996 and 1997 results represent mean monthly flows and not the range of flows nor critically lower short-term (e.g., daily or instantaneous) flows that may occur. Therefore, larger increases in percentage of optimum habitat may occur as the flows decrease, depending on the shape of the curve. For example, if the existing flow in the Dungeness were 50 cfs, Alternatives 2, 4, and 6 would likely provide a larger percentage increase in optimum habitat than under the 1996 and 1997 modeled conditions.

At flows less than 100 cfs, each cfs is generally equal to 0.75 percent or more of the optimum chinook spawning area (Figure D-2-1), mainly because below 100 cfs, the slope of curve is nearly constant. Any incremental changes in existing flows below 100 cfs would provide a roughly similar change in the percentage of optimum habitat (i.e., about 0.75 percent of optimum per cfs). For example, the percentage of optimum change between 30 cfs to 60 cfs or 60 cfs to 90 cfs would provide roughly the same changes in percentage of optimum habitat (i.e., 0.75 percent/cfs x (60-30) cfs = 22 percent). However, the change in flow from 30 to 60 cfs roughly doubles the amount of weighted usable area, whereas 60 to 90 cfs provides roughly a 50 percent increase in habitat. The amount of weighted usable area is roughly the same in both, but the percentage of change in weighted usable area (<u>not</u> percentage of optimum area) increases as flows decrease.

Because the study by Wampler and Hiss (1991) provided only a relative indication of effects on potential habitat with differing flows, a second study interpreting the same IFIM data was reported by Hiss (1993). This paper provided minimum recommended streamflows based on the monthly occurrence of species and life stages; the maximum (potential) habitat area for each species, weighted toward the priority (depressed) species such as chinook and pink salmon; and the seasonality of side channels. Hiss (1993) recommended the following minimum flows in the river, as measured immediately below the irrigation diversions, to maximize habitat: 180 cfs for the months of August through October, 575 cfs for November through March, and 475 cfs for April through July. The author pointed out that aggradation effects provide exaggerated flow requirements because aggradation creates wider, shallower channels with higher bars; hence, a higher flow would be required to allow fish access into the side channels.

Limitations of the IFIM Study

Five important notes should be considered when evaluating an IFIM study: 1) habitat is only one of the many factors that affect the success of wild salmon populations. Other influences exist including harvest or unmeasured effects on habitat not directly considered by the study (e.g., rearing habitat in tributaries, the estuaries, or in the ocean); 2) other variables in the immediate habitat (e.g., temperature, water quality, or predation), but not included in the study, may have significant influences on salmonid habitat; 3) decisions using data collected about 13 years prior to this date should be done with restraint; 4) biological connectivity (or continuity) is assumed in such a study and if a barrier such as a gravel bar, high temperatures, or low dissolved oxygen exists, then the results of a study may not be completely useful; and, 5) there are no confidence limits associated with weighted usable area curves.

In addition to the above points, the IFIM "textbook" by Bovee et al. (1998) provides several additional basic caveats about the use of IFIM. Possibly the most important and basic issue is the need for a better understanding of the relationships among flow, habitat, and fish production. These relationships need significant research, as well as a confirmation of the relation of IFIM habitat output and fish.

Lastly, habitat bottlenecks caused by critical microhabitats at specific life history junctures may not be reflected in IFIM studies. These bottlenecks are most commonly encountered in the early life history phases of fish and may affect spawning and incubation, rearing areas for young fry, and optimal feeding/predator avoidance areas for fingerlings.

Table D.2-2. Chinook Spawning Weighted Usable Area for Dungeness River IFIM Study Reported by Wampler and Hiss and Modeled Dungeness River Stream Flow through Study Reaches

Study Site	Year	Month	Alternative 1			Alternative 2			Alternative 4			Alternative 6		
			Modeled Q[1/]	WUA	% Optimum Habitat[1/ 2/]	Modeled Q[1/]	WUA	% Optimum Habitat[1/ 2/]	Modeled Q[1/]	WUA	% Optimum Habitat[1/ 2/]	Modeled Q[1/]	WUA	% Optimum Habitat[1/ 2/]
RM 2.3[3/]	1996	August	103.7	22,063	70	130.9	26,553	84	127.6	26,103	83	128.2	26,185	84
		September	113.7	23,905	76	125.1	25,761	82	123.6	25,556	81	123.7	25,570	82
	1997	August	190.7	31,212	99	224.0	31,038	99	220.0	31,212	99	220.8	31,177	99
		September	231.3	30,721	98	243.1	30,150	96	241.3	30,262	96	241.7	30,237	96
RM 4.2[4/]	1996	August	103.8	17,863	75	131.3	19,718	83	127.9	19,562	82	128.6	19,600	83
		September	102.5	17,740	75	114.1	18,729	79	112.6	18,627	78	112.7	18,634	78
	1997	August	187.5	23,065	97	221.0	23,722	100	217.0	23,703	100	217.8	23,710	100
		September	223.0	23,700	100	235.1	23,572	99	233.4	23,590	99	233.7	23,587	99

1/ Modeled flows reflect flow values that incorporate irrigation withdrawals for each specific study site (i.e., RM 2.3 and RM 4.2).
2/ Percent optimum habitat was calculated against maximum weighted usable area determined by Wampler and Hiss (1991) for each life history stage.
3/ For spawning chinook at River Mile 2.3, the maximum weighted usable area was 31,393 at 200 cfs.
4/ At RM 4.2, the maximum weighted usable area for spawning chinook was 23,732 at 220 cfs.

Figure D.2-1. Dungeness River Habitat Changes for Spawning Chinook, IFIM Methodology, August 1996 and 1997 at RM 2.3

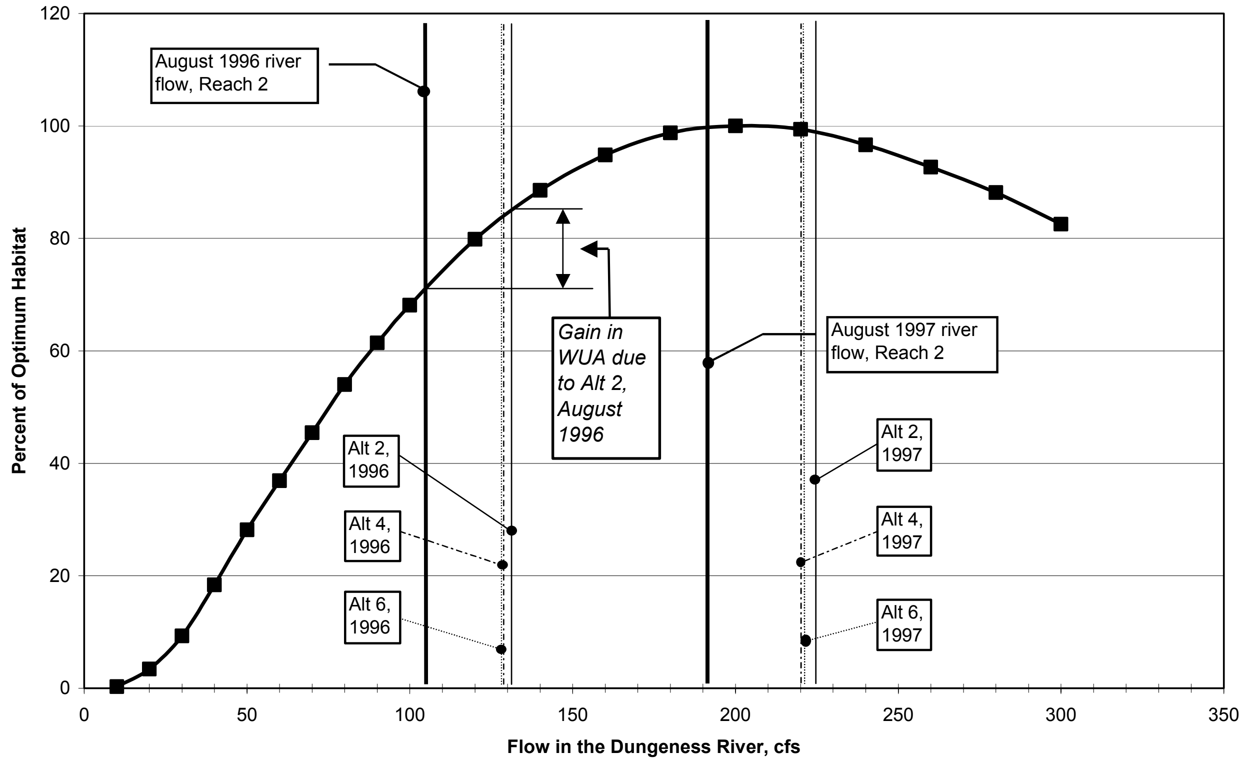


Figure D.2-2. Dungeness River Habitat Changes for Spawning Chinook, IFIM Methodology, September 1996 and 1997 at RM 2.3

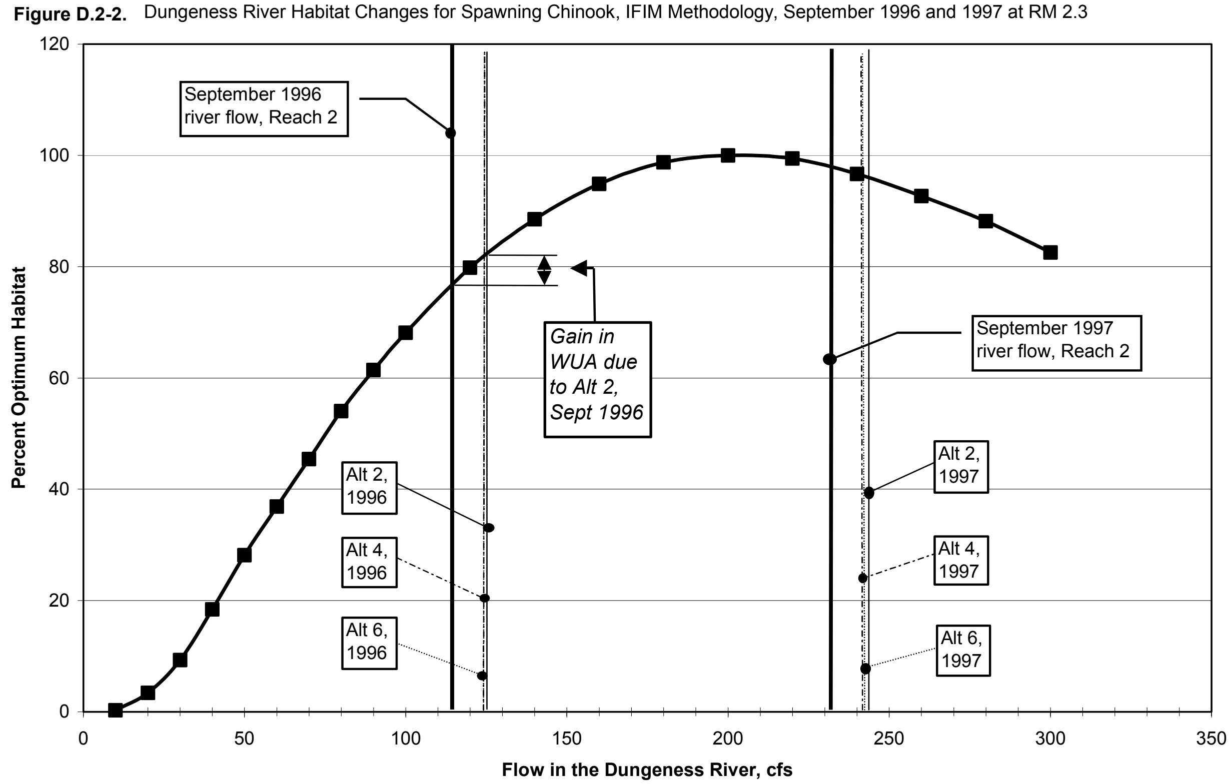


Figure D.2-3. Dungeness River Habitat Changes for Spawning Chinook, IFIM Methodology, August 1996 and 1997 at RM 4.2

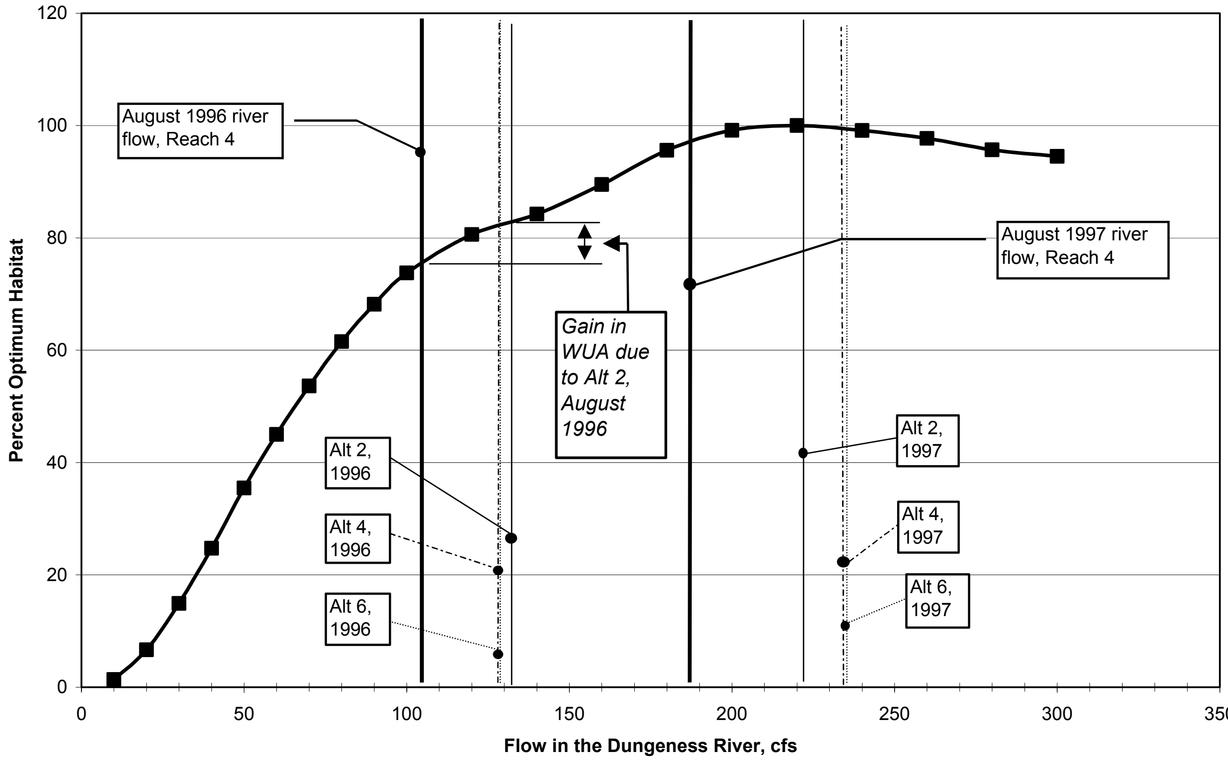
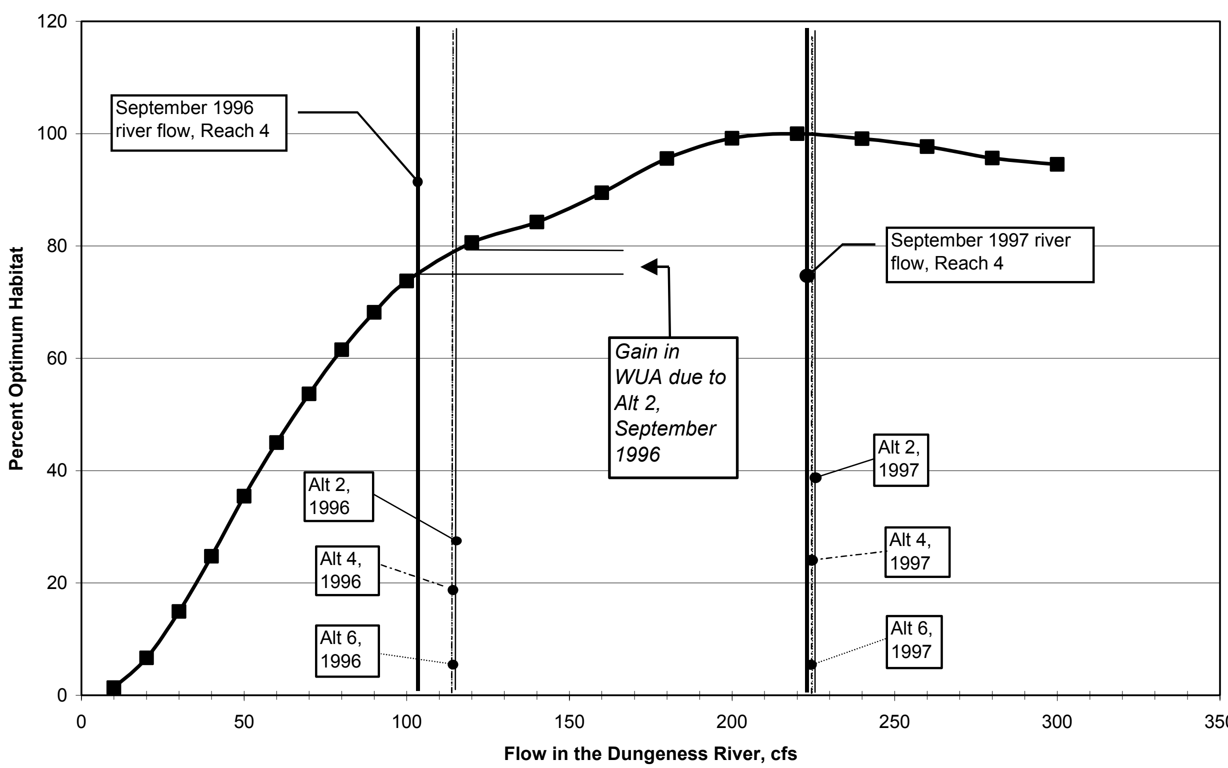


Figure D.2-4. Dungeness River Habitat Changes for Spawning Chinook, IFIM Methodology, September 1996 and 1997 at RM 4.2



Appendix E

Summary Table of all Comments Received on DEIS

Comments Received on the Draft EIS

	Commentor	Details	Response
	FACTUAL		
	Fish		
1	Pat Crain, planning biologist, Clallam County DCD Bruce Moorehead, President, North Olympic Land Trust	DEIS states that savings of 2.2 cfs would not "significantly improve streamflow"; however, at extreme low flows, 2.2 cfs could represent nearly 5% of the available chinook spawning habitat.	Text altered in Section 3.3.2 to emphasize extreme cost and stormwater management concerns as the reasons for not following this alternative through the full process.
2	Pat Crain, planning biologist, Clallam County DCD	Summer chum were listed March 24, 1999, and not March 24, 1991	Typo, changed.
3	Pat Crain, planning biologist, Clallam County DCD	Fall chum spawn in early November to early December, while the Strait of Juan de Fuca salmon natural coho spawn through the middle of January. So comment that fall chum are the latest spawning is not true.	Changed text.
4	Pat Crain, planning biologist, Clallam County DCD	Unclear what Table 4.5-2 is to portray.	Changed text of caption.
5	Pat Crain, planning biologist, Clallam County DCD	SASSI for the Strait of Juan de Fuca shows creeks and side-channels supporting coho, but may be Sequim Bay coho rather than Dungeness coho. (SASSI, by WDFW and WWTIT, '92)	Changed.
6	Pat Crain, planning biologist, Clallam County DCD	Siebert/McDonald coho may be different from Dungeness coho (SASSI, by WDFW and WWTIT, '92)	Changed.
7	Pat Crain, planning biologist, Clallam County DCD	All creeks support cutthroat, but Gierin and Cooper Creeks are not listed as supporting this species.	Changed.
8	Pat Crain, planning biologist, Clallam County DCD	Bull trout use the mainstem of the Dungeness River including the lower mainstem for feeding. Should be on the table.	Changed.
9	Pat Crain, planning biologist, Clallam County DCD	Need to quantify effect on fish populations in the mainstem and the smaller creeks. Need to know the trade-offs between alternatives between numbers of fish in mainstem versus small creeks, but currently the analysis is entirely qualitative as it pertains to numbers of fish.	Fisheries science has not advanced to the point of being able to positively correlate fish numbers and increased flow. In addition, there are a multitude of other factors that control and constrain fish numbers in addition to streamflow, all of which can and have varied over time in the study area. Discussions of fish response to increased instream flow are therefore necessarily qualitative and focus on changes in habitat, which is measureable and reported (see Appendix D.2, IFIM Study).
10	Perkins Coie, for Graysmarsh	Reduced groundwater likely to result in increased temperatures in open water components of the multi-channeled area in Graysmarsh. This area is ideal habitat for juvenile salmonid rearing and increases in water temperature would likely reduce the suitable habitat.	Letter of Oct 9, 2002, by Cedarock Consultants describes habitat only, and does not document any observations of salmonids. In addition, water quality parameters including water temperature are not discussed in the paper. Will include observations in letter in Chapter 4, Affected Environment. Note: Robin Berry (personal communication to Mary Clare Schroeder 2002) made a comment during a tour of Graysmarsh that the channeled area is too warm for salmonid rearing. The area is maintained to be open vegetation and the channels are too warm for salmon during most of the summer. The creek itself is not too warm.

Comments Received on the Draft EIS

	Commentor	Details	Response
11	Cathy Lear, salmon recovery planner, Clallam County DCD	Should update species info in Siebert Creek since access improved. Box culvert under Old Olympic Highway was replaced by a bridge which improved fish passage.	Left message at Pacific Woodrush at 360.417.0980 for an update to Siebert Creek. They are to call me on my cell phone. Will add to text.
12	Cathy Lear, salmon recovery planner, Clallam County DCD	Please be more specific about the effects, or lack of effects, on listed chum. Forage habits in particular should be described. Do chum from the Dungeness forage near the independent streams? Are only unlisted chum affected?	Text amended.
13	Cathy Lear, salmon recovery planner, Clallam County DCD	The point of this paragraph that, due to low water conditions, salmon may dig redds in areas that are later scoured by high flows-is lost. If the term "excessive flows" remains in the text; please define it.	Text amended.
14	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	DEIS needs more discussion of IFIM study, particularly chinook spawning habitat curves	See additions in Section 5.5.1 and Appendix D.2, IFIM Study.
15	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	The tribe's data does not show chinook rearing in Matriotti Creek above its confluence with Dungeness River. Impacts of Action alternatives on salmon in Matriotti Creek would be negligible.	Text amended.
16	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	When discussing seasonal flows, should be specific about discussing fish-significant months (June through Sept).	Text amended.
17	Perkins Coie, for Graysmarsh	DEIS does not include information about aquatic habitat and fish use in Graysmarsh provided by Graysmarsh.	Text amended to include the information from Cedarrock Consultants about habitat, although no fish use was actually documented and no water quality parameters (e.g., water temperature) were included.
18	Perkins Coie, for Graysmarsh	DEIS does not adequately analyze impacts to fish habitat or populations for individual stream segments, locate important stream segments, or evaluate cumulative impacts.	The DEIS was faced with a paucity of data from reliable stream gages maintained over time and through many different flow levels. In addition, there is no reliable scientific data on the relationship of fish populations in the streams to flows, though there are many casual observations recorded. While ranges of stream flow are available for many small streams, the stream data has not been gathered by segment or reach. The project has direct impact on streams only where tailwaters will be regulated through reservoir construction. These impacts are discussed and are clearly identified by the cfs reduction in flow (see Table 5.3-6). The indirect impact of the project on streams through alterations in ground water contributions is also identified (see Tables 5.3-7 through 5.3-10). While we do not have accurate flow data for the creeks, these tables allow us to make a comparison of the relative impacts of the action alternatives as compared to the no action alternative.
19	Perkins Coie, for Graysmarsh	DEIS does not identify or evaluate potential impacts to coho habitat in Gierin Creek.	Text amended.

Comments Received on the Draft EIS

	Commentor	Details	Response
20	Perkins Coie, for Graysmarsh	DEIS insufficiently analyzes benefits of increased instream flow to quantity or quality of fish habitat.	Comment noted.
21	Perkins Coie, for Graysmarsh	A difference of 3 cfs saved is not a measurable difference in a river the size of Dungeness.	During extreme low flow years, the Dungeness River contains as little as 75 cfs, even given the WUA's commitment to leave at least 60 cfs in the river. A 3 cfs increase represents a 5 percent increase in flow-hardly a trivial difference and certainly measureable. Also, at extreme low flows, 2.2 cfs could represent nearly 5% of the available chinook spawning habitat.
22	Perkins Coie, for Graysmarsh	Should not conclude that benefits of increased flow in Dungeness justifies adverse cumulative effects on threatened fish in independent streams.	There are no known populations of fish listed as threatened under the Endangered Species Act that depend on the small streams in the project area. Therefore, there are no adverse impacts on threatened fish in independent streams.
23	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	pg 4-50 pr 3 - should read, "the extent and quality of spawning habitat in reaches subject to water withdrawal is reduced substantially compared to pre-withdrawl conditions. During very low flows, salmon are forced to spawn in the middle of the river, the same location where bed scour is the highest during winter floods. Eggs flushed from the gravel do not survive..."	Text amended. See Section 4.5-1.
24	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Table 5.5-1. Under Atl 1, it states that "chinook spawn to perhaps about RM 8.0." Tribe has spawning survey data of chinook up to RM 17.5 on the Dungeness and roughly RM 5.5 on the Graywolf.	Table amended.
25	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Table 5.5-1. There is no fish habitat above Hurd Creek hatchery, so loss of groundwater will not have any effect.	Table and text amended.
26	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Table 5.5-1. Regarding the statement, "Artificial flow if river water to supply the hatchery may alleviate flow problems in the lower reaches." The hatchery obtains water from wells, not direcdtly from the river. If Hurd Creek's well is shallow, it is so close to the Dungeness to be hydaulically connected. So the impacts of Alt 2, 4, and 6 are negligible.	Table amended.

Comments Received on the Draft EIS

	Commentor	Details	Response
	Hydrology		
1	Perkins Coie, for Graysmarsh	Water balance computed in the Conservation Plan is limited by inaccuracies inherent in computation of evapotranspiration and assumptions regarding crop types, acreages, and irrigation efficiencies. These uncertainties do not allow adequate assessment of potential impacts to the extent required by SEPA.	Water balance computation in the Conservation Plan uses widely accepted methods specific to Washington State published by Washington State University and detailed in Appendix B.7. Current science is used to calculate evapotranspiration as required under SEPA. Crop type varies over time, and that variation was taken into account and explicitly referenced in Chapter 6 of the Plan.
2	Perkins Coie, for Graysmarsh	DEIS understates impacts to the Graysmarsh system by ignoring the much larger groundwater discharge directly to the marsh.	Impacts to the Graysmarsh system from shallow aquifer level reduction is discussed in Section 5.4.1. The Graysmarsh-funded AESI study is discussed and referenced in the following sections: Section 4.3.1 (independent streams) incorporates the ground water input to Gierin Creek from irrigation leakage; Section 4.4.2, page 4-36 (wetlands) discusses AESI 1999 study results showing that irrigation leakage recharges the shallow aquifer and contributes to Graysmarsh hydrology; and Appendix H.2 shows the relationship between AESI "Zone of Contribution" and ditches selected for no piping in Alternative 6.
3	Perkins Coie, for Graysmarsh	DEIS does not include accurate assessment of ground water elevations and surface flows.	The DEIS included the most accurate assessment available of ground water elevations and surface flows. It also reflected the difference between the results of the 1999 Ecology model and the estimates presented in the AESI study paid for by Graysmarsh. The FEIS includes a more accurate ground water model, more accurate understandings of changes in surface flows under each alternative, and also includes the estimates presented in the AESI study. Please see section 5.3 for more detail.
4	Perkins Coie, for Graysmarsh	Alternative 6 does not use the AESI 1999 study to determine the groundwater "zone of contribution" to Graysmarsh and Gierin Creek.	Refer to section 3.3.5 of the DEIS that discusses the 1999 AESI study and how it was incorporated into the design of Alternative 6. For further clarification, refer to Figure H-2 in Appendix H.
5	Perkins Coie, for Graysmarsh	A detailed potentiometric map of the shallow aquifer is needed to analyze and identify additional piping projects that should be eliminated to mitigate impacts to Graysmarsh.	A detailed potentiometric map of the shallow aquifer is provided in Figure 4.3-7 of the DEIS as derived from Thomas et al., 1999. In addition, the careful detailing of shallow aquifer levels and their changes can be seen in section 5.3 of the FEIS based on the Ecology 2003 model.
6	Perkins Coie, for Graysmarsh	Groundwater model used for analysis is limited and does not accurately identify hydrologic conditions in Gierin Creek and Graysmarsh wetlands.	The ground water model used for analysis in the DEIS was the best available science at the time. Because estimates had to be made for Alternatives 4 and 6, the wetlands function analysis assumed a worst- case situation and conducted the analysis accordingly, as required under SEPA (WAC 197-11-080). Since the publication of the DEIS, a new model is available that better details impacts to the shallow aquifer and small streams, including Gierin Creek. See Appendix B and Section 5.3 for more information.

Comments Received on the Draft EIS

	Commentor	Details	Response
7	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Should not use 2001 instream flow data b/c that year irrigation was shut down by Ecology. Also, should discuss percentages of water withdrawn/diverted from the river, not cfs.	Comment noted. Text amended. Added percentages to text.
8	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Figure 2.1-2. Graph would provide more information if a hydrograph of the average annual flows of the Dungeness River was included with the diversion graph. Diversion graph could use % of flow diverted rather than cfs.	Hydrograph provided in Figure 2.1-1.
9	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Pg. 5-10. Clarify difference between channelize and straighten, or eliminate one of the terms.	Text amended, used "channelize" only.
10	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	pg. 5-12. "water levels declines exceeding 20 feet were predicted to occur both west and east of the Dungeness River." Figure 5.3-1 does not indicate an exceedance of 20 ft on the west side of the river.	PGG/MWG 1999 model did not achieve full calibration. This means that the overall reliability of the 1999 model cannot be fully evaluated. Please see Section 5.3-1 for a complete discussion of the Ecology 2003 model and its results.
11	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Pg. 5-12. The discussion about the area of insufficiency caused the reader to wonder about the reliability of the model for the other areas. Is there a way to know the reliability of the other areas of the model?	PGG/MWG 1999 model did not achieve full calibration. This means that the overall reliability of the 1999 model cannot be fully evaluated. Please see Section 5.3-1 for a complete discussion of the Ecology 2003 model and its results.
	Land Use		
1	Bruce Moorehead, President, North Olympic Land Trust	Lowered groundwater table is raising concerns with local farmers regarding water availability.	Comment noted.
2	Bruce Moorehead, President, North Olympic Land Trust	Wherever wetlands recede, be assured that development will follow. This in turn will increase the need for domestic water, probably from groundwater.	See Section 5.4.3 for analysis of this potential.

Comments Received on the Draft EIS

	Commentor	Details	Response
	Other Wildlife		
1	Bruce Moorehead, President, North Olympic Land Trust	Wildlife—many other wetland-dependent species missing: - Northern Harrier (marsh hawk), the Lincoln sparrow, the swamp sparrow and the king fisher, a rare butterfly. Also other animals: river otter, coyotes, and deer will lose their water source.	According to WDFW 1999 Breeding Bird Atlas (BBS) and USFWS 1984 (otters) Northern harriers, belted kingfishers, and river otters routinely forage and nest/den in coastal or estuarine wetlands. Neither Lincoln's *(Melospiza lincolnii)* nor swamp sparrows *(Melospiza georgiana)* nest in the project area (no nesting records in GAP Analysis, BBS databases), the period when these species are dependent on wetlands. Regarding the rare butterfly, the comment is noted but is not specific enough to respond to. Though the water may be redistributed, drinking sources in independent streams, ponds, and perched wetlands will remain available to deer and coyote. Riverine habitat will be improved through increased river flows, benefiting river otters.
2	Bruce Moorehead, President, North Olympic Land Trust	DEIS doesn't recognize significance of night time feeding of waterfowl in wetlands and farms. Should not just analyze bald eagle impacts based on habitat; must look at prey base. Also, eagles can and do nest in smaller trees.	Bays and the Dungeness estuary, which will not be appreciably affected by plan implementation, also serve as important waterfowl night roosts. This project is intended to improve farming conditions and will not cause a decrease in farmland acreage. Bald eagle prey base (fish and waterfowl) populations in the bay/estuary areas are not expected to be negatively impacted by this project. Comment regarding eagle nesting noted. Added text to "Other Wildlife" about night-time feeding.
3	Bruce Moorehead, President, North Olympic Land Trust	Blue winged teal and cinnamon teal are uncommon in this area and therefore the loss of individual pairs is significant.	This project will not cause a significant loss of emergent marsh or open water habitat, the primary nesting habitats of these game birds. See Section 5.5.2.
4	Bruce Moorehead, President, North Olympic Land Trust	Analysis does not consider efforts of private and public to preserve wetlands and the animals that frequent them, particularly the Meadow Brook, Cassalary, Cooper Creek wetland complex .	The comment is noted. Impacts of this project on named wetland complexes are minimal. This project will not interfere in anyway with conservation efforts. In fact, by responding proactively to the urgent state and federal mandates for salmon recovery, this plan helps to assure the continuation of agriculture in this area, essential for the maintenance of open space and farm habitat.
5	Bruce Moorehead, President, North Olympic Land Trust	Alternative 6 has the same analysis as Alternative 4. Need more information.	Corrected in FEIS.
	Public Safety		
1	Cathy Lear, salmon recovery planner, Clallam County DCD	Reduced cover, reduced infiltration, and increased runoff are mentioned. All three conditions imply an increased likelihood of flooding during storm events.	Comment noted. Implementation of an action alternative will neither encourage nor discourage further urbanization. Thus, the impacts of urbanization are not analyzed in the EIS.
2	Bruce Moorehead, President, North Olympic Land Trust	Covered ditches will no longer convey stormwater runoff, and wetlands that previously accommodated storm water would be additionally impacted.	The Highland and Agnew main canals catch a significant amount of stormwater runoff in the project area and are not proposed to be piped in any alternative in the EIS.

Comments Received on the Draft EIS

	Commentor	Details	Response
	Public Utilities		
1	Andy Brastad, Environmental Health Director, Clallam County DCD	Lowering of groundwater will increase the ability to site septic systems.	Comment noted.
2	Andy Meyer, Planning Director, Clallam County DCD	Clarify water supply section to include private wells.	Please see Sections 4.3.4 and 5.3.4 in FEIS for discussion of wells including private wells.
	Socio-economics and costs		
1	Bruce Moorehead, President, North Olympic Land Trust	Decreased waterfowl diversity will impact birdwatching and potentially local economy associated with recreation.	There is no projected decrease in the waterfowl diversity. With potential decline in wetland area, the waterfowl will redistribute throughout the area, but will not be overall negatively impacted.
2	Bruce Moorehead, President, North Olympic Land Trust	Request a cost estimate based on the net savings realized in the river for Alternative 2.	SEPA does not require cost analysis (WAC 197-11-450) and there is no economic analysis in this EIS. Cost estimates for Alternatives 2 and 4 were calculated in Chapters 6 and 9, respectively, of the Conservation Plan.
3	Bruce Moorehead, President, North Olympic Land Trust	List costs for each project in Alternative 4.	See Chapter 9 of the Conservation Plan.
4	Bruce Moorehead, President, North Olympic Land Trust	Should examine socio-economic effects on land use and indirect costs to landowners.	See comments on item 2, above.
5	Bruce Moorehead, President, North Olympic Land Trust	Certain projects proposed in this plan would lessen the conservation values of easements.	There is no evidence that any project proposed in this plan would lessen the conservation value of easements.
	Wetlands		
1	Perkins Coie, for Graysmarsh	DEIS does not analyze water quality and sediment removal capacity of wetlands.	The commentor states that Section 5.4.1 reads that the ability to perform sediment removal remains in the land even if there is a vegetation change, such as the loss of emergent vegetation. It reads, "The potential for the function to be performed with a reduced source of water generally will not change unless there is a significant change in the vegetation, such as major change in emergent vegetation." The potential to perform the function will remain otherwise and would be available when water is reintroduced. Based on the Ecology 2003 ground water model results, the sediment removal function is addressed for each of the large wetlands. The comment that production of organic matter could be reduced with a reduction of emergent wetland habitat is true. The document has been clarified.
2	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Dungeness water should not be diverted to supplement water lost to the wetlands due to tide gates and dikes. Removing tide gates and dikes at Graysmarsh along with slough restoration would very likely increase fish productivity and bird habitat in tidally influenced areas.	Comment noted. See also report on Graysmarsh, Appendix H.1.
3	Bruce Moorehead, President, North Olympic Land Trust	Please state the percentage of the project area that is wetland.	The project area contains 32,816 acres. Clallam County has mapped 2,732 acres as wetlands in the project area, which accounts for 8.3 percent of the area.

Comments Received on the Draft EIS

	Commentor	Details	Response
4	Steve Gray, Senior Planner, Clallam Co DCD	Should clarify that the DEIS wetland functional assessment is based on a modified version of the County's wetland hydrologic function classification system, as approved by Ecology.	See modified text in Section 4.4.2.
5	Perkins Coie, for Graysmarsh	DEIS ignore direct groundwater contributions to wetlands and DEIS analysis likely understates adverse impacts.	Discussion of the impacts to Graysmarsh uses the AESI information as well as the Ecology 2003 ground water model, both showing a reduction in ground water supply to Graysmarsh. The DEIS does not ignore direct ground water contributions to wetlands. The analysis of the impacts to wetlands is based on the changes in ground water. The DEIS made a worst-case scenario assumption in estimating impacts. The DEIS determined that there would be a likely significant adverse impact to Graysmarsh. Under SEPA, that is the most powerful statement of adverse impact. The ground water model showed different impacts to the level of the ground water in different parts of the project area. This is discussed in section 5.4.2 and is summarized in 5.4.3. The FEIS also performed a worst-case analysis and also found a significant adverse impact.
6	Perkins Coie, for Graysmarsh	DEIS does not recognize or discuss wetlands less than 100 acres. They are not mapped or shown relative to irrigation ditches.	These wetlands are described in Section 4.4.2. The impacts of proposed actions are discussed in Section 5.4.3. They are mapped in Figures 4.4-1 and 4.4-5. They are also mapped in comparison to the irrigation ditches in Figure 3.3-1.
7	Perkins Coie, for Graysmarsh	DEIS does not assess complete impact to larger wetlands and ignores groundwater loss that feeds Graysmarsh from the shallow aquifer.	5-29, 5-34 discussion of the impacts to Graysmarsh uses the AESI information as well as the Ecology 2003 ground water model, both showing a reduction in ground water supply to Graysmarsh.
8	Perkins Coie, for Graysmarsh	DEIS does not analyze water quality and sediment removal capacity of wetlands.	See Section 5.4.3 for discussion of water quality and sediment removal.
9	Perkins Coie, for Graysmarsh	DEIS states 265 wetlands; Conservation Plan states 522.	In Section 4.4-2 the EIS specifies the county database and GIS map as the source of information. While there are 265 wetland complexes, there are a total of 609 different vegetative types within the 265 complexes. Source for the 522 wetlands estimate not given in plan.
10	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	pg 5-40. Why include the perched wetland at Agnew in the list of high quality wetlands? This wetland should be removed from Alternative 6.	Agnew is not included in the list of high quality wetlands, and is not considered for protection under Alternative 6. However, the impact of GW reductions are evaluated for all large wetlands under each alternative.
	PROCEDURAL		
	Alternatives		
1	Perkins Coie, for Graysmarsh	DEIS does not adequately or accurately address impacts for each alternative.	Comment noted; however the EIS analyzes impacts for each alternative. FEIS incorporates new ground water model that allows for more quantitative analysis of alternatives. However, the relative impacts of each alternative were clear in both the DEIS and the FEIS.

Comments Received on the Draft EIS

	Commentor	Details	Response
2	Bruce Moorehead, President, North Olympic Land Trust	Prefer Alternative 6.	Comment noted.
3	Matt Heins, Dungeness Farms	Prefer Alternative 6.	Comment noted.
4	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Prefer Alternative 2.	Comment noted.
5	Perkins Coie, for Graysmarsh	DEIS discounts mitigation alternative.	Ms. Robin Berry, a Graysmarsh employee, proposed Alternative 6 in the public scoping meeting held July 31, 2002 in Sequim during the public scoping period for this EIS. This alternative was proposed as an intermediate in the range from no action (Alternative 1) and full implementation of the Conservation Plan (Alternative 2). It is not a "mitigation alternative" any more than Alternative 2, representing the maximum benefit to Dungeness River stream flow and salmon habitat, is a "mitigation alternative". Nowhere in the EIS is a preferred alternative identified, because Ecology has not yet identified a preferred alternative. Alternative 6 was carried through full analysis and was never "discounted" in any way.
6	Perkins Coie, for Graysmarsh	DEIS does not include adequate range of alternatives.	The range of alternatives examined in the DEIS meets the intent and letter of the SEPA guiding administrative code (WAC 197-11-440). First, the alternatives considered in the Conservation Plan that could have an impact on the environment—that is, those that could alter diversions from the Dungeness River or contributions to the shallow aquifer or small streams—cover the full range of potential, from No Action (Alternative 1) to full implementation of the proposal (Alternative 2). Ecology is not obliged to pick any alternative in the set analyzed in the EIS, so long as the decision is within the range of alternatives considered (WAC 197-11-655). The range of alternatives must meet the purpose and need of the project, which exclusively addresses stream flow in the Dungeness River while recognizing the need and the right for ongoing irrigation diversion from the River. The project never purported to address other habitat conditions and therefore is not obligated to consider other habitat modifications in the river. However, the need for water conservation measures other than those considered as structural modifications to the irrigation water distribution system were in fact considered by the WUA and have been implemented systematically across all entities (see Appendix A.1). These measures include a drought response plan, a public education program, specifications of amount of type of water use permissible, and plans for increased measurement and monitoring.
7	Ann Soule, Ground Water Specialist, Clallam County DCD	Clallam County Department of Community Development endorses Alternative 2 as their primary preferred alternative. Secondarily, we endorse Alternative 6, and strongly oppose Alternative 1.	Comment noted.

Comments Received on the Draft EIS

	Commentor	Details	Response
	ESA		
1	Perkins Coie, for Graysmarsh	No activity proposed to federal fisheries agencies requiring proposed action in order to comply with Section 4(d) or avoid sanctions from Section 9. As the State has not sought approval of watershed conservation planning guidelines from NOAA Fisheries, there is no applicable 4(d) limitation to exempt habitat restoration activities taken by WUA through the proposed action. Either current irrigation practices are causing take and are subject to enforcement action, or NOAA Fisheries jurisdiction for review of a HCP has not been invoked and will not be until CIDMP is complete.	The Conservation Plan was proposed to minimize the need for diverting water from the Dungeness River. Even prior to the listing of salmonid species as threatened under the federal Endangered Species Act (ESA), Dungeness fish stocks were considered critically low (WDFW and Western Washington Treaty Indian Tribes 2000, Wampler and Hiss 1993). After the listing of the salmonid species, implementation of the plan became even more important to *avoid* the need for section 9 sanctions. This is a pro-active proposal that does not wait for federal intervention or state response to the 4(d) rules, but rather proposes to minimize impact on a recognized critically depressed set of fish stocks. This proposal (together with its state-level environmental analysis) does not purport to address the concerns raised by the commenter regarding federal compliance, including comments regarding NEPA compliance, a biological opinion, or "take" as defined under ESA. Compliance with both the Clean Water Act and the ESA is being planned currently under the Comprehensive Irrigation District Management Plan (CIDMP) process.
2	Perkins Coie, for Graysmarsh	There is no compliance issue unless irrigation practices are causing take, which would require a biological opinion to adequately assess necessary changes. It would be better to obtain an incidental take permit and go through NEPA review.	It should be noted that two full-time members of the Technical Advisory Team for the CIDMP are Graysmarsh employees or consultants, such that Graysmarsh is not only fully aware of the CIDMP process but is an active participant in it. The DEIS does not identify permits under either Section 401 (administered by the Washington Department of Ecology and having to do with pollution discharge into navigable waters of the United States, including wetlands connected thereto) or Section 404 (administered by the U.S. Army Corps of Engineers and having to do with discharge of dredged or fill material in navigable waters of the United States, including wetlands connected thereto) of the Clean Water Act because neither is likely to apply to any project proposed under the Conservation Plan.
3	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Pg. 5-39. Alternative 6 leaves leaky ditches in the vicinity of Graysmarsh, lower Bell Creek, and Siebert Creek. Part of the leaky Bell Creek ditches will be fixed if Gary Smith's project (re-reg reservoir) is funded; however, this is not the H-15 line that is cited in the report as important for Bell Creek.	Alternative 6 summary Table 3.3-3 shows that H-15 ditch is a separate impact from the re-reg reservoir (HW1). The observation in the wetlands section referred only to H-15 ditch lining.

Comments Received on the Draft EIS

	Commentor	Details	Response
	General		
1	Anne Soule, Clallam County DCD	Should address impacts of non-structural projects.	Though non-structural projects will improve efficiency and contribute to water savings in the system, there are no direct or easily measured savings associated with these projects.
2	Perkins Coie, for Graysmarsh	DEIS does not identify Army Corps of Engineer's jurisdiction over natural wetlands by discussing CWA Section 404 and 401 permits.	The DEIS does not identify permits under either Section 401 (administered by the Washington Department of Ecology and having to do with pollution discharge into navigable waters of the United States, including wetlands connected thereto) or Section 404 (adminstered by the U.S. Army Corps of Engineers and having to do with discharge of dredged or fill material in navigable waters of the United States, including wetlands connected thereto) of the Clean Water Act because neither is likely to apply to any project proposed under the Conservation Plan.
3	Gary Doelle, Citizens for Water Sanity	Proposed action will negatively affect wildlife, vegetation, and farming operations. Should only shut down irrigation diversions during salmon spawning periods.	No irrigation shutdowns are proposed under the Conservation Plan. This plan only addresses increasing the efficiency of water delivery, not removing or reducing water delivered for irrigation or stock watering.
4	Ann Seiter, Natural Resources Director, Jamestown S'Klallam Tribe	Pg 5-6. Cite resource for statement "there is increasing evidence that the local climate is warming and drying somewhat".	Statement deleted.
	Mitigation		
1	Perkins Coie, for Graysmarsh	DEIS does not identify appropriate mitigation for impacts.	The DEIS in fact identifies appropriate mitigation for impacts to wetlands and small streams, as shown in Chapter 6. Mitigation options include continuing to divert water from the Dungeness to continue to artificially supply small streams and wetlands, the Graysmarsh stated preference.
2	Perkins Coie, for Graysmarsh	DEIS seems to imply that wetlands and streams augmented by irrigation water are less deserving of mitigation.	The DEIS does not imply, or seem to imply, that wetlands and streams augmented by irrigation water are less “deserving” of mitigation. It does carefully accept that the wetlands and streams augmented by leakage from the irrigation water delivery system, among other sources, are the “Environmental Baseline” and all such wetlands and streams were analyzed in the EIS. It also does point out that the methods reasonably open for consideration to mitigate the *acknowledged significant impact* of the projects all depend, directly or indirectly, on water from the Dungeness River.
3	Perkins Coie, for Graysmarsh	Should eliminate all piping projects in Independent, Sequim-Prarie, and Eureka districts to adequately mitigate impacts to Graysmarsh and Gierin Creek.	There are no scientific data that show these additional leaking ditches contribute to the ground water inflow to Graysmarsh. These ditches are well outside of the AESI 1999 delineated "zone of contribution," and would cause an additional 8.32 cfs to continue to be wasted, for a total of 9.68 cfs to be deliberately diverted from the river by failing to line all ditches listed by Perkins Coie.

Comments Received on the Draft EIS

	Commentor	Details	Response
4	Perkins Coie, for Graysmarsh	Just as Ecology and the PCHB determined irrigation inefficiency should not result in loss of WUA water rights, natural resources that have benefited from those inefficient practices should not have to suffer with no mitigation for ground water losses.	WUA water rights were adjudicated in 1924 at 518.16 cfs. The recent Memorandum of Understanding (Washington State Legislature 1998) tentatively sets maximum diversion at the lesser of 50% of the gauged flow or 156 cfs. The MOU recognizes the significant gains the WUA has made in water conservation and further makes plans for allocation of saved water from future conservation. Neither Ecology nor the PCHB has determined irrigation inefficiency should not result in loss of WUA water rights. Even had such a determination been made, it does not follow that water should be allocated where no water right had ever been established.
	Project description		
1	Andy Meyer, Planning Director, Clallam County DCD	Need description of reservoirs size and locations.	Reservoirs will be located within the canals or farm property. The size range is 1 to 5 acres. Refer to the maps of Alternatives 2, 4, and 6 for locations.
2	Andy Brastad, Environmental Health Director, Clallam County DCC	Why is Johnson Creek not in the project area?	Text amended.
	SEPA Procedural		
1	Perkins Coie, for Graysmarsh	Individual projects should be reviewed independently due to lack of data for each site.	Full data on each site has been gathered and is summarized, project by project, in the Conservation Plan. Please see Chapter 6 of the plan for the details of piping, including size, cost, and number of turnouts for domestic and agricultural uses. Chapter 6 also includes a project-by-project estimate of 1997 leakage losses, expressed in terms of cfs. There is enough information on a project-by-project basis as well as on a plan-wide basis to calculate the impacts of individual projects on portions of the aquifer as well as the cumulative impacts of all projects on aspects of the aquifer, surface waters, wetlands, and wildlife.
2	Perkins Coie, for Graysmarsh	DEIS does not explore other options of improving efficiency, i.e., using pipes only during low flows, water storage in reservoirs, reduce diversions during low flow, invest in river channel restoration, educate water users on efficient methods.	The range of alternatives must meet the purpose and need of the project, which exclusively addresses streamflow in the Dungeness River while recognizing the need and the right for ongoing irrigation diversion from the River. The project never purported to address other habitat conditions and therefore is not obligated to consider other habitat modifications in the river. However, the need for water conservation measures other than those considered as structural modifications to the irrigation water distribution system were in fact considered by the WUA and have been implemented systematically across all entities (see Appendix A.1). These measures include a drought response plan, a public education program, specifications of amount and type of water use permissible, and plans for increased measurement and monitoring.

Comments Received on the Draft EIS

	Commentor	Details	Response
3	Perkins Coie, for Graysmarsh	Environmental review improperly segmented due to the failure to analyze the proposed action along with the CIDMP.	Segmentation is the separation of logically connected projects in environmental analysis without full consideration of their potential collective or cumulative impacts. WAC 197-11-060 (3) requires that "proposals or parts of proposal that are related to each other closely enough to be, in effect, a single course of action shall be evaluated in the same environmental document." Alternative 2, or full implementation of the Conservation Plan, represents the maximum reasonable set of actions that could be taken by the WUA to minimize irrigation distribution system inefficiencies, thereby minimizing Dungeness River diversions. Therefore, consideration of Alternative 2 effectively allows the full range of possible impacts, including cumulative impacts, to be considered. The idea that the CIDMP process might select only some of those projects merely means that the CIDMP decision would fall in the range between Alternatives 1 and 2. And while coordination of the federal environmental analysis process under the National Environmental Policy Act (NEPA) and the state process under SEPA is a nice idea, it is required under neither law. The assertion of segmentation due to a pending federal decision is therefore incorrect and not relevant to this EIS.
4	Perkins Coie, for Graysmarsh	Cannot use DEIS as a project-level review of many individual projects. Should clarify whether environmental review is project-level or nonproject-level. DEIS is contradictory.	While it is uncommon for an EIS to be conducted at both the planning and the project levels, there is no prohibition from conducting the analysis at both levels provided sufficient data is available. In the case of the Conservation Plan, ample information was available to analyze the impacts of both individual projects and of the overall plan. As shown in this EIS, it is particularly important to consider all the projects together because of the hydrogeologic complexity of the area and the overall impacts of the projects on the shallow aquifer as well as on the stream flow in the Dungeness River. There is no contradiction in the EIS. In fact, in Chapter 2, the nonproject nature of the Plan is discussed, while in Chapters 4 and 5 the project-level impacts are considered.
5	Perkins Coie, for Graysmarsh	The environmental baseline is the existing conditions, including irrigation-augmented habitats.	Had the environmental analysis not identified irrigation augmented habitats as baseline, there would have been no adverse impacts identified. Environmental effects were analyzed for irrigation-enhanced elements of the environment. See Sections 5.3 through 5.6.
6	Perkins Coie, for Graysmarsh	SEPA requires the lead agency to set forth the reasonable opposing views rather than ignoring a potential impact.	Agreed and illustrated in the EIS by frequent reference to the Graysmarsh-financed AESI study, especially in the Wetlands section. No attempt was made to either ignore an impact or fail to set forth opposing views.

Appendix F

Copy of all Comments Received During Scoping

Appendix F

Scoping Comment Letter, Robin Berry, Graysmarsh LLC, November 1, 2002

Robin Berry
Graysmarsh LLC
331 Graysmarsh Ln.
Sequim, WA 98382
Nov. 1, 2002

Penny Eckert
Foster Wheeler Environmental Corporation
12100 NE 195th Street, suite 200
Bothell, WA, 98011

RE: Environmental Impact Statement for the WUA Water Conservation Management Plan

Dear Penny;

I'm taking this opportunity to put in writing a summary of comments to consider in drafting the Environmental Impact Statement for the Water Conservation Plan. Graysmarsh's primary concerns are regarding the environmental impacts to the Gierin creek and its associated marsh. Although the impacts on surface flows in the small streams have been at least qualitatively identified in the WUA's management plan, the affects of these diminished flows on habitat, wildlife populations and biological processes have not been identified. As I understand this to be within the scope of the EIS, I am directing my comments to you.

Graysmarsh is comprised of approximately 1000 acres of mostly undeveloped land located near Sequim, WA. It is bordered by the Straits of Juan De Fuca on the North and East, and by Port Williams and Holland Rd to the South. There are three major types of habitat on Graysmarsh; upland forest, open meadows, and a freshwater marsh of approximately 200 acres. An additional 200 acres of land is actively farmed.

The marsh consists of a series of sloughs that drain water from upper Gierin Creek as well as from the many artesian springs that well up along the perimeter of the marsh. Water exiting the marsh is controlled by a weir and flapper doors which control the height of the marsh and the influx of salt water. In the fall and winter the marsh is flooded to provide open fresh water habitat for migrating waterfowl. The sloughs have an associated high marsh that is vegetated with fresh water marsh grasses merging with brackish and saltwater species as the marsh nears the shore. The marsh is an environmentally sensitive area supporting many species including waterfowl and salmonids. The annual Audubon bird count for Graysmarsh is often the most diverse in the county. There is a resident heron rookery, eagle and osprey nests and resident wood ducks. Beaver use the wooded portion of the marsh and otter are present throughout.

My work at Graysmarsh consists of monitoring the quantity and quality of the water supply for the marsh. I analyze the data in order to provide the owners of Graysmarsh with the necessary information to make appropriate management decisions for the protection of the ecosystem that has existed there for at least the last 100 years.

Based on my analysis and the analysis completed by others regarding Graysmarsh, it is my opinion the Water User's Association Conservation Plan will, as currently proposed, have a significant adverse environmental impact on the marsh. The plan estimates a probable loss of fresh water supply to Graysmarsh, with a probable de-watering of the upper reaches of Gierin Creek and other small streams in the Dungeness watershed (pg. 8-11 WUA conservation Plan). The Plan cites Drost's (1983) prediction of drops in groundwater levels of up to 20 feet (pg. 5-1). This would almost certainly affect the volume of flow from the artesian springs that currently feed the marsh. Hydrologic studies conducted for Graysmarsh, which I transmitted to you previously, confirm the probability of these impacts occurring. Mitigation is proposed in the Plan (pg. 5-3 of the Appendix), but the form and implementation of such a plan is not outlined.

It is my opinion that a number of negative impacts would result from a significant loss of fresh water. The upper mile of Gierin Creek could be completely lost both as spawning and rearing habitat. More detail on potential habitat losses is provided in the attached letter from Carl Hadley, biologist from Cedarbrook Consulting, Inc. Graysmarsh contracted with Mr. Hadley in 2000 to conduct a habitat assessment of Gierin Creek. I am providing his comments as additional information for the EIS.

While the area of the marsh covered by water can be maintained by the weirboards, loss of fresh water will results in lower turnover rates, causing water quality concerns. During summer months, water temperatures will be higher, likely exceeding temperatures favored by salmonids. Oxygen levels will decrease; velocities will decrease, favoring the growth of algal mats, which can threaten eutrophication. Siltation can increase, giving rise to an anoxic, acid marsh bottom. This could eliminate the benthic invertebrate population that serves as an important food source for fish.

In summary, implementation of the WUA Conservation Plan is likely to have significant adverse impacts on Graysmarsh. It is clear that the loss of aquatic habitat resulting from implementation of the Plan needs to be fully understood before the work begins.

Robin Berry

Robin Berry
Graysmarsh Biologist

Attachment: Letter from Carl Hadley, biologist from Cedarbrook Consulting, Inc.

October 9, 2002

Robin Berry
Graysmarsh LLC
331 Graysmarsh Lane
Sequim, Washington 98382

Subject: Gierin Creek Aquatic Habitat and Fish Use Assessment

Dear Ms. Berry:

This letter provides a summary of my conclusions regarding aquatic habitat and fish use of Gierin Creek near Sequim, Washington. I am a Principal Fisheries Biologist with Cedarock Consultants with over 14 years of experience assessing and mitigating development impacts on aquatic resources.

I am familiar with the Graysmarsh area near Sequim, Washington. I have visited the site, walked Gierin Creek from the ocean upstream for approximately three miles, and conducted some quantitative descriptive analysis of instream habitat. Aquatic and riparian habitat were also qualitatively assessed to evaluate the potential for both resident and anadromous fish use of the channel. Interviews with local biologists familiar with the stream were conducted.

Physical habitat in Gierin Creek can be roughly divided into several general types:

- The first mile upstream of the ocean consists of a large freshwater marsh. This very low gradient, multi-channeled area provides ideal habitat for juvenile salmonid rearing.

- An alluvial fan is found for the next 450 feet upstream of the marsh. The channel contains approximately 30 percent pool habitat by length and provides good riverine rearing habitat. Small patches of suitable spawning substrate are also found in this reach.

- A slightly higher gradient reach is found upstream of the fan. This reach winds through a well forested, gently sloped ravine for about 900 feet. Substrate is dominated by a mix of fine and coarse gravels and contains many areas highly suited for spawning by resident trout and coho salmon.

- A large manmade lake and adjacent river reaches make up the next 1,000 feet. The river reaches are controlled with structures and have been stocked with coarse gravels. The channels appear to provide good spawning habitat and substantial holding pools below each

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weir. The deep lake provides rearing opportunity for all species but is probably most heavily used by resident trout.

- An 1,800-foot reach upstream of the lake runs through a dense, medium-aged forest. This relatively undisturbed stream reach is shallow, low gradient, and contains few pools. Woody debris has been removed from some areas. A deep silt layer overlies gravel and cobble in areas. The reach currently provides moderate quality rearing habitat but minimal spawning habitat.

- For the last mile, the channel has been heavily influenced by property owners and adjacent land uses. Realignment has occurred and the stream channel runs through a farmyard, cattle trough, ditches, and culverts. Much of the channel exists as a straight line feature within a pasture. This area currently provides some rearing habitat but only poor quality spawning habitat. Some habitat enhancement efforts have occurred with beneficial results. With adequate instream flows, the upper reach could be restored to a very productive condition for juvenile coho and resident trout.

It is my professional opinion that Gierin Creek from the mouth to the headwaters contains significant potential for use as salmonid rearing habitat. Because of the very low gradient and fine substrate, year-round fish use for rearing is likely to consist primarily of smaller resident trout species (rainbow and/or cutthroat) and juvenile coho salmon. Isolated patches of gravels potentially suitable for use as resident trout and coho spawning habitat were observed in the creek, primarily in the middle and upper reaches. It is also possible that chum and pink salmon make occasional use of the stream for spawning, although the resultant fry would quickly migrate downstream to the ocean to rear.

Stream channel morphology and instream habitat conditions are a function of the historic flow regime. In my experience, and as is supported by a substantial body of literature, reducing instream flows below historic levels in low gradient streams systems usually results in less habitat available to fish. Lower instream flows typically also have a negative effect on habitat quality and the ability of habitat to renew itself via sediment transport, large woody debris recruitment, and bed-scouring processes.

It is my understanding that a proposal to reduce flows contributed by upslope agricultural ditches will result in instream flow reductions in Gierin Creek ranging from approximately 75 to 100 percent with the upper reaches being effected to the greater extent. For salmonids, this degree of flow reduction would certainly have an effect on both the quantity and quality of fish habitat available in the creek. Although the upper reaches are currently degraded by human influences, a permanent reduction of instream flows would forever prevent these areas from being restored to productive habitat.

It is possible that the proposed flow reduction could entirely prevent the creek from being used in the future by coho salmon. The National Marine Fisheries Service is currently reviewing the Puget Sound run of coho salmon for possible listing under the federal Endangered Species Act.

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Please feel free to call me if you have any questions.

Sincerely,

Carl G. Hadley
Principal Biologist
Cedarock Consultants, Inc.

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Appendix G

Copy of all Comments Received on DEIS

Gary W. Doelle
442 W. Silberhorn Road
Sequim, WA. 98382
360-683-5352 * Fax 360-683-0685

December 30, 2002

Dear Ms. Nelson;

In regards to the proposed shutting down of the irrigation water presently flowing into the Sequim Valley, we have concerns as property owners.

The original intent of the irrigation was to provide the Sequim Valley with water enough to provide farming and dairy operations to the valley. As a side bar, It changed the entire valley into a completely different ecology, which supports flora funa and wild life that will parish if the water were shut off.

The farms and dairy operations will either have to shut down or drill deeper wells which will further drain down the static water level and allow sea water to enter the inland water system. All of the existing trees and greenery will die out over a period of years, and in combination with the abandoned dairy and farming operations, will turn the valley to a dust bowl.

We propose that a compromise be applied to the problem. Let the water be shut down during the spawning periods, if there is low flow. During the summer or non spawning periods or time of high water allow the gates to be opened to replenish the valleys water supply.

Sincerely,

Gary W. Doelle

GD/ajd

Gary W. Doelle
Citizens for Water Sanity

6 January 7, 2003

Ms. Cynthia Nelson
Department of Ecology
PO Box 47775
Olympia, WA

Dear Ms. Nelson,

I am writing on behalf of the Dungeness Wetlands Association, a newly formed association of private landowners dedicated to preserving wetlands.

We have reviewed the Draft EIS and alternatives. We feel Alternative 6 best addresses the objective of the Water Conservation Plan. We understand the goal of the Water Conservation Plan and the EIS is to conserve irrigation water, thus keeping more water in the Dungeness River. Alternative 6 meets this goal while saving almost as much water as any other alternative, and will allow wetlands and small streams to continue to function without noticeable effect on the Dungeness River.

Alternative 6 is the only choice.

Thank you,

Matt Heins
John Willits

Informed choice:

The North Olympic Land Trust is very concerned about the Draft Environmental Impact State for the Water User's Conservation Plan because we hold many conservation easements in the area which we are obligated to protect, and certain projects proposed in this plan would lessen the conservation values of those easements.

The issues facing the Dungeness-Sequim Valley regarding water use and threatened and endangered fish species are complex. As with any difficult decision, various factors and their impacts should be carefully weighed and balanced before a specific course of action is chosen. The purpose of an EIS is to examine the effects of an all or nothing approach, along with at least one in-between alternative. The draft EIS presents those alternatives, but incompletely analyses their impacts. Except for alternative 2, it seems that the impacts noted in alternative 4 and 6 are mostly qualitative, rather than quantitative. Therefore it is nearly impossible to truly weigh trade offs between alternatives. There is no doubt that greater flow in the Dungeness at critical times will enable fish passage and increase various types of important habitat. But more information was needed so that alternatives could be adequately compared. For example, we could not find anywhere that says just how many more fish could make it up stream or how much habitat would be gained *for each cfs* saved. For the most part the EIS simply says there will be more. But how much more? This becomes significant when choosing between a $20 million project and a $10 million project; (there is no cost estimate whatsoever for Alternative 6) or choosing between continuing to divert some water to save present wetlands or overcharges to independent streams versus devoting all savings to the river.

Unfortunately the wildlife section in both chapters 4 and 5 seems to illustrate an incomplete knowledge and understanding about wildlife species abundance, diversity, and life-cycle requirements within the project area (other than fish), and therefore calls into question the analysis of the impacts that proposed projects would have on them.

Although there is no easy answer or remedy for water problems in the Dungeness, Alternative 6 seems to best balance the needs of the fish, the overall environment and all water users. For this reason we strongly recommend the adoption of **Alternative 6, Minimized Impact to High Value Streams and Wetlands**.

On a final note in our general comments, we understand that although an EIS is not required to directly consider socio-economic impacts, the water use decisions being proposed here have such a large potential to alter the landscape that their impact on land use and the indirect costs borne by individual landowners should be more deeply examined and quantified.

Specific Comments

- **Pg 3-2** The cost estimate for alternative 2 is probably greatly undervalued because it appears that the per cfs cost was based only on the gross savings to the river, not the true net savings (minus the loss of groundwater recharge that is mentioned in later chapters). Please give a cost estimate based on the net savings realized in the river.

- **Pg. 3-3** Please detail further how Alternative 4 examines cost efficiencies (as proposed in Chapter 9) adding only those projects that would cost $50,000 or less per cfs saved. Each project is listed, but not the costs.

- **Pg 4-31** Please state the percentage of the project area that is wetland. This is important in that it is hard to understand what value to place on the net loss of wetlands, if we do not know how many acres of wetlands there are in comparison to other land types.

- **Pg 4-55** Table 4.5-4 What is the purpose of this table? There are many other wetland dependant species missing. For example, the Northern Harrier (marsh hawk), the Lincoln sparrow, the swamp sparrow and the king fisher, are not mentioned. A rare butterfly that is threatened has also been seen utilizing wetland areas. Additional mammals should be added to the list like river otter, coyotes and even deer as these animals require water sources that may become difficult to access given the patchwork land use and barriers that will become more difficult to circumvent if all the ditches are piped and wetlands recede.

Pg 5-51

- **5.5.2 Other Wildlife**-We believe that the impact to other wildlife in your analysis of the various Alternatives, especially the favored Alternative 2 is very underestimated.

In general, this statement ignores the fact that most waterfowl come into the farms and wetlands at night to feed and therefore their winter feed and resting areas are significantly affected by any change in the availability of this type of habitat.

Mature, old growth trees are not the only necessary ingredient for bald eagles, peregrines red tailed hawks, etc. What is necessary is a prey base. Up to 5 eagles have been noted on 15 year old cottonwoods.

Blue winged teal and cinnamon teal are uncommon in this area and therefore the loss of individual pairs is significant.

This project analysis also ignores the efforts of private individuals and public agencies to preserve wetlands and the animals that frequent them. Currently there are over 600 acres in the Meadow Brook, Cassalary, Cooper Creek wetland complex that are being voluntarily protected; nearly half of which are in permanent conservation easements.

- 5-51 under Alternative 6, there is no analysis. What is written is merely a copy of the information under Alternative 4.

- **5.6.1 Land Use-** The initial statement that none of the proposed Alternatives will have a direct impact on land use is misleading. Wherever wetlands recede, you can be assured that development will follow. This in turn will increase the need for domestic water, probably from ground water.

Pg 5-52

- **5.6.3 Recreation-**The affects of Alternative 2 and 4 to the project area in this category are again under estimated. Already the number of hunters is surpassed by those who wish to view wildlife, such as birders. The project area, as noted in previous sections is well known for its diversity of birds which is highly attractive to wildlife viewers. Reducing waterfowl numbers and likely diversity, will adversely affect this important recreational activity which will in turn adversely affect the local economy.

- **5.6.2 Agriculture** Some farmers are already concerned about a drop in the ground water level. Most of the alternatives that are proposed will lower the water level.

- **5.6.6 Public Safety** No mention is made about whether piping projects would leave the ditches open. If the ditches are filled, what allowances are made for stormwater runoff, a problem that is rising with increased urban development and more impervious surfaces? It is possible that wetlands that previously accommodated storm water would be additionally impacted by this loss.

Bruce Moorehead
(President, North Olympic Land Trust)

January 6, 2003

Cynthia Nelson
Southwest Regional Office
Department of Ecology
P.O. Box 47775
Olympia, WA 98504-7775

RE: Comments on the Draft EIS for the Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan

Dear Cynthia Nelson,

Thank you for providing the Jamestown S'Klallam Tribe (Tribe) with a copy of the Draft EIS for the Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan. Tribal Natural Resources staff members, including the Natural Resources Director, have reviewed the draft report and submit written comments below. Comments include a general statement from the Tribe, as well as specific remarks, questions and/or observations about certain sections of the draft report.

General Comment:

The Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan (Conservation Plan) was prepared following years of discussion between the Water Users Association (WUA), Department of Ecology, and the Jamestown S'Klallam Tribe (Tribe), regarding the need to address in-stream flow problems in the Dungeness River which inhibited the production of salmon.

An In-stream Flow Incremental Methodology (IFIM) study, conducted in 1988/89 by the U.S. Fish and Wildlife Service, found that observed flow levels left only 10 percent of available habitat area in the Dungeness River for Chinook salmon at the spawning life stage. Optimum flows have not been met for decades. Biologist analyzing the IFIM results have indicated that even small amounts of change to in-stream flow in the main channel can affect salmon through passage, temperature and available habitat. Low flows force salmon to spawn in areas of the main channel that are more susceptible to scour during winter high flows.

While wetlands perform significant functions, we remain concerned that the intentional diversion of water to artificially supplement wetlands, such as Graysmarsh, will negatively impact salmon in two ways: first, by reducing in-stream flows; and second, by perpetuating artificial fresh water conditions in areas that were once natural salt marsh. Both impacts have been identified as limiting factors to salmon.

The Tribe has worked with the WUA for many years to avoid total irrigation system shutdown and disruption of the local community. The Jamestown S'Klallam Tribe favors full implementation of the Conservation Plan as soon as possible.

Specific Comments:

1. The Draft EIS fails to refer to the Executive Summary of the Dungeness River IFIM Study, prepared by Joe Hiss and Jim Lichatowich (1990). This report is significant, in that it provides valuable information on "life stages and seasons where flows appear to be a critical bottleneck reducing production of anadromous salmonids in the Dungeness River." Of particular interest in the report is the discussion of reduced available weighted usable area of Chinook spawning habitat (94% reduction) at low flows, during the irrigation season. Citation: Hiss, J. and Lichatowich, J. 1990.

Executive Summary of the Dungeness River IFIM Study. Prepared for The Dungeness River Management Team.

2. Page 2-4, Figure 2.1-2: Graph would provide more information if a hydrograph of the average annual flows of the Dungeness River was included with the diversion graph for the same years. Alternatively, the diversion graph could be created using % of Dungeness River Flow diverted, rather than cfs diverted.
3. Page 3-2, Table 3.2-1: Whether or not the Tribe will administer individual piping and regulatory reservoir construction projects, depends on the outcome and legal ramifications of the EIS. Currently, project administration by the Tribe for water conservation construction projects is on hold. Also, the Issue/Action for this condition refers to Appendix B. It should refer to Appendix A.
4. Page 4-50, Paragraph 3. Should read: "The extent and quality of spawning habitat in reaches subject to water withdrawal is reduced substantially compared to pre-withdrawal conditions. During very low flows, salmon are forced to spawn in the middle of the river, the same location where bed scour is the highest during winter floods. Eggs flushed from the gravel do not survive...."
5. Page 5-3, Dungeness River, Alternative 1: Clarify the following phrase: "continue to range over 50 cfs" (1st paragraph).
6. Page 5-4, Table 5.3-2: Footnotes 3/ and 4/ are labeled beneath the Table, but are not shown *in* the Table.
7. Page 5-6, top paragraph: Is there a resource that can be cited for the statement, "there is increasing evidence that the local climate is warming and drying somewhat". What does "somewhat" mean?
8. Page 5-8, the last sentence below the "Hurd Creek" heading: "No tailwater discharge measurements were available for Hurd Creek". This statement is redundant if the statement at the top of the page is true: "There is no tailwater that discharges to Hurd Creek".
9. Page 5-9, 3rd paragraph: This paragraph is redundant, and doesn't belong under Gierin Creek. It belongs, and already appears, beneath the "Matriotti" Creek heading.
10. Page 5-10, Cumulative Impacts: Is there a difference between "straightened" and "channelized"? If not, then omit one of the terms.
11. Page 5-12, top paragraph: "...water level declines exceeding 20 feet were predicted to occur both west and east of the Dungeness River". I don't see, from Figure 5.3-1 (page 5-13), where declines exceed 20ft on the west side of the river. From the map, the highest decline appears to be 20ft.
12. Page 5-12, 2nd paragraph: The discussion about the area of insufficiency causes the reader to wonder about the reliability of the model for the other areas. Is there a way to know the reliability of the other areas that were modeled?
13. Page 5-35, 3rd line from bottom of page: Incorrect spelling of "River".
14. Page 5-39, Alternative 6. Alternative 6 leaves leaky ditches in the vicinity of Graysmarsh, lower Bell Creek, and Siebert Creek (south of Hwy101). Part of the leaky Bell Creek ditches will be fixed if Gary Smith's project (Re-regulation Reservoir) is funded; however, this is not the H-15 line that is cited in the report as important for Bell Creek (page 5-39).
15. Page 5-40, Agnew Perched Wetland. Why include the perched wetland at Agnew in the list of high quality wetlands? It is important to protect it from a regulatory standpoint, but is it important to artificially enhance it with irrigation water? Portions of the wetlands are degraded from farming and the rest is forested. This wetland should be removed from Alternative 6.
16. Page 5-47, Table 5.5-1. Under Alternative 1, it states that "chinook spawn to perhaps above RM 8.0..." The Tribe has spawning survey data of chinook up to RM 17.5 on the Dungeness and roughly RM 5.5 on the Gray Wolf.
17. Page 5-47, Table 5.5-1, Hurd Creek. There is no fish habitat (no water except during hard rains) above Hurd Creek hatchery, so loss of groundwater will not have any effect.
18. Page 5-47, Table 5.5-1 Hurd Creek. Regarding the statement, "Artificial flow of river water to supply the hatchery may alleviate flow problems in the lower reaches." The hatchery obtains water from wells, not directly from the river. If Hurd Creek's well is shallow, it is so close to the Dungeness to be hydraulically connected. So, the impacts of Alternatives 2,4,and 6 are negligible.

19. Page 5-47, Table 5.5-1, Matriotti Creek. We do not have any data showing whether chinook use Matriotti Creek to rear. However, based upon the life history studies in the Dungeness, juvenile chinook would only use the very lowest portion of Matriotti, where it joins the Dungeness. Matriotti has similar velocity conditions to Spring Creek (which chinook do not use) and Gagnon, prior to the new Burlingame Bridge (whereby chinook were only found at the confluence with the mainstem). So, the impacts of Alternative 2,4, and 6 on salmon are negligible.
20. Page 5-50. Regarding the statement claiming that "the diversions have dropped from a seasonal average of 150 cfs during flood irrigation to 56 cfs in 2001": First of all, what months are included in the "season" above. For fish, the months that should be examined are the portion of the irrigation season including June through early September. Also, 2001records are a little misleading, as this was when Department of Ecology paid farmers to not farm (and leave the water in-river), so that is not an appropriate year to cite to show where water conservation has taken us. 2002 withdrawal, for example, ran from 70-76 cfs (June-August).
21. Page 5-50 (and again on page 2-3): "The diversions have dropped from a seasonal average of 150 cfs during flood irrigation to 56 cfs in 2001". This statement would be better clarified if percentages of water withdrawn/diverted from the river were used instead of cfs - so that we know what the river was flowing for both time periods. Also, what is the year for the 150 cfs diversion?
22. Page 6-3, Section 6.4.2, Other Mitigation Measures. The overriding issue is that Graysmarsh is artificially maintaining a freshwater marsh where a salt marsh would naturally exist, and demanding that Dungeness water be wasted in that effort. In other words, because Graysmarsh has a dike and tide gate, the recharge to the salt marsh that would be tidally produced, must now come as freshwater from Gierin Creek (and the Dungeness). So an artificial irrigation system maintains an artificial wetland. The one sentence in the draft EIS regarding this issue (in the mitigation section of the report) should be expanded upon. Graysmarsh's argument of loss of wetland benefits does not completely hold water. Removing the tide gates and dikes at Graysmarsh, along with slough restoration would almost certainly increase fish productivity and migratory bird habitat (in the tidally influenced area) over the current levels.

Sincerely,

Ann Seiter

Ann Seiter
Natural Resources Director
Jamestown S'Klallam Tribe

February 13, 2003

Cynthia Nelson
WA Dept. of Ecology, SWRO
PO Box 47775
Olympia, WA 98504

Dear Ms. Nelson:

Please consider the attached comments from Clallam County Dept. of Community Development on the Draft EIS for the Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan, dated November 2002.

Clallam County DCD believes that the goal of restoring the hydrology in the Dungeness watershed to as close as possible to its original state is preferred, through full implementation of the conservation plan proposed by the water users. Therefore we endorse Alternative 2 as our primary preferred Alternative.

However, the benefits afforded to fish in small streams by Alternative 6 may potentially outweigh the benefits to fish in the Dungeness River. I.e, the negative impact of the few cfs “sacrificed” by the River under Alternative 6 may result in a disproportionately large positive benefit to fish and wildlife populations in small streams and wetlands. For this reason we secondarily endorse Alternative 6.

We strongly oppose Alternative 1, non-implementation of the conservation plan.

Thank you for your consideration of these comments. If you have any questions or comments regarding the above information, please contact me by phone, (360)417-2424, e-mail, ***asoule@co.clallam.wa.us***, or by stopping by the County Courthouse. Please contact directly the individuals listed in the attachment regarding their comments.

Sincerely,

Ann Soule
Groundwater Specialist

encl.: Clallam County DCD Comments on the irrigators’ conservation plan DEIS

c. Bob Martin, Andy Brastad, Pat Crain, Cathy Lear
Andy Meyer
correspondence file
project file – EIS/groundwater model

Clallam County DCD Comments on the irrigators' conservation plan DEIS 1/7/03

From Pat Crain, planning biologist, 360-417-2423
Generally, I found the DEIS to cover most of the issues of importance to fish. My specific comments follow:

Section 3.2: Is the first paragraph of this section worded correctly? It now reads "If this proposal is <u>not</u> implemented…". Shouldn't it be "If this proposal is implemented…"? [Suggestion from Ann Soule: clarify early in Chapter 3 that "this proposal" refers to "the irrigation conservation plan" (or other description).]

Section 3.3.2: In the third paragraph, the comment is made that a savings of 2.2 cfs would not "significantly improve streamflow". Actually, at extreme low flows, 2.2 cfs could represent nearly 5% of the available chinook spawning habitat.

Section 4.3, page 4-7: In the second paragraph, I would suggest rewording the phrase "has required the construction of levees" to "has ***led*** to the construction of levees". There were other alternatives to levee construction which were simply not chosen.

Section 4.5, page 4-47: Summer Chum were listed on March 24, 1999, not March 24, 1991. Also, the comment that fall chum are the latest spawning of all Pacific salmon is not true. Fall chum tend to spawn in early November to early December, while the Strait of Juan de Fuca natural coho populations spawn through the middle of January.

Table 4.5-2: It is unclear what this table is intending to portray. All of these creeks and side-channels support spawning coho populations, but they may or may not be "Dungeness" stock. The Salmon and Steelhead Stock Inventory (SASSI) for the Strait of Juan de Fuca (WDF&W and WWTIT, 1992) identifies Sequim Bay coho as separate and distinct from Dungeness coho. Similarly, it distinguishes between Dungeness coho and Siebert/McDonald Creek populations.

Also, all of the creeks support cutthroat trout populations, although Gierin and Cooper Creeks are not listed in the table as supporting this species. Finally, Bull trout are not shown for any location, although they do utilize the mainstem of the Dungeness, including the lower mainstem for feeding.

Chapter 5 – As a general comment, it is not possible to pull from this section a quantitative effect on fish populations in either the mainstem or the smaller creeks. It seems to me that in order to make a choice between options, it would be important to understand the trade-offs which are made relative to fish populations in various streams. For example, Alternative 1 leaves the most water in the small streams and tributaries, but at what cost to the mainstem Dungeness. Similarly, Alternative 2 leaves the most water in the Dungeness, but at what cost to the smaller tributaries. Currently the analysis is entirely qualitative as it pertains to numbers of fish.

From Ann Soule, groundwater specialist/water resource planner, 360-417-2424
Page 2-7, 1st para.
It doesn't seem wise to quote Entrix 2000 at this point relative to the expected completion of the east side watershed plan. The current expectation is that a draft will be done in Feb. 2003, and final in June. Quote me if you want.

Pages 2-7, 8, CIDMP and Trust Water Right
How does this document address the potential various impacts of irrigation water management, as distinguished from structural conservation projects? Or doesn't it? Shouldn't the document say something about this here?

Pg 4-44, top
Second paragraph should be connected to first, otherwise clarify which wetlands are referred to as "These" wetlands.

figure 4.6-1, caption and end of paragraph are out of place

pg 4-57, second sentence
I suggested a change that didn't come across exactly right. This sentence is better:
"Commercial and light industrial development generally follow the US Hwy 101 corridor, although the only industrial park in the area is north of Hwy 101 in the Carlsborg urban growth area."

General:
There are at least a few places where it is not clear what "this ~" or "these ~" are referring to. Please clarify.

Finally, given that over the past 100 years the irrigation ditch system has radically changed the natural hydrology of the watershed, Alternative 2, full implementation of the conservation plan, provides the most benefit to the watershed as a whole. Mitigation for anticipated environmental and other costs, discussed in Chapter 6, covers potential problems as best as can be expected.

From Cathy Lear, salmon recovery planner, 360-417-2361
In general, I think the DEIS provides a good general picture of the alternatives and their potential impacts. Here are some specific observations:

Page 4-53, Siebert Creek: In 1998 the double-box culvert at the Old Olympic Highway crossing was replaced with a bridge, which improved fish access in Siebert Creek. Species abundance and composition may have changed since 1999. Please contact Pacific Woodrush at 360.417.0980 for current information.

Page 5-15, In the first paragraph of the "Cumulative Impacts" section: Reduced cover, reduced infiltration and increased runoff are mentioned. All three conditions imply an increased likelihood of flooding during storm events.

Page 5-45, First paragraph below the bullet points: Please be more specific about the effects, or lack of effects, on listed chum. Forage habits in particular should be described. Do chum from the Dungeness forage near the independent streams? Are only unlisted chum affected? Please clarify.

Page 5-45, Last paragraph: What appears to be the point of the paragraph - that, due to low water conditions, salmon may dig redds in areas that are later scoured by high flows - is lost. If the term "excessive flows" remains in the text, please define it.

From Andy Brastad, Environmental Health Director, 360-417-2415
Page 4-54. Is Johnson Creek in the project area? It receives tail water from the Highland Irrigation ditch? Why is it not listed in section 4.5.1?

Page 5-3, Alternative 1 – No Action. The document states that irrigation-related recharge to the shallow aquifer would remain at 38 cfs. Does that include recharge from crop watering and tail waters too or only water loss from irrigation laterals?

Page 5-52, Public Services and Utilities. In areas near ditches and laterals, water loss from irrigation ditches and laterals may have caused an increase in the presence of shallow ground water (between the ground surface to six foot below ground surface). It is possible that the disappearance of this ground water due to piping and the piping of the surface water itself will increase the ability to site septic systems.

From Andy Meyer, Planning Director, 360-417-2326
4.6.2 : Public services and utilities section: water is also provided by private wells; this isn't mentioned. As written, the sentence also implies the County provides public water systems through the PUD...maybe can be clarified.

5.6.2 : Refers to 5.3.3; I think it should be 5.3.4 instead...

Also, while Alternative 2 refers to, and maps potential sites for re-regulating reservoirs, there is not a clear discussion of where these might be proposed, (private land, public land,???) and the alternatives analysis does not refer to this aspect of the alternative. For example, in 5.6.4, there may be land use implications (how big are these things, and would they take current ag land out of production?) ...this seems to be a weak point in the alternatives analysis. If I lived near one of the sites shown on the map, I'd want a clearer discussion of what these reservoirs are, their potential impacts, etc.

Steve Gray, Senior Planner, 360-417-2520
My review was limited to Section 4.4.2 and Appendix B.

<u>Page 4-41 Wetland Functional Assessment (Paragraph 4)</u>

- Steve Gray, Clallam County Wetlands Biologist, should read Clallam County Senior Planner.
- The second to the last sentence states that the County system automatically classifies all wetlands of a particular hydrologic type as having the same function, ***<u>regardless</u>*** of their other characteristics. This is a true statement in terms of the characterization and assessment of wetland watershed functions. However, it fails to recognize that the County system also accounts for wetland landscape functions including habitat size, habitat diversity, significant habitat features, plant community value, upland habitat type, species use, anadromous fish use, and connection of wetlands to other significant habitats. The County's characterization and assessment of wetland landscape functions is described within the County's 1995 report titled: *Assessment of Wetland Functions and Watershed Guidance for the Lower Dungeness River Area and Sequim Bay Watersheds*. Based on the results of this study, wetland landscape functions are used by Clallam County to classify regulated wetlands (*see Clallam County Critical Areas Code, CCC 27.12.210 (2)).* I do not necessarily object to using County data to assess data under the Ecology system, but the description of the County system should be clarified.

<u>Page 4-42 - Wetlands Larger than 100 Acres</u>

- Please clarify that functional assessments Table 4.4-1 is based on a modified version of the wetland functional assessment system proposed by Ecology. It does not reflect the actual functional assessment results nor all the parameters of the County's landscape and watershed functional assessment methodologies. I recognize that the County's wetland data base and hydrologic typing was used to help generate the results in Table 4.4-1. However, under the County system, the landscape and/or watershed (i.e., hydrologic) functions that a wetland provides (or has the potential to provide) may be rated higher.
- Please clarify that Table 4.4-2 is based on a modified version of the County's wetland hydrologic function classification system.

<u>Appendix B</u>

- Please clarify that the County system also characterizes and assesses wetland landscape functions (see related comments above). A reference to the County's 1995 study should be included.

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January 7, 2003

VIA HAND-DELIVERY

Ms. Cynthia Nelson
Shorelands and Water Resources Program
Washington State Department of Ecology
P. O. Box 47775
Olympia, WA 98504-7775

Re: Dungeness River Agricultural Water Users Association Comprehensive Water Conservation Plan, Draft Environmental Impact Statement ("DEIS"); Comments of Graysmarsh LLC

Dear Ms. Nelson:

We represent Graysmarsh, LLC, an entity who owns property on which approximately 405 acres of wetland currently exist that will be significantly, adversely affected if the above-named plan is approved and implemented ("Graysmarsh"). We provide these written comments on behalf of Graysmarsh to you for conveyance to the SEPA Responsible Official, Washington State Department of Ecology ("Ecology"), Joe Stohr, for consideration.

In transmitting these comments, Graysmarsh acknowledges that the Washington State Conservation Commission has identified the Dungeness River as the river system most affected by irrigation withdrawals in western Washington. Graysmarsh would support a Conservation Plan that did not ignore adverse impacts to important streams, creeks, and wetlands. Unfortunately, the Conservation Plan unnecessarily and ingenuously pits aquatics resources using the Dungeness River against aquatic resources and wildlife using other streams and wetlands in the Dungeness River and hydraulically connected basins.

When Ecology targeted the Dungeness River basin for conservation planning, and thereby made conservation planning grant funds available for interested parties, it embarked on a course of action which has put into motion a series of events that threatens to limit the choice of reasonable alternatives in violation of the SEPA rules. WAC 197-11-070(1)(b). The water savings assigned under the Water Rights Trust Agreement[1] between the Dungeness River Water Users Association (DRUA) and Ecology appears to have created the need for a predetermined result, i.e., the piping of the maximum number of ditches possible. This need serves, then, as the impetus for the DEIS conclusion that there are ***no*** mitigation measures that can be imposed to mitigate acknowledged significant adverse impacts to water supplies and wetlands. In fact, the concluding section of the DEIS appears to invalidate the only alternative designed to address some wetland impacts, Alternative 6, by suggesting that the difference in water savings between the proposed alternative (Alternative 2) and Alternative 6 (about 3.28 cfs according to the DEIS) will so substantially reduce flows below those targeted by Alternative 2 as to create "liability" under the Endangered Species Act ("ESA"). The only way this could be true is if liability already exists under Section 9 of the ESA due to current irrigation practices, because the Plan increases instream flows in the Dungeness River under each of the three action alternatives analyzed in the DEIS.

The thrust of the written comments provided herein will focus on those aspects of the DEIS that render it inadequate to serve SEPA's requirement that agencies with jurisdiction preface their actions by informed, detailed analysis of the environmental impacts that will result from those actions. See, e.g., WAC 197-11-055(1). Under the judicially created doctrine for determining EIS adequacy under SEPA, "the rule of reason" seeks to prevent cursory environmental review and instead to promote comprehensive, detailed review that includes a reasonably thorough discussion of the significant aspects of the probable environmental consequences of a proposal. Leschi Improvement Council v. Washington State Highway Comm'n, 84 Wn.2d 271, 280-87, 525 P.2d 774 (1974). In the context of an EIS that fails to accurately or adequately assess impacts among alternatives, it would be irresponsible, arbitrary, and capricious, for an agency action to approve the proposed action without requiring mitigation for identified significant, adverse environmental impacts. See Save Our Rural

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[1] The record is unclear as to what level of environmental review was given to the agreement.

Environment v. Snohomish Cy., 99 Wn.2d 363, 372, 662 P.2d 816 (1983). As will be described in more detail, the DEIS is inadequate for the following reasons;

a) The DEIS improperly and without authority purports to serve as project-level SEPA review for hundreds of individual structural improvements to be undertaken by nine irrigation companies adversely affecting three Dungeness tributaries, eight independent creeks, and more than 265 wetlands[2] covering 2,732 acres with the apparent intent to eliminate site-specific environmental review for any of these valuable resources, with the knowledge that analysis of specific impacts is impossible at this time because the specifics of individual structural improvements are not presently known to allow for an assessment of the impacts on these critical areas; and

b) The DEIS fails to identify numerous probable, significant adverse environmental impacts to wetland functions and values, water quality, and fish and wildlife habitat; and

c) The DEIS fails to include an accurate assessment of groundwater elevations and surface water flows that leads to a significantly understated adverse impact on streams and wetlands in the "project" area; and

d) The DEIS arbitrarily discounts an alternative that would mitigate for some unavoidable, significant adverse impacts on streams and wetlands based upon the unsupported premise that there is a measurable difference on Dungeness River flows and/or habitat conditions between the mitigated (Alternative 6) and unmitigated (Alternative 2, 4) alternatives; and

e) The DEIS supports its preference for the alternative with the highest increase in stream flows in the Dungeness River without identifying the nature or fact of habitat improvements associated with the specific increases in flows for specific segments of the river, thereby generalizing and overstating the beneficial impacts of Alternative 2 over the other action alternatives; and

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[2] In fact, aside from the eight wetlands over 100 acres in size for which the environmental impacts are superficially analyzed, the remaining wetlands are not specifically described anywhere in the DEIS.

f) The DEIS fails to identify appropriate mitigation for unavoidable, significant adverse impacts; and

g) The DEIS fails to identify an adequate range of reasonable alternatives; and

h) Environmental review has been improperly segmented due to the failure to analyze the Conservation Plan along with the Comprehensive Irrigation District Management Plan ("CIDMP"), demonstrated by the DEIS's express statement that the Conservation Plan is the "key element" of the CIDMP. As a key element, the Conservation Plan is an "interdependent part of a larger proposal that depends on that proposal for its justification and implementation."

Contributing authors to this comment letter include; Robin Berry of Graysmarsh LLC (extensive knowledge of Graysmarsh and Gierin Creek watershed and related fish and wildlife), Judith Light of Associated Earth Sciences, Inc. (wetland biology, wildlife, water quality, aquatic resources), and Mark Shaffer and Erick Miller of Aspect Consulting, Inc. (hydrology).

Some Preliminary Issues

The Relevance of the Endangered Species Act

Although actions that improve conditions for endangered and threatened species are important to increasing the likelihood of survival of these species, it should be noted that there is no activity being proposed to the federal fisheries agencies that requires a conservation plan be completed in order to be in compliance with Section 4(d), or avoid sanctions under Section 9, of the Endangered Species Act ("ESA"). As the State of Washington has not sought approval of watershed conservation planning guidelines from the National Marine Fisheries Service ("NOAA Fisheries"), there is no applicable 4(d) limitation to exempt habitat restoration activities taken by DRUA through the Conservation Plan. See 50 C.F.R. 223.03(a). Thus, either the current irrigation practices are causing take and are subject to an enforcement action that has not yet been instituted, or, NOAA Fisheries' jurisdiction for review of a proposed Habitat Conservation Plan has not been invoked and will not be until the CIDMP is complete.

The DEIS seeks to create the impression that the Conservation Plan is a "must" that needs to be completed quickly in order to "comply" with the ESA. This is simply not the case unless the irrigation practices are causing take, in which case a biological opinion will need to be prepared before it is known exactly what changes will need to be made to avoid civil and criminal penalties. In fact, it would make more sense to obtain an incidental take permit and complete an environmental assessment under NEPA before completing SEPA review, as reasonable and prudent measures that will be identified in the ESA process may result in a different course of action and a different proposal. If this does occur, then additional SEPA review will need to be undertaken and the current environmental review process will not serve its intended purpose, i.e., to dispense with DRUA's and Ecology responsibilities under SEPA.

The Environmental Baseline Under SEPA is the "Existing Condition"

SEPA makes no distinction between wetlands and streams that are created or supplemented by inefficient irrigation practices that have resulted in decades of groundwater supply and those that receive their source from groundwater supplies that are not supplemented; the environmental baseline against which adverse impacts must be measured is the condition that exists at the time environmental review is undertaken. WAC 197-11-440(6)(a); WAC 197-11-444(1)(c). The DEIS seems to infer that wetlands and streams augmented by water from irrigation are somehow less deserving of mitigation. This position is not supported by law.

Other Permits

We take note that the DEIS does not identify the need to obtain permits from the United States Army Corps of Engineer (the "Corps") under Section 404 of the Clean Water Act. Although the Corps does not regulate wetlands whose sole water source is irrigation water and does not regulate ditches constructed in upland soils, the Corps does regulate natural wetlands and channels that are supplemented by irrigation flows. Therefore, it is likely that some of the structural improvement work will require a permit from the Corps, along with a 401 Water Quality Certification and CZMA Consistency Determination from Ecology. Moreover, the recently affirmed Borden Ranch case may result in the Corps' jurisdiction extending even farther. See Borden Ranch Partnership v. U.S. Army Corps of Engineers, 261 F.3d 810 (2001).

The Identification of the "Zone of Contribution" for the Elimination of Piping Projects Under Alternative 6 of the DEIS

In the event that the mitigated alternative, Alternative 6, is selected for implementation, it is important to note inadequate data is relied on to identify the sources of groundwater flow to Gierin Creek and the Graysmarsh wetlands. As such, the piping projects identified for elimination will not adequately maintain the source of groundwater to the creek and wetlands. Graysmarsh did a site specific analysis of existing conditions to identify groundwater flows and the system hydrology, which was provided to DRUA in 1999, titled, "Graysmarsh Hydrogeologic Investigation," January 14, 1999, by Associated Earth Sciences, Inc. ("GHI Study").[3] This study confirmed that ground water flow converges on Gierin Creek and the Graysmarsh wetlands, causing a much more significant inflow of groundwater than anticipated by the regional and scant data relied on in the groundwater model for the DEIS. See GHI Study, Figure 5.2.1, potentiometric maps, attached hereto as Exhibit A.

Although the DEIS assigns a less than 1 cfs groundwater inflow, flows in excess of 9 cfs have been observed at the down gradient discharge from the marsh. Although it will not be possible to identify all of the potential piping projects that need to be eliminated until a detailed potentiometric map of the shallow aquifer is developed to evaluate down-gradient impacts of projects on streams and wetlands, Graysmarsh has performed a preliminary analysis and identified additional piping projects that need to be considered for elimination in order to make Alternative 6 effective by identifying ditches immediately up gradient from Gierin Creek and the Grasymarsh wetlands. See Exhibit B, attached hereto. Alternative 6 should be revised to exclude these additional projects.

Project versus Non-Project Environmental Review under SEPA

The introductory section of the DEIS is equivocal in its description of the nature of environmental review it is intended to support. On the one hand, it notes that the DEIS analyzes an area-wide conservation plan qualifying for non-project level environmental review. On the other hand, it purports to present "project level"

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[3] A true and correct copy of the GHI Study is being provided with this comment letter for the SEPA record.

environmental review due to the inclusion of more than 100 structural improvements. SEPA allows proponents of non-project actions to undertake a much less detailed level of environmental review than is necessary for project actions because not enough is known about site-specific impacts at the non-project stage. Either the environmental review is project level or non-project level; it cannot be both.

SEPA defines nonproject actions as "actions which are different or broader than a single site specific project, such as plans, policies, and programs." WAC 197-11-774. More specifically, as applied to the Conservation Plan, a nonproject action is the adoption of a plan "that will govern the development of a series of connected actions (WAC 197-11-060)." WAC 197-11-704(2)(b). The DEIS describes the Conservation Plan as proposing "a series of connected actions focusing on improving the efficiency of the irrigation water delivery system..." Thus, both DRUA's action in adopting the Conservation Plan and Ecology's action in approving funding for the Conservation Plan under Referendum 38 are appropriately classified as nonproject actions.

Although the Conservation Plan identifies a number of possible physical improvements that will modify the environment, none of these individual improvements are ripe for site-specific environmental review because not enough is known about them for their environmental impacts to be reasonably identified and meaningfully evaluated. WAC 197-11-055(2). However, it is appropriate to analyze the cumulative impacts at the nonproject level at this time to avoid segmentation of environmental review of all of the possible irrigation efficiency projects. WAC 197-11-060(5)(d)(iii). In turn, the nonproject DEIS that has been prepared can be used to narrow and focus site-specific environmental review for those projects that are implemented and consistent with the Conservation Plan EIS. WAC 197-11-443.

The level of detail in the DEIS given to each of the scoped elements of environmental review is very generalized. The groundwater model used to assess existing conditions is a regional model with limited data points to provide reliable results at specific geographic locations, as specifically acknowledged in the Conservation Plan at Page 7-29 (providing a specific list of recommendations for construction and calibration improvements to the model used to improve the accuracy of the results). One example of the results of the model run indicates the probability that it fails to accurately assess the way groundwater flows in the various basins analyzed and which ditches are leaking into the shallow aquifer, thereby leading to the potential misinterpretation of the whole hydrologic system. The DEIS states that the model predicts that approximately .40 cfs will be lost in Gierin Creek if the ditches that have been identified as contributing to groundwater flows are piped. See DEIS, at 5-2, Table 5.3-1. In the GHI Study done to identify actual conditions in Gierin Creek and the Graysmarsh wetland, gaging indicated that 1.5 cfs enters Gierin Creek from the shallow aquifer and an additional 7.8 cfs enters the Graysmarsh wetland directly from the shallow aquifer. See GHI Study, Figure ES-1, attached hereto as Exhibit C. Three (3.0) cfs of these shallow aquifer inputs were found to result from ditch leakage within the Gierin Creek basin and up to another 1.5 cfs originated from ditches outside the Gierin Creek basin. For the Graysmarsh wetland area, this example demonstrates that the model seriously underpredicts actual conditions by not accounting for as much as 4 cfs (ten times the amount attributed to Gierin Creek from the model relied on in the DEIS) of groundwater recharge from ditch leakages.

Furthermore, the DEIS ignores direct groundwater contributions to all of the many wetlands in the Conservation Plan planning area. As is demonstrated by the Graysmarsh wetland example above, for which 7.8 cfs of groundwater contribution to the marsh was ignored for the DEIS impact analysis, it is likely that the DEIS has severely understated adverse impacts on other significant wetlands.

This example demonstrates that the level of environmental review provided in the DEIS is not adequate for assessing environmental impacts at the project level of review as required by SEPA.

Inadequate Assessment of Impacts

Due to the described inadequacies of the groundwater modeling, which could have been remedied according to current accepted hydrology modeling practices through ditch gaging, adding sufficient data points to the water table maps, and incorporating the data provided in the GHI Study, the DEIS fails to properly assess impacts on wetlands, water quality, fisheries, and wildlife. Moreover, there are several inconsistencies between the DEIS and the Conservation Plan. For example, the DEIS states there are approximately 265 wetlands or wetland complexes in the planning area in Section 4.2.2, while the Conservation Plan states there are 522 wetlands within the planning area in the Volume 2 appendices. Nowhere in the DEIS are the wetlands smaller in size than 100 acres identified, described, mapped, or put in comparison to the location of the irrigation ditches. It is impossible, based on the information provided, to determine what impacts the proposal will have on these wetlands. For the larger wetlands like the Graysmarsh wetlands, the DEIS performs a limited impact assessment, again, though, completely ignoring the documented loss of groundwater that directly feeds the marsh from the shallow aquifer. Instead, the DEIS only analyzes the impact of the groundwater loss associated with (under) predicted groundwater flows to the wetland through Gierin Creek.

Two of the more significant adverse impacts the DEIS fails to analyze with respect to affected wetlands are water quality and sediment removal capacity. With respect to water quality, reduced groundwater is likely to result in increased temperatures in the open water components of the wetland. As this area of the Graysmarsh wetland is a very low gradient, multi-channeled area providing ideal habitat for juvenile salmonid rearing, increases in water temperature are likely to reduce the area of suitable habitat. These increased water temperature impacts would be in addition to the loss of all late spring and summer flows in the upper creek sections and reduced flows in the lower creek sections. Graysmarsh provided additional, detailed comments on the Gierin Creek aquatic habitat and fish use in a letter submitted to the Foster Wheeler Environmental Corporation, located in Appendix C of the DEIS. There is no evidence this analysis was taken into consideration in the DEIS, but it is another example of how the assumed positive tradeoff between Dungeness flows and reduced groundwater flows is not supported in the DEIS because it fails to more than superficially analyze the possible consequences of predicted, lost groundwater. SEPA requires the lead agency to set forth the reasonable opposing views rather than ignoring a potential debilitating effect. Byers v. Bd. of Clallam Cy. Commr's, 84 Wn.2d 796, 802, 529 P.2d 823 (1974).

In the wetland impact analysis section of the DEIS, Section 5.4.1, sediment removal capability is a wetland function that the DEIS chooses not to address for each of the large wetlands. Section 5.4.1 states the ability to perform sediment removal remains in the land even if there is a vegetation change, such as the loss of emergent vegetation. However, emergent vegetation has a greater ability to filter sediment than shrubs or trees. Therefore, as the DEIS acknowledges that conversion of emergent vegetation to shrub or forested habitat would be the most likely plant community change to result from decreased hydrology to support wetland habitat, sediment removal should be discussed in the individual wetland sections in the DEIS. Just because groundwater is not available as a hydrology source does not mean that surface flows during storm events will not still occur and benefit from filtering through emergent vegetation (Section 5.4.1). The same is generally true for nutrient and toxic removal functions. The effect of the nutrient/toxic removal would not be limited to loss of opportunity; it would also be affected by a reduction in emergent wetland habitat. Likewise, production of organic matter could also be reduced with the reduction of emergent wetland habitat and increase in scrub-shrub wetland habitat. None of these factors are considered in the DEIS, resulting in yet another failure to evaluate the impacts of the Conservation Plan.

With respect to fisheries impacts, the DEIS identifies several Dungeness tributaries and independent creeks that provide high quality, functioning habitat for salmonid and other species (DEIS, at Table 4.5-2), but cursorily dismisses impacts on these streams and creeks by suggesting, without evidence or analysis, that increased flows in the Dungeness may result in backflows in Dungeness tributaries, thereby reducing potential fish habitat losses in these tributaries. Little attempt is made to evaluate the extent of habitat losses for any individual stream segments, or to locate important stream segments, or to evaluate the total cumulative effect of all of the losses from all of these streams and creeks if the Conservation Plan is approved. The analysis for independent creeks, like Gierin Creek, is similarly lacking. For example, it is estimated, based on the data evaluated by Graysmarsh (Cedarock Consultants, Inc., App. C to DEIS), that important segments of Gierin Creek will be de-watered and significant spawning habitat for coho salmon, and other species, thereby lost. This impact is not specifically identified or evaluated.

Likewise, the water balance method used to compute conveyance losses in the Conservation Plan at Page 4-13 is a preliminary method limited by inaccuracies inherent in computation of evapotranspiration and assumptions regarding crop types, acreages and irrigation efficiencies. At best, this methodology provides a high level overview of possible conveyance losses and water savings from proposed structural improvements; at worst it can result in a complete misassessment of the actual conveyance losses and water savings from the proposal. This level of uncertainty may be appropriate at the preliminary planning stages, but is inadequate to enable the assessment of probable impacts resulting from a proposal to the extent required by SEPA.

No Measurable Difference In Beneficial Impacts on Dungeness River Between Analyzed Action Alternatives

Although not required in an EIS, the DEIS analyzes the beneficial impacts of the proposed Conservation Plan on Dungeness River instream flow conditions on the expectation that increased flows will improve threatened fisheries chances for survival and improve their habitat in the river channel and side channels. Unfortunately, the beneficial impacts analysis that is provided does no more than equate, without sufficient analysis, increased flows with better habitat for more fish. As between the unmitigated action alternatives (2 and 4) and the mitigated action alternative (6), the DEIS predicts a difference of about 3 cfs (38.66 cfs versus 35.38 cfs "savings to diversion," corresponding to about a 26 cfs net flow increase as compared to a 23 cfs net flow increase). This is not likely a measurable difference in a river channel with an average width of 300 feet.

The DEIS states that the IFIM study shows the increase in water returned to the Dungeness under Alternative 2 would provide a slight increase in fish habitat benefits, but the DEIS also states that this benefit may not be detectable in terms of improved fish habitat considering ground water interactions, water quality, and channel geomorphology that is not considered by the IFIM model (Section 5.5.1 Alternative 4 discussion). However, even the weighted usable area (WUA) curves predicted by the IFIM fish habitat analysis (Wampler and Hiss 1991) show little to no change in WUA in flows differing by 3 cfs in the 140 cfs range. If one assumes a 50 cfs irrigation withdrawal in September (see Table 4.3-2) when 50% exceedence flows are 167 cfs (see Table 4.3-1), then the instream flows below the irrigation diversion would be 143 cfs with a 26 cfs reduced withdrawal [(167cfs - 50cfs) + 26cfs) = 143 cfs] while a 23 cfs reduced withdrawal would result in 140 cfs flows below the diversion. Although the recommended flow for the lower Dungeness River is 180 cfs (Hiss 1993), the predicted weighted usable areas (WUAs) for graphs presented in the IFIM fish habitat analysis (Wampler and Hiss 1991) for the braided stream section show little to no change in WUAs between 140 cfs and 143 cfs flows for most salmonid species and life stages modeled, including dolly varden and chinook spawning.

The maximum WUAs predicted by the model for the braided channel study site is in the 450 cfs to 750 cfs range for salmonid spawning; however, there is a steady increase in WUA as flows increase until reaching approximately 100 to 240 cfs (depending on species and life stage) and then remain steady or decreases until reaching the higher flows in the braided section. The DEIS (Section 4.3.1) characterizes the river channel as braided from approximately RM 10 to 3.2, which constitutes the majority of the channel below the irrigation diversion. The WUAs predicted by the IFIM model for the non-braided channel show a slight WUA increase for spawning dolly varden, steelhead, and chinook at 143 cfs than at 140 cfs, but less WUA for spawning coho and pink salmon and juvenile chinook at 143 cfs than 140 cfs. However, the maximum WUAs predicted for salmonid spawning in the non-braided channel range from approximately 140 cfs to 240 cfs and then generally decrease for all increased flows unlike the braided section that benefits from high flows (typically greater than 450 cfs). Although the IFIM model shows a fish habitat benefit with a 26 cfs flow increase, if one takes into consideration modeling error, as well as the stream factors not included in the IFIM, the fish habitat benefit of a 26 cfs flow increase versus a 23 cfs flow increase would not be detectable in the lower Dungeness River.

Need for Mitigation for Unavoidable, Significant Adverse Impacts

The Conservation Plan was initiated in the face of a determination by Ecology that irrigation practices in the DRUA irrigation areas was suffering from a 45% inefficiency rate. Okanogan Wilderness League v. Dep't of Ecology, PCHB No. 98-84, § XVII. In other words, the irrigation practices of the association entities was found to result in almost half of the water being diverted not applied to irrigation purposes. Just as Ecology and the PCHB determined this inefficiency should not result in loss of DRUA water rights, natural resources that have benefited from those inefficient practices should not have to suffer with no mitigation for groundwater losses that increased efficiency will cause.

For example, the DEIS predicts that if irrigation ditches that currently provide groundwater supply to Gierin Creek and the Graysmarsh wetland are piped, at least 65% of the water supplying Gierin Creek will be lost. Graysmarsh believes the DEIS grossly understates impacts to the Graysmarsh system by ignoring the much larger ground water discharge directly to the marsh. The 405 acre wetland will undoubtedly suffer a radical change in habitat and production without this groundwater source or other mitigation measures. The immeasurable benefits for the Dungeness River fisheries, as addressed previously, do not warrant a conclusion that no mitigation should be required for impacts such as these. The balance between the nonmitigated alternatives (2 and 4) and the mitigated alternative (Alternative 6), therefore, weighs heavily in favor of the mitigated alternative.

Furthermore, it does not seem logical to conclude that the immeasurable benefits of slight flow increases justify "relatively minor adverse cumulative effects on fish whose populations are not as severely threatened that use the independent streams." Additionally, if groundwater recharge to these streams has already been reduced by increased groundwater utilization for human consumption, stockwatering, irrigation, and changes in infiltration and recharge of the shallow aquifer due to increased development, an additional decrease in available stream habitat and reduced water quality that will result from the Conservation Plan actions could be expected to have a much greater impact on the affected independent streams and Dungeness tributaries than a "minor" cumulative effect. Although there are other numerous human factors that can and do affect the hydrology of the planning area (section 6.2), this does not dismiss the need to mitigate for the adverse impacts of the Conservation Plan actions on small streams and wetlands in the planning area. Typically such a situation would point to the need to mitigate an adverse impact.

The DEIS fails to take these effects into consideration, and, owing in large part to the paucity of information available on site-specific, stream segment impacts, fails to adequately assess the probable impacts of the Conservation Plan on these streams and tributaries. This failure renders the DEIS inadequate, to the extent it is intended to serve as project level environmental review of the individual structural project impacts. More importantly, it results in a complete lack of attention to needed mitigation for the cumulative impacts the Conservation Plan will have on the tributaries and streams. As the activities of DRUA in connection with specific projects may not be regulated under Clallam County critical area regulations, there are no regulatory requirements that could serve to provide needed mitigation. More detailed environmental review is necessary to justify the course of future actions that will be prompted by Alternative 2, an alternative that fails to consider individual project impacts and their cumulative effects.

Inadequate Identification of Reasonable Alternatives

The stated objectives of the Conservation Plan are to improve the efficiency of the DRUA entities' irrigation water delivery system and improve fish habitat conditions in the lower Dungeness River. The DEIS evaluates essentially two alternatives, a no action alternative, and an action alternative, Alternative 2, with two variations, Alternatives 4 and 6 that include all of the non-structural and all but a few of the structural improvements identified in Alternative 2. The majority of structural improvements proposed are piping projects, which are predicted to result in 30.16 cfs of the predicted 38.66 cfs that would no longer need to be diverted from the Dungeness River.[4]

There is no exploration in the DEIS of any other methods of improving the efficiency of the water delivery system, changing irrigation practices, or using other methods to improve habitat quality in the Dungeness River, such as; a) installing pipes in existing irrigation ditches but utilizing the piping for certain important ditches only during critical low flow periods, b) storing water for irrigation in reservoirs and/or by artificial recharge, reducing or cutting off diversions to the ditches during the low flow period, c) implementing Alternative 6 and using the money saved on structural improvements towards river channel habitat restoration, such as installing gravel berms or carefully designed bank protection and gravel removal, as noted by Hiss, 1993, p.6, and d) educating water users on more efficient ways to apply diverted water so that less is needed, imposing use restrictions if necessary. The exclusive focus on piping projects and on maximizing flows in the Dungeness River unnecessarily pits fish, plant, and wildlife species that use small streams and wetlands supported by groundwaters against those using the Dungeness River. Other reasonable alternatives were available to attain or approximate the proposal's objectives at the same or lesser environmental cost and should have been evaluated. WAC 197-11-440(5).

Improper Segmentation of Nonproject Level Environmental Review

SEPA requires that all aspects of a proposal be analyzed in the same environmental document, to avoid piecemealing and improper segmentation of environmental review. WAC 197-11-060(3)(b) specifically provides that proposals or parts of proposals that are related closely enough to each other to be, in effect, a single course of action be evaluated in the same environmental document. As indicated in the DEIS, the Conservation Plan is described as the "key element" of the CIDMP that is being prepared. Apparently, the first four steps of the CIDMP have been completed and

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[4] The DEIS alternatives analysis overstates the actual water savings in two ways, 1) the net savings, when considering lost return flows to the Dungeness, is no greater than 26 cfs for all alternatives, and 2) the Water Right Trust Agreement allows for possible additional diversions of 1/3 of the water saved, making the net effect no more than 17 cfs.

DRUA is seeking proposals for the remaining six (6) steps based upon a published RFP with a stated deadline of January 3, 2003. The CIDMP guidelines suggest SEPA review of the CIDMP take place in Step 9, after the implementation program has been prepared. Chapter 1, at 1-1, Guidelines for Preparation of Comprehensive Irrigation District Management Plans, Ecology, May 2001. Step 5 of the CIDMP process, according to the guidelines, is to assess the impacts on water quality and fish and wildlife needs as a preface to preparing an action plan designed to prioritize the action in relation to resource needs. The fact this step has not been taken further exposes the inadequacy of the DEIS, which was prepared without this assessment.

Because the CIDMP process envisions interaction with federal fisheries agencies, it is possible, if not probable, that the action plan will look very different from the Conservation Plan analyzed in the DEIS. To the extent the CIDMP and the Conservation Plan are interdependent parts of a larger proposal, environmental review of one should not occur without the other. If Ecology decides it is necessary to delay detailed environmental review until the CIDMP process is complete, it should also issue an order preventing DRUA from implementing any further piping projects identified in the Conservation Plan until said environmental review is complete to prevent it from taking actions that will impermissibly limit the choice of reasonable alternatives. WAC 197-11-070(1). A proper EIS must be prepared before Ecology or DRUA commits to a particular course of action. WAC 197-11-055(2)(c).

Conclusion

Graysmarsh respectfully requests Ecology require further, detailed environmental review of the significant adverse impacts on Dungeness tributaries, independent creeks, and affected wetlands in the Conservation Plan planning area. Within this context, Graysmarsh requests Ecology instruct DRUA to include a detailed analysis of the impacts of reduced groundwater flows on Gierin Creek, its use as fisheries habitat, the Graysmarsh wetlands, and their use as fisheries and wildlife habitat through an investigation of actual site conditions with the assistance of the GHI Study or other reliable data. Following such analysis, adequate mitigation should be identified. Alternatively, Graysmarsh requests that Ecology approve only Alternative 6 analyzed in the DEIS as satisfying the substantive requirements of SEPA (with the addition of the elimination of piping projects identified through a site specific investigation, aided by Exhibit A hereto and the GHI Study).

Sincerely,

Pamela Krueger

Pamela W. Krueger

PWK:pwk

cc: Gary Reed
Charlie Lyford
Robin Berry
Margi White
Judith Light
Mark Shaffer
Erick Miller
Joe Stohr (w/ GHI Study)
DEIS Distribution List (w/o attachments)

Exhibit A
Figure 5.2.1 of GHI Study

GRAYSMARSH HYDROGEOLOGIC INVESTIGATION

PREPARED FOR:

GRAYSMARSH LIMITED PARTNERSHIP

AESI PROJECT NO. BH96028

JANUARY 14, 1999

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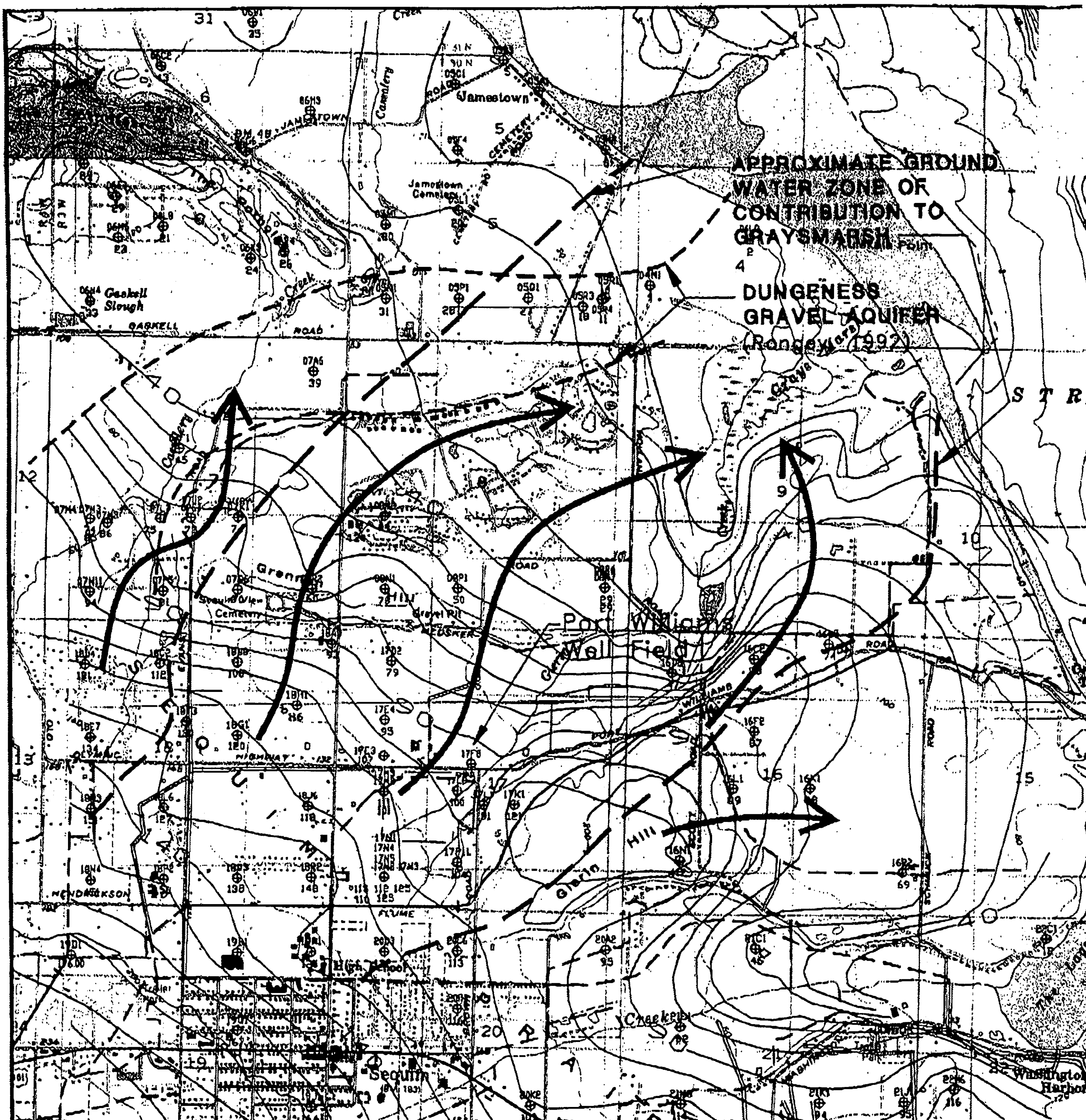

Legend

Unit 1 Well Identifier
Static Water Level Elevation
See Table A-1 for Well Location and Elevation Accuracy and Water Level Measurement Dates

80
Inferred Ground Water Elevation Contour

Graysmarsh Property Boundary

Approximate Ground Water Zone of Contribution to Graysmarsh

Ditch/Pipe

Ground Water Flow Direction

Dungeness Gravel Aquifer (Rongey, 1992)

0 1250 2500
FEET

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DESIGNED	E.W.M.
DRAWN	S.C.C.
CHECKED	E.W.M.
APPROVED	M.E.S.

Ground Water Elevation Contour Map
Unit 1
Graysmarsh Hydrogeologic Investigation

PROJECT NO. WB9628E
FIGURE NO. 5.2.1

BH9628E-07.dwg xref: BH9628E-05 01/07/99 fl

Exhibit B
Additional Piping Projects for Elimination

Independent Ditch Company – all ditches listed in Table 9-6 of the Water Users Association Conservation Plan with the following specific ditch sections; I-1, I-2, I-3, I-4, M1, M2, M3

Sequim-Prairie Ditch Company – all ditches listed in Table 9-7 of the Water Users Association Conservation Plan with the following specific ditch sections; SP-1, SP-2, SP-4, SP-5, SP-6, M1, M2, M3

Eureka Ditch Company – all ditches listed in Table 9-8 of the Water Users Association Conservation Plan with the following specific ditch sections; E-1, M1

Exhibit C
Figure ES-1 of GHI Study

GRAYSMARSH HYDROGEOLOGIC INVESTIGATION

PREPARED FOR:

GRAYSMARSH LIMITED PARTNERSHIP

AESI PROJECT NO. BH96028

JANUARY 14, 1999

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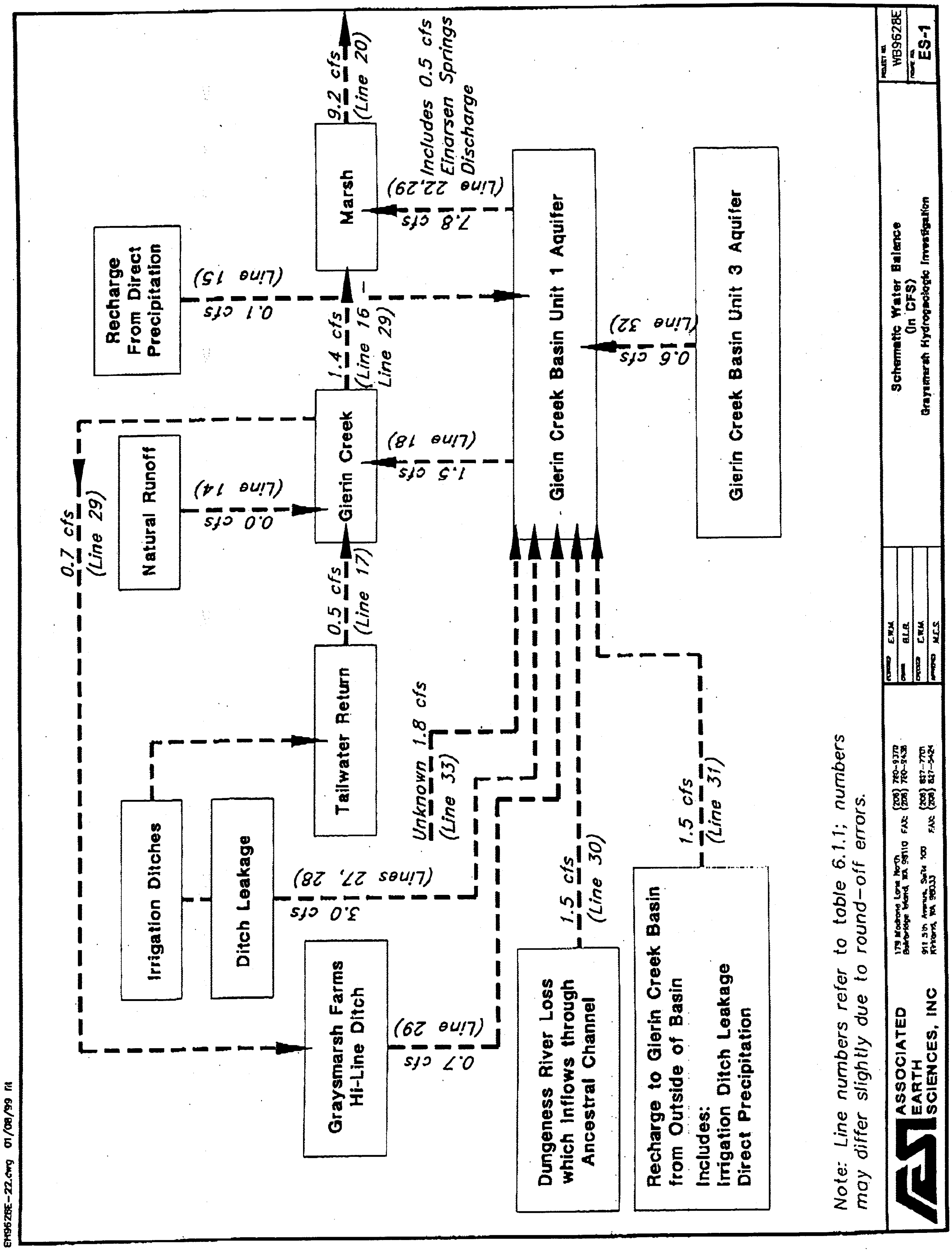

Recharge From Direct Precipitation
0.1 cfs
(Line 15)
Natural Runoff
0.0 cfs
(Line 14)
Irrigation Ditches
Ditch Leakage
3.0 cfs
(Lines 27, 28)
Graysmarsh Farms Hi-Line Ditch
0.7 cfs
(Line 29)
0.7 cfs
(Line 29)
Tailwater Return
0.5 cfs
(Line 17)
Gierin Creek
1.4 cfs
(Line 16
Line 29)
Marsh
9.2 cfs
(Line 20)
7.8 cfs
(Line 22,29)
Includes 0.5 cfs
Einarsen Springs
Discharge
1.5 cfs
(Line 18)
Gierin Creek Basin Unit 1 Aquifer
Gierin Creek Basin Unit 3 Aquifer
0.6 cfs
(Line 32)
Unknown 1.8 cfs
(Line 33)
Dungeness River Loss which Inflows through Ancestral Channel
1.5 cfs
(Line 30)
Recharge to Gierin Creek Basin from Outside of Basin
Includes:
Irrigation Ditch Leakage
Direct Precipitation
1.5 cfs
(Line 31)
Note: Line numbers refer to table 6.1.1; numbers may differ slightly due to round-off errors.
ASSOCIATED EARTH SCIENCES, INC
Schematic Water Balance
(In CFS)
Graysmarsh Hydrogeologic Investigation
WB9628E
ES-1
EW9628E-22.dwg 01/08/99 fit

Appendix H

Responses to Comments Not Included in FEIS

Appendix H.1

Randy Johnson Memo On Graysmarsh

interoffice
MEMORANDUM

WDFW Puget Sound Technical Assistance
332 East 5th Street, Port Angeles 98362

To: Bob Barnard, Environmental Engineering Division

From: Randy Johnson, Fish & Wildlife Biologist

Subject: Maintenance Options for Graysmarsh

Date: November 23, 1998

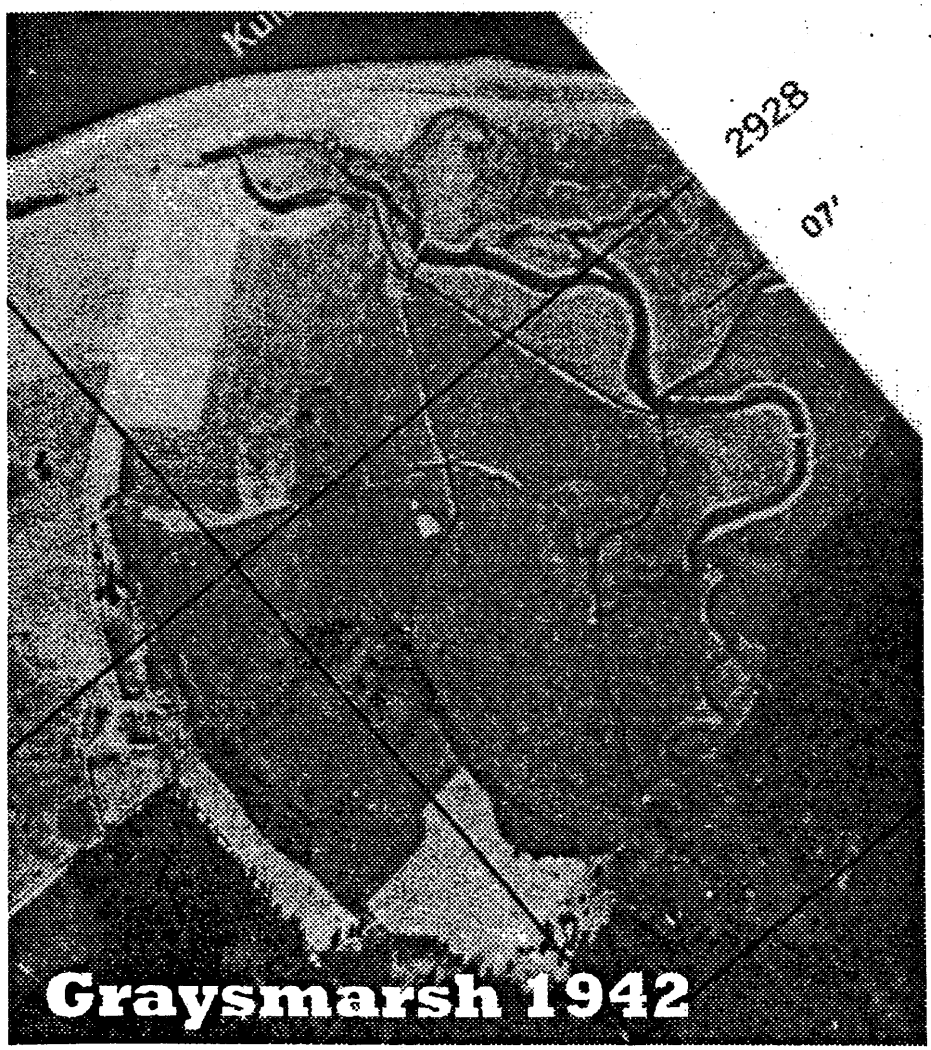
The following information is based upon numerous site visits made to Graysmarsh between 1983 and 1997, conversations with current and former Graysmarsh employees, and an examination of aerial photos dated 1942, 1971, and 1997. The term "Graysmarsh" is used to denote the actual marsh, rather than any portion of the adjacent Graysmarsh farmlands.

Background

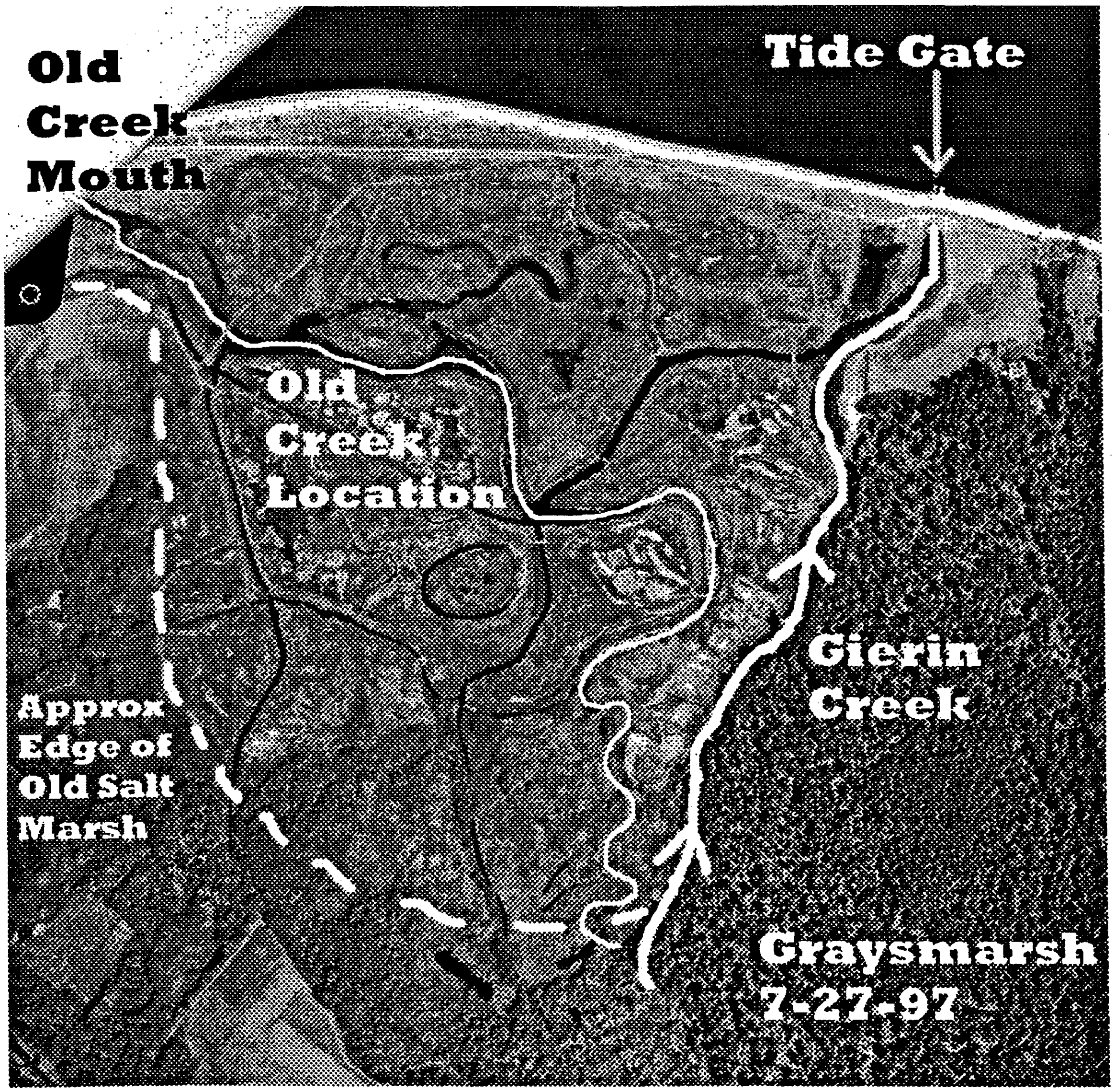
Graysmarsh is an approximately 140-acre freshwater/brackish water marsh located at the mouth of Gierin Creek (WRIA 18.0005), which enters the Strait of Juan de Fuca immediately east of Dungeness Bay. Although it is significantly affected by a tide gate, the brackish portion of Graysmarsh constitutes what remains of the Gierin Creek estuary. In approximately 1910, measures were taken to exclude tidal intrusion into the marsh. This may have been done either for agricultural purposes or perhaps to create conditions viewed as "improved" for dabbling-ducks (mallards, pintails, and teal). Gierin Creek now drains through a tide gate that presently allows enough tidal exchange to support about 30 acres of salt marsh, while keeping the remainder of the marsh primarily freshwater. In contemporary times, Graysmarsh has been managed exclusively for wildlife and fish habitat. Livestock are not allowed access to the marsh, nor do any agricultural practices occur within the marsh. The private owners of Graysmarsh diligently strive to maintain good waterfowl habitat through the practices of 1) growing barley specifically for duck forage on adjacent agricultural land, 2) annually mowing expansive areas of cattails and Reed's canary grass and 3) occasionally dredging certain channels within the marsh to maintain depth. These measures are expensive. The Graysmarsh wildlife biologist, Robin Berry, has suggested that the owners might wish to consider options that would reduce maintenance costs while retaining Graysmarsh's value to wildlife and fish.

Physical Processes

Evidence indicates that at least 115 acres of Graysmarsh were once salt marsh. Therefore, the physical characteristics of Graysmarsh were created by the interaction of dynamic processes typical of the mesotidal salt marsh/estuarine delta environment - tidal, fluvial, and wave energies which together produce a complex, productive, and remarkably stable landscape feature. Pristine salt marshes are sufficiently stable that changes in their elevation often reflect long-term changes in sea level. Throughout Europe and Asia, historical records have shown that estuarine deltas and salt marshes may hardly change over a period of centuries. However, anthropogenic impacts that affect the interaction of fluvial, wave, and tidal energies generally cause sudden, dramatic changes in these aquatic ecosystems.



Although taken about 32 years after tidal exclusion, the 1942 air photo clearly shows the tortuous meandering of Gierin Creek where the stream first becomes visible in the photo, characteristic behavior of streams near their upper end of tidal influence. Severe meandering has been found to be integral to the efficient transport of sediment from the fluvial into the marine environment. Immediately downstream, the channel becomes dramatically wider and the meander length correspondingly longer, indicating the contribution of flow from the system's tidal prism. Also visible are numerous sinuous channels of tidal origin and several relatively straight man-made channels or ditches. Although not apparent in this photo, I suspect Gierin Creek had previously been routed into a new course tight against the southeast side of the old tidal prism, where the creek runs today.



Fifty-five years later, the 1997 air photo shows a distinct decrease in the vitality of the old Gierin Creek channel despite several dredging treatments. Much of its length appears overgrown with aquatic vegetation. Also visible is an apparent advance of upland vegetation into the marsh along its southern edge.

Interpretation

The partial exclusion of tidal processes at Greysmarsh has caused much of the old salt marsh to become freshwater marsh. The loss of wave and tidal energy has decreased the system's ability to transport sediment and detritus into the Strait of Juan de Fuca. In response, the marsh is attempting to rapidly evolve into a freshwater equivalent of the salt marsh - most likely a scrub/shrub or forested wetland. The prolific production of cattails and Reed's canary grass coupled with the marsh's reduced ability to export material is likely causing the marsh surface to aggrade with organic soil, promoting encroachment of woody vegetation. The accumulation of freshwater aquatic vegetation in the channels will cause these channels to eventually fill-in or will necessitate routine dredging projects. Unquestionably, the practices of mowing and dredging are slowing the rate of evolution. But, I suspect that as time passes the Graysmarsh owners will find that ever-increasing maintenance expenditures will produce decreasing results.

Maintenance Options

According to the wildlife manager, the Graysmarsh owners wish to maintain Graysmarsh as highly productive waterfowl and fish habitat, not only for its intrinsic value to these resources, but also to provide themselves with hunting and fishing opportunities. The routine practice of planting forage crops for waterfowl on adjacent agricultural land benefits waterfowl and ensures that they will be attracted in large numbers to the vicinity of the marsh for hunting opportunities. This appears to be a sound management practice that can be maintained at the owners' discretion without negative consequences. Options for maintenance of physical habitat in the marsh appear to fall into two main categories: 1) a continuation of traditional mowing and dredging practices, and 2) restoring natural processes. Option number 2 could be implemented as either partial or full restoration of natural processes.

Partial Restoration of Natural Processes

The objective of this alternative would be to reduce the surface area covered by freshwater marsh vegetation, especially cattail, Reed's canary grass and aquatic macrophytes, by increasing the penetration of saltwater into the marsh. This could be accomplished by manipulation of the tide gate/outlet structure. Studies have found that increased tidal flushing can lead to a measurable spread of salt marsh in a single growing season. Areas transformed to salt marsh would no longer require routine mowing. This action could also hinder the proliferation of freshwater aquatic vegetation in certain channels, thereby reducing the amount of maintenance dredging needed. Increased tidal penetration would also benefit anadromous salmonid habitat.

Full Restoration of Natural Processes

The objective of this alternative would be to virtually eliminate the need for maintenance of physical habitat at Graysmarsh by restoring the physical processes responsible for the creation of the marsh. Elements of this alternative would include:

1. Return Gierin Creek to its former, meandering location which essentially bisected the marsh.

2. Reestablish the Gierin Creek mouth at the northwest corner of the marsh without any outlet structure.

3. Ensure that the old tidal channels in the marsh are sufficiently open to convey flow.

4. Plug or fill the man-made ditches.

5. Where tidal channels were cut by ditches, reconnect tidal channels to their tidal prisms.

This alternative would provide the greatest reduction in maintenance costs and the greatest benefits to anadromous salmonids - primarily cutthroat trout and coho, chum, and possibly chinook salmon. The long-term degradation of the marsh by encroachment of upland or woody vegetation would be essentially halted and possibly reversed.

Summary of Expected Pros and Cons of the Various Maintenance Options and Alternatives

Option Number 1 - Status Quo

Pros:

1. No large change in marsh morphology will occur from year to year.

2. No significant change in waterfowl hunting opportunities will occur from year to year.

Cons:

1. Continued or escalating maintenance costs associated with mowing, dredging, and the tide gate/outlet structure.

2. Long-term degradation of the marsh by the aggradation of organic soil and the encroachment of woody vegetation.

3. Continued reduction in potential salmonid habitat within the marsh.

4. Continued concerns about fish passage for adult and juvenile salmonids at the tide gate.

Option Number 2 - Restoration of Natural Processes
Alternative A - Partial Restoration

Pros:

1. Decreased maintenance costs.

2. Improved salmonid habitat within the marsh.

3. Might cause Gierin Creek to become inhabited by white sturgeon.

4. Decreased concerns about fish passage for adult and juvenile salmonids at the tide gate.

5. Requires little or no cost to implement.

6. May decrease long-term degradation of the marsh.

7. Initial changes to marsh morphology and waterfowl hunting opportunities are less than would occur with full restoration.

Cons:

1. Although reduced, maintenance costs associated with mowing, dredging, and the creek outlet structure will continue.

2. Although reduced, long-term degradation of the marsh will occur.

3. Although improved, salmonid habitat is not restored to its full potential.

4. Maintenance costs associated with the Gierin Creek outlet structure will continue.

5. The lower reaches of Gierin Creek may tend to import rafts of marine vegetation more efficiently than it exports this material.

Option Number 2 - Restoration of Natural Processes
Alternative B - Full Restoration

Pros:

1. Virtually eliminates maintenance costs associated with mowing, dredging, and the tide gate/outlet structure.

2. Restores salmonid habitat within the marsh to its full potential.

3. Will likely cause Gierin Creek to become inhabited by white sturgeon.

4. Eliminates any possible concerns about juvenile and adult fish passage into Gierin Creek.

5. Restores significant amounts of shorebird habitat.

6. Eliminates and possibly reverses long-term degradation of the marsh due to the aggradation of organic soils.

7. Benefits the tidal energy budget of adjacent marine areas.

8. Restores Graysmarsh to a natural, dynamic ecosystem.

Cons:

1. Initial cost of implementation may approximate one-year's mowing and dredging cost.

2. Visible changes to the marsh's morphology would be immediate and dramatic.

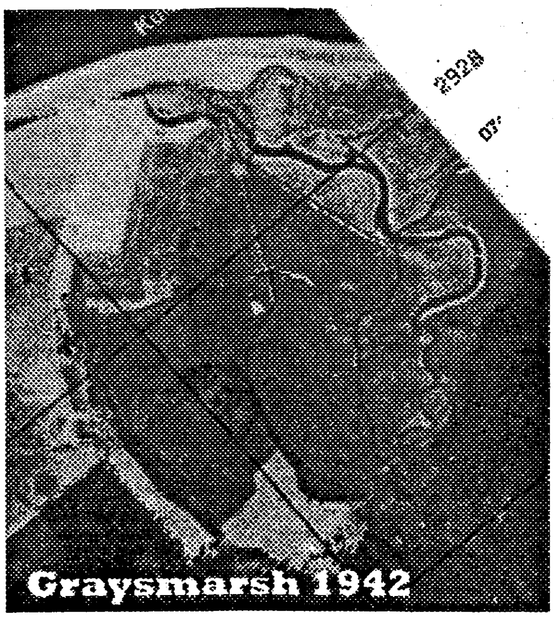
3. Waterfowl hunting opportunities would likely change significantly, **although not necessarily for the worse.** In Washington, extremely successful waterfowl hunting is often found in salt marshes, estuaries, and other tidal areas. In addition to the inherent value salt marsh estuarine systems have for waterfowl, the proximity of the marsh to waterfowl forage crop areas, suggests that duck hunting at Graysmarsh would remain excellent. However, compared to freshwater areas, waterfowl are often seen to move more frequently in tidal areas, in response to changing conditions caused by flooding and ebbing tides.

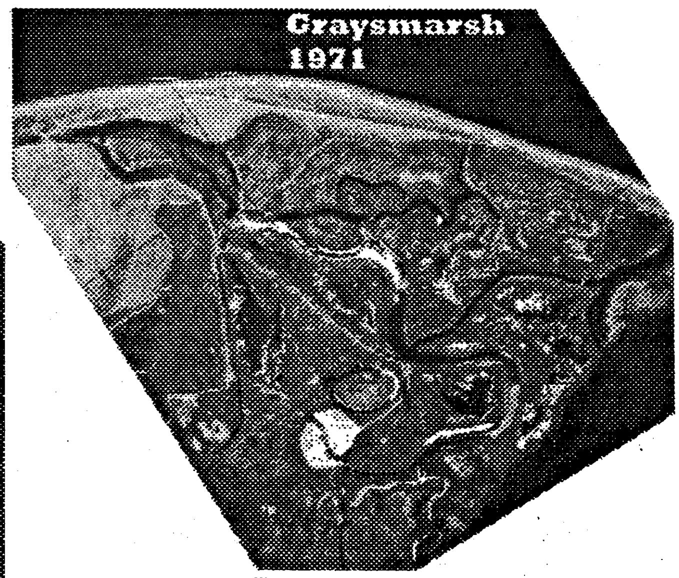
Request for Engineering Assistance

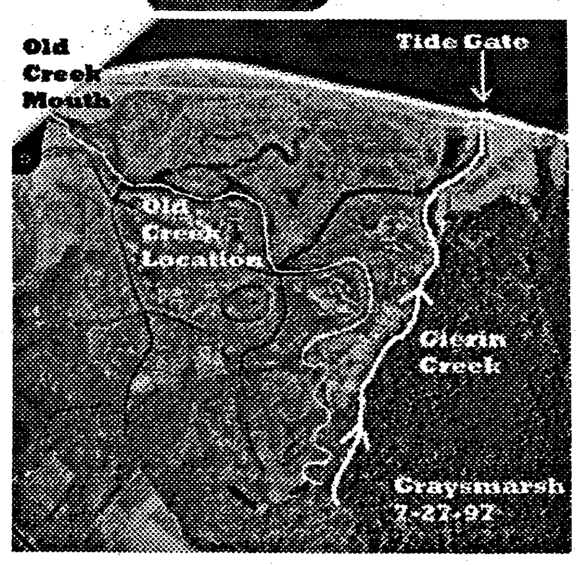
If the Graysmarsh owners decide to consider implementation of option No. 2, they will likely need more specific information on the potential effects of the two alternatives. With your experience modeling tidal systems, your assistance could be invaluable. If you would be available to work on this project, please contact either myself or Ms. Robin Berry at Graysmarsh (360-683-6025).

Thanks for your help.

CC: Robin Berry - Graysmarsh
WDFW - Tim Rymer, Anita McMillan & Randy Carman








Graysmarsh 1997
1870 Channels
1870 Coastline
1870 Wetland Boundaries
1997 Gierin Cr Channel

Appendix H.2

Comment Response

Appendix H.2

During the public scoping meeting held on July 31, 2002, a Graysmarsh representative proposed Alternative 6 as an intermediate in the range of alternatives from no action (Alternative 1) to full implementation of the Conservation Plan (Alternative 2). The Graysmarsh representative requested that Figure 5.2.1 (Ground Water Elevation Contour Map Unit 1) of the AESI 1999 Graysmarsh Hydrogeologic Investigation be used to determine the elimination of piping projects from Alternative 6 in an effort to minimize impact to Gierin Creek and Graysmarsh wetlands.

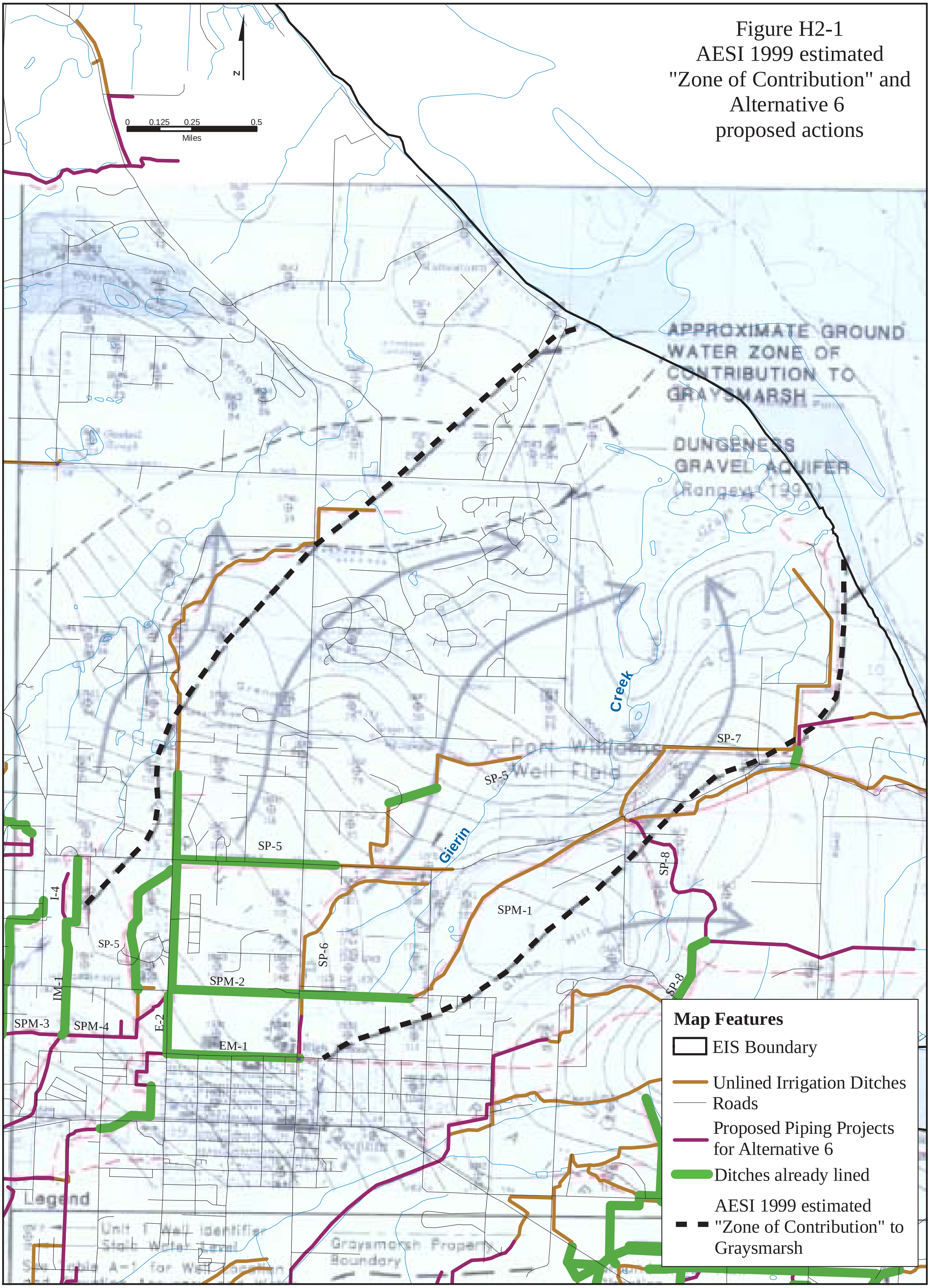
This figure is shown in a map attached to the Graysmarsh comment letter, submitted by their attorneys at Perkins Coie LLP, and found in Appendix G of this EIS. To develop Alternative 6, the AESI figure 5.2.1 was overlain upon a map of the irrigation ditches to identify ditches within the zone that had not already been piped (see figure H-1). The identified ditches were excluded from Alternative 6, except for a small portion of EM-1. Approximately 800 feet of ditch EM-1 (2% of total length within the zone) at the upgradient end of the "zone of contribution" are proposed to be piped under Alternative 6. An unknown amount of leakage is associated with 800 feet of EM-1, however there is a tailwater discharge at the end of EM-1 that contributes to Gierin Creek.

It should be noted that the delineated "approximate zone of ground water contribution to Graysmarsh" in Figure 5.2.1 of the AESI study does not identify a southwestern boundary of the zone. Ditch leakage southwest of the delineated zone may contribute to Gierin Creek, which is a source of water for Graysmarsh wetland. For the purpose of alternative 6, only the ditches CLEARLY within the delineated "approximate zone of ground water contribution to Graysmarsh" were eliminated for proposed piping to potentially protect the highest value wetland in the watershed.

A comment letter on the Draft EIS received from Pamela Krueger of Perkins Coie LLP (Graysmarsh representative), discussed the AESI 1999 study and recommended Alternative 6 be expanded as illustrated as described in their letter in Attachment A. That Figure 5.2.1 be used to expand the development of Alternative 6, attached as Exhibit A to that letter (Appendix G). Furthermore, the letter asserts that "Graysmarsh performed a preliminary analysis and identified additional piping projects that need to be considered for elimination in order to make Alternative 6 effective by identifying ditches immediately up gradient from Gierin Creek and the Grasymarsh (sic) wetlands." The additional projects were listed in Exhibit B to that letter, and include the entire set of ditches within the boundaries of Independent Ditch Company and Eureka Ditch Company as well as 70 percent of the ditches within Sequim Prairie Company. These additional ditches are outside of the AESI 1999 delineated "zone of groundwater contribution".

Alternative 6 was therefore not modified and contains the same list of ditches that would not be piped as was found in the Draft EIS. Graysmarsh has the opportunity to conduct further research and gather data on the ditches in question.

Figure H2-1
AESI 1999 estimated
"Zone of Contribution" and
Alternative 6
proposed actions



q:\projects_2002\dungeness\workdir\maps\maps_jan2003\groundwater_zone_graymarsh8x11.mxd

Appendix I

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