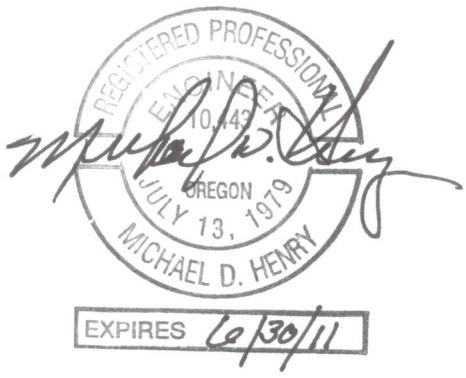
City of Rockaway Beach

Tillamook County, Oregon

JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM RESTORATION PROJECT FEASIBILITY STUDY

September 2010

Project No. 2004-027.17



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EXECUTIVE SUMMARY

The City of Rockaway Beach is proposing an innovative solution to resolve a number of issues affecting the quality and quantity of the raw water available in its impoundment pond. In its existing configuration, all flows from Jetty Creek flow through the City's 6,000 gallon raw water impoundment, which consists of a screened intake and small dam to maintain water level. As a result, sediment accumulates in the impoundment and requires annual dredging to maintain function. Furthermore, storm events cause spikes in raw water turbidity resulting in increased treatment costs.

Additionally, the existing impoundment acts as a barrier to fish passage on Jetty Creek. This is especially significant because the area has been identified as critical habitat for Oregon Coast (OC) Coho salmon, a listed species on the Federal Endangered Species Act. Removing this barrier would open an additional 1.8 miles of critical habitat to fisheries.

The proposed *Jetty Creek Impoundment Improvements & Stream Restoration* project would re-route the main stem of Jetty Creek to a restored relict channel east of the impoundment allowing unimpeded fish passage. A new fish-friendly diversion structure would be constructed to divert water from Jetty Creek to the City's impoundment, which would be increased to nearly 300,000 gallons. Restoration of the relict channel would include placement of boulders and large woody debris to enhance aquatic habitat. The area would be revegetated to provide shelter and maintain low water temperatures in the creek. Overall, this proposed project will be beneficial to both the City's water operations and the area's aquatic resources, including OC coho.

Although Jetty Creek flows year round, stream flows are highly variable. This will require careful consideration in the design process to ensure the new diversion structure will function properly under variable flow conditions and fish passage criteria are met. All structures will need to be protected from peak flow and flooding damage. Operation of the diversion will need to be carefully managed to ensure the City conforms to terms and conditions of its water rights as well as the in-stream water right allocation for Jetty Creek.

Various alternatives for the new diversion structure have been investigated. These alternatives were evaluated on their ability to meet required design objectives, such as conformance to State and Federal fish protection criteria; flexibility in diversion operations, including the ability to stop all diversions; flow monitoring capability to ensure compliance with water right terms and conditions; and low O&M and a capital cost requirements.

The preferred alternative for the new diversion structure recommended includes a flat plate fish screen to prevent fish from entering the City's diversion. The total cost for the preferred alternative is estimated at $76,500. Key design elements of the screened diversion should include:

- Conformance to Federal and State design criteria.
- Screen material should be composed of wedge wire or profile bar material for increased strength and durability.
- Provide air burst cleaning system.
- Concrete 'wall' and abutment adjacent to the channel and paired with a riprap revetment on the opposite bank to create a natural scour pool adjacent to the structure.

- Head gate located behind fish screen. Gate should be able to be operated manually or remotely by integration into the City's existing SCADA system.
- Downstream grade control maintains to minimum pool elevation.
- Piping to deliver diverted water to the impoundment via gravity system.

In addition to developing a preferred alternative design for the City's new diversion structure, this plan also indentified other items that must be completed. This includes additional studies and task, which are required to obtain necessary information for design and/or required by permitting agencies. It is important these tasks be properly planned for so that they do not cause a delay in the project.

The total project is estimated to cost $280,500 to $295,500, depending on required permitting work. The City has currently secured funding to complete 50% of design work and to begin permit process. Additional grant money will need to be obtained to complete proposed design, permitting, and construction.

SECTION 1

INTRODUCTION

The City of Rockaway Beach has authorized this study to determine the feasibility of proposed improvements to its existing raw water impoundment. The goal of these improvements is to not only improve the quality and quantity of the City's raw water supply, but also to restore fish passage and improve the habitat value of Jetty Creek. These proposed improvements have been discussed by the City and other governmental officials for some time; however, this *Feasibility Study* represents the first tangible step forward in the planning and design process.

1.1 Study Objectives

The objective of this study is to determine the feasibility of the City's proposed *Impoundment Improvement and Stream Restoration Project*. In order to determine the project's feasibility, this study investigated and summarized various site conditions that have direct impacts on project design, cost, and implementation. These conditions include:

- General description of the project area and associated watershed.
- Geological characteristics of site.
- Hydraulic analysis Jetty Creek stream flows and proposed rehabilitated creek channel.
- Inventory of biological resources in the project area and assessment of potential impacts.

Based on the findings of the initial site condition analysis, key design components and criteria were developed. These criteria were used to develop a range of appropriate alternatives for the proposed diversion structure. For each alternative, preliminary layouts and detailed cost estimates have been developed. A final design recommendation has been made based on the alternative that is most cost effective and best able to meet project goals

1.2 Study Authorization

This *Feasibility Study* has been funded by a combination of local and State money. In the spring of 2009, the City of Rockaway was awarded a grant from the Water Conservation, Reuse, & Storage Grant Program, administered by the Oregon Department of Water Resources (OWRD). This program requires the City to provide a of dollar-to-dollar match.

The City of Rockaway Beach has authorized HBH Consulting Engineers, Inc. to investigate and prepare this report to determine the design and financial feasibility of the proposed *Impoundment Improvement and Stream Restoration Project.*

1.3 Project Background & Need

The City of Rockaway Beach utilizes surface water from Jetty Creek as its main municipal water supply source. The intake for the system consists of a small impoundment with a screened intake. Currently, the entire steam flow of Jetty Creek is routed through the impoundment. Water that is not utilized by the municipal system discharges over a small spillway and back into the Creek. Although this spillway does include a fish ladder, the ladder is undersized and too steep to allow for successful fish passage.

Summer stream flows are typically insufficient to meet the City's full water rights as well as maintaining the in-stream water right. This is also the period when the City experiences its highest water demands. The existing impoundment is relatively small and cannot fully supplement flows to meet peak demands. Therefore, these flows are supplemented with water from the City's wells. This practice is more costly due to the additional pumping and treatment requirements.

Additionally, winter storms generate large quantities of runoff resulting in increased turbidity in Jetty Creek. The increased turbidity negatively impacts the quality of the City's water source and consequently increases treatment costs. High turbidity also results in sedimentation within the impoundment reducing its holding capacity. As a result of sedimentation, the City must dredge and remove excess sediment from the impoundment on an annual basis. Since all the flow from Jetty Creek is routed through the impoundment, the City is not able to protect its raw water impoundment from upstream contamination.

The following provides a summary of the problems associated with the City's existing Jetty Creek impoundment:

- Limited holding capacity.
- Difficult balance water demands and in-stream water rights due to low summer stream flows.
- High runoff during storm events increases raw water turbidity and the cost of water treatment.
- Sedimentation in impoundment reduces volume and requires frequent dredging.
- Unable to manage and monitor flow diversion.
- Diversion dam creates a barrier to fish passage.
- Disconnects the upstream and downstream reaches of Jetty Creek which affects sediment transport and habitat value.

The City has begun investigating a range of alternatives to improve its source water reliability, quality, and management by making improvements to its raw water impoundment on Jetty Creek.

1.4 Project Description

Currently, the City's raw water impoundment is situated within the main reach of Jetty Creek. The proposed improvement project would re-route the creek around the impoundment by restoring a relict stream channel thereby creating an off-channel impoundment for the City without having to relocate its water intake facilities. This would provide the City with greater operation and management flexibility of its raw water source. The City is also proposing to enlarge the impoundment to increase its holding capacity.

Re-routing Jetty Creek around the existing impoundment would require constructing a new diversion structure. Flows through the structure will need to be monitored to ensure compliance with water right permits for both the City and the in-stream requirements. Furthermore, flows through the structure will be regulated so that the City has the option to stop all water diversions from Jetty Creek. This would allow the City to cease diversions during and after large storm events when turbidly levels rise as well as protect the City's raw water supply if upstream contamination were to occur. This diversion structure would be constructed to meet all State and Federal fish protection requirements.

Key elements of this project include:

- New fish-friendly diversion structure upstream of the existing impoundment.
- Excavation of existing impoundment to increase holding capacity.
- Restoration of relict creek channel.

1.5 Project Goals & Criteria

In order to properly develop and evaluate design alternatives, goals for the City's *Impoundment Improvement and Stream Restoration Project* must be identified. For this project, both primary and secondary goals have been developed. Primary goals focus on improvements to the City's water system while secondary goals are aimed at improving the biological value of Jetty Creek.

Primary Goals

- Increase available volume of impoundment.
- Decrease maintenance requirements.
- Eliminate (or drastically reduce) dredging requirements.
- Improve operation controls.
- Reduce turbidity during storm events.
- Decrease potential risk of upstream contaminant sources.

Secondary Goals

- Eliminate existing fish passage barrier.
- Enhance aquatic habitat by improving structural complexity and re-establishing transport capability.
- Improve in-stream flow conditions.
- Reconnect the upstream and downstream reaches of Jetty Creek.

Initial criteria for design elements were developed to provide a "starting point" for feasibility assessment. The criteria are provided below:

Diversion Structure. A new diversion structure will allow water from Jetty Creek to enter into the City's existing impoundment. The diversion of water through the structure will be monitored and regulated to ensure that flows do not exceed City's permitted water rights. The new structure will also allow the City to completely close off the diversion, preventing any stream flow from entering the impoundment. This will reduce the amount of sediment entering the impoundment during large storm events as well as protect the City's raw water supply in the case of upstream contamination. A fish screen will be integrated into the design to prevent fish from entering the impoundment and potentially being harmed. The fish screen will meet all relevant Federal, State, and local regulations and requirements.

Impoundment Excavation. The existing impoundment will be enlarged to increase its holding capacity. This may be accomplished by additional excavation of the impoundment westward. Retaining walls along the perimeter of the impoundment may also be necessary.

Creek Restoration. Flows in Jetty Creek will be redirected to a relict channel that lies east of the City's impoundment. Restoration will include excavation to re-establish channel bed as well as placement of large wood and rock structures to enhance stream complexity and improve aquatic habitat. Stream restoration will also focus on creating unimpeded fish passage upstream of the City's impoundment and meet State and Federal requirements.

SECTION 2

STUDY AREA

The study area for this *Feasibility Study* consists of the general vicinity of the City's existing raw water impoundment, including the area of the relict Jetty Creek channel. Additional consideration was given to the overall Jetty Creek watershed area to identify potential hydraulic and ecological impacts of the final project.

The City of Rockaway Beach is located on the Oregon coast approximately 75 miles west of Portland. As shown in Figure 2-4, the City is situated between Tillamook Bay to the south and Nehalem Bay to the north; Jetty Creek discharges into the southern portion of Nehalem Bay. The City's point of diversion on Jetty Creek is approximately 700 feet east (upstream) of Highway 101 in Township 2N, Range 10W, Section 17 NE-SE. The general vicinity of the City's intake is shown in Figure 2-5.

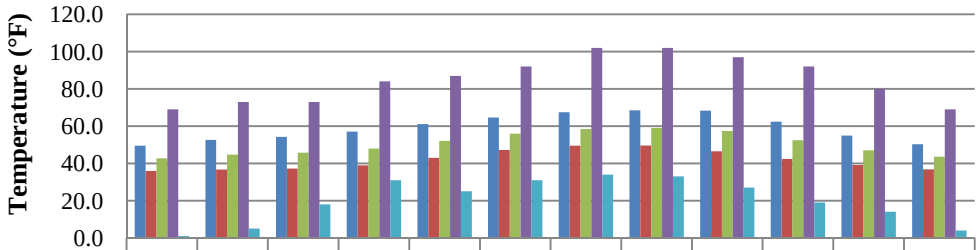
2.1 General Watershed Description

Jetty Creek is part of the Cook Creek/Lower Nehalem River Watershed in the Nehalem Sub-Basin of the Northern Oregon Coastal Basin. The approximate limit of the Jetty Creek watershed is depicted in Figure 2-6. The creek carries year-round stream flow from the western flank of the Oregon Coast Range into Nehalem Bay through a steep sided valley. Jetty Creek flows in a generally west to southwest direction. The total watershed area is approximately 2.3 square miles. Watershed elevations range from sea level at the mouth of the Jetty Creek to approximately 650 feet inland with a mean basin slope (computed from 30m DEM) of 17.1 degrees.

Climate

Climate information was obtained from the Western Regional Climate Center collected at the nearby weather station in Tillamook from 1948 to 2007. As shown in Figure 2-1, the area generally has mild summers and winters. Typical summer temperatures range from 49-67°F and winter temperatures range from 37-51°F. The average annual temperature is 50.6°F.

Figure 2-1- Monthly Temperature Summary



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Avg. Max.	49.5	52.6	54.3	57.1	61.1	64.6	67.4	68.5	68.3	62.4	54.9	50.3
Avg. Min.	35.9	36.7	37.2	38.9	43.0	47.2	49.5	49.6	46.5	42.4	39.1	36.8
Avg. Mean	42.7	44.7	45.8	48.0	52.1	55.9	58.5	59.1	57.4	52.4	47.0	43.6
Extreme Day High	69.0	73.0	73.0	84.0	87.0	92.0	102.0	102.0	97.0	92.0	80.0	69.0
Extreme Day Low	1.0	5.0	18.0	31.0	25.0	31.0	34.0	33.0	27.0	19.0	14.0	4.0

The study area receives approximately 89 inches of precipitation annually (Figure 2-2). The majority of this precipitation is in the form of rainfall. Snowfall does occur some winters but accumulations are usually short-lived. The average annual snowfall is 2.3 inches. Nearly half (43%) of yearly precipitation occurs during the winter months of December through February (Figure 2-3).

Figure 2-2 - Annual Precipitation (1949 – 2007)

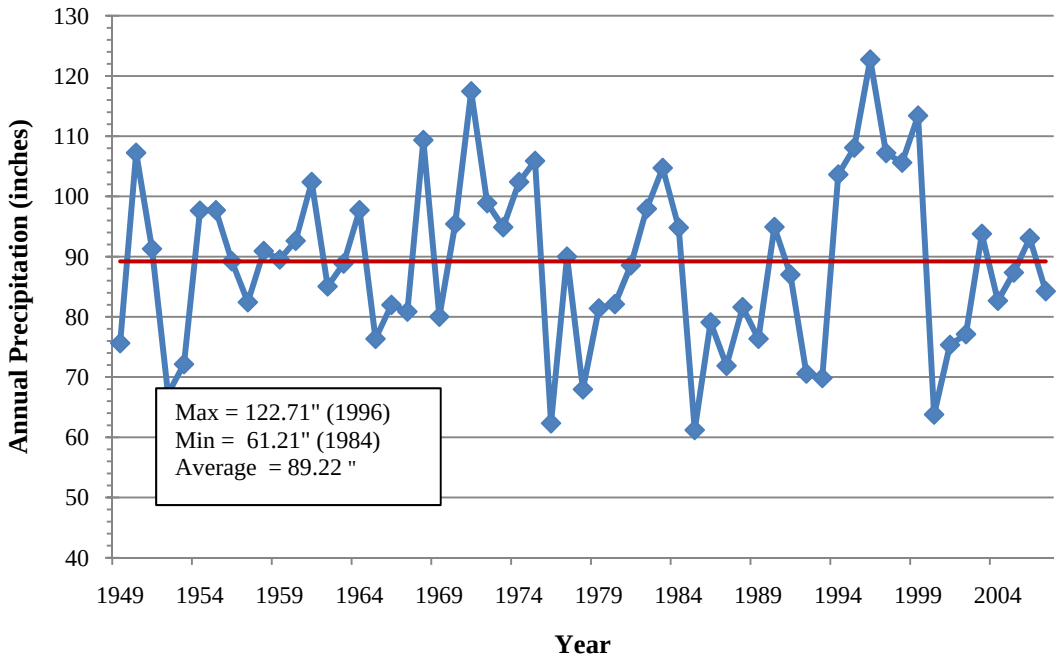
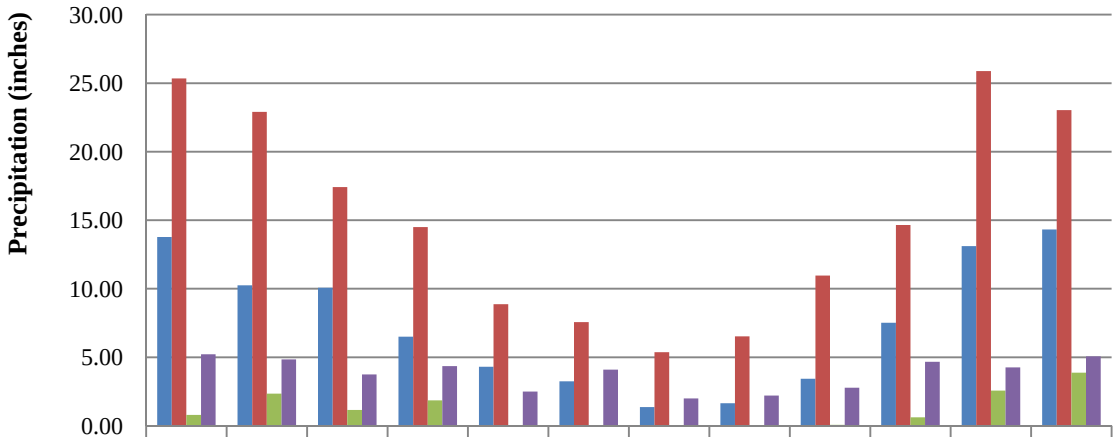
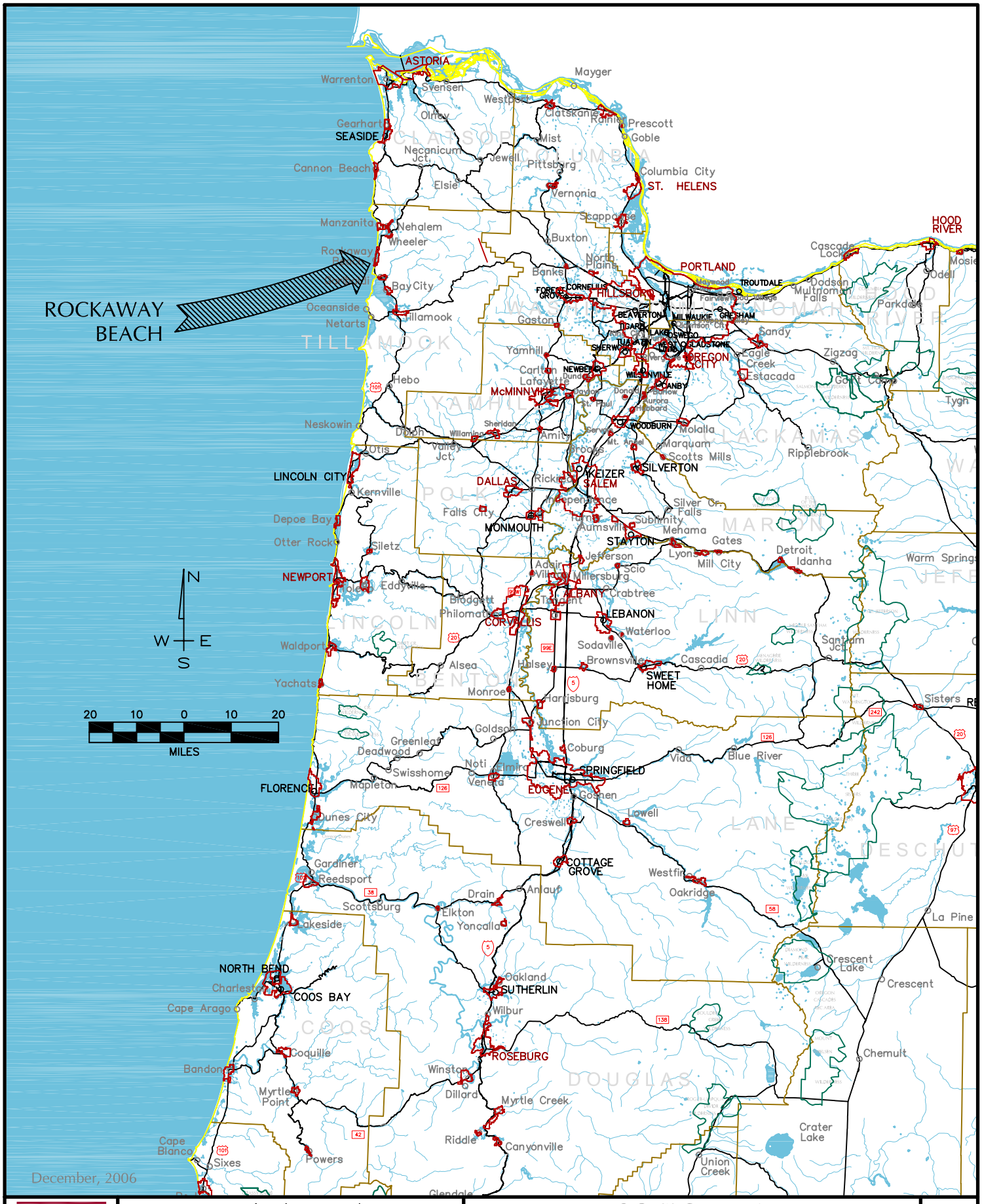


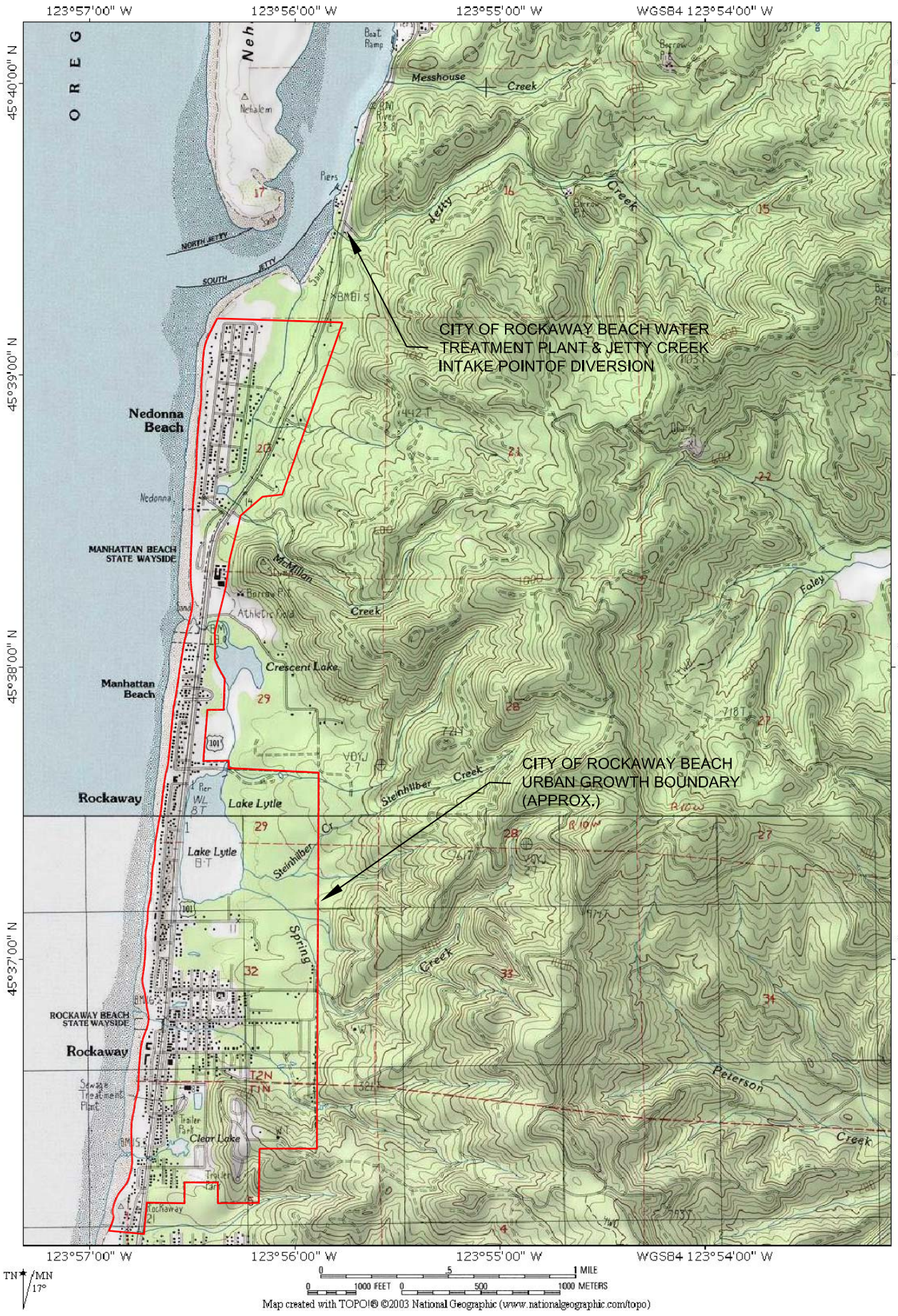
Figure 2-3 – Monthly Precipitation Summary (1949-2007)



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Mean	13.77	10.25	10.07	6.50	4.31	3.24	1.36	1.64	3.43	7.52	13.11	14.32
High	25.34	22.90	17.42	14.50	8.87	7.56	5.37	6.53	10.96	14.65	25.88	23.03
Low	0.79	2.34	1.16	1.86	0.00	0.00	0.00	0.01	0.07	0.62	2.57	3.88
1-Day Max	5.22	4.84	3.75	4.35	2.50	4.10	2.00	2.20	2.78	4.67	4.26	5.06



H B H Consulting Engineers	City of Rockaway Beach *JETTY CREEK IMPOUNDMENT & STREAM RESTORATION FEASIBILITY STUDY*	LOCATION MAP City of Rockaway Beach Tillamook County, Oregon	FIG. 2-4



H B H Consulting Engineers	City of Rockaway Beach *JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM REHABILITATION FEASIBILITY STUDY*	VICINITY MAP	FIG. 2-5

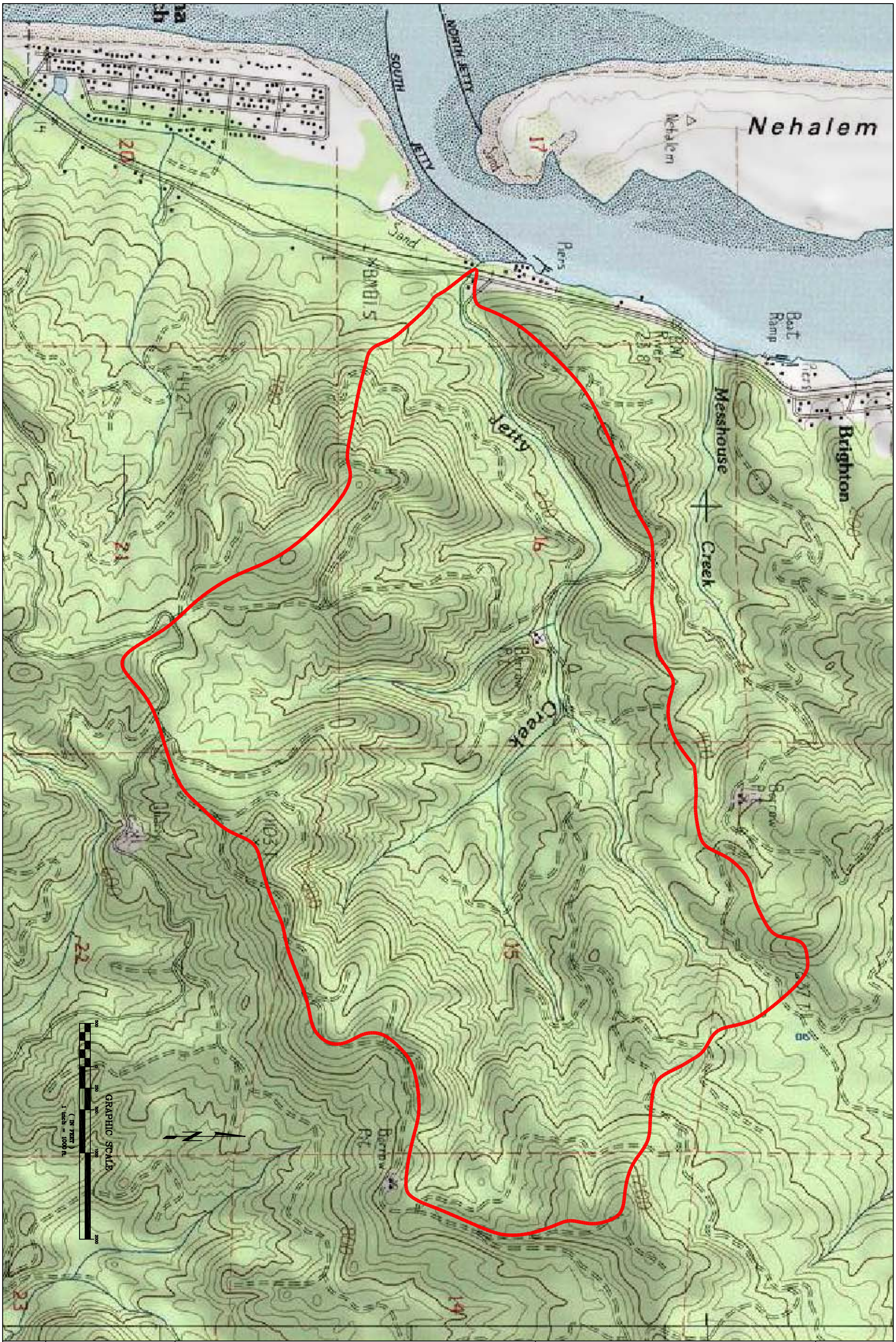


FIG. 2-6	DRAWN BY: CLL DATE: March 2009	JETTY CREEK WATERSHED	City of Rockaway Beach *JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM REHABILITATION FEASIBILITY STUDY*	H B H Consulting Engineers

Soils

Information on soils was obtained from the National Resource Conservation Service (NRCS) Soil Survey of Tillamook County, Oregon (2009). As shown in Figure 2-7, a variety of different soil types are found within the Jetty Creek watershed. The soil types within the study area are listed in Table 2-1.

The average water capacity of the top 60 inches of soil, as determined from the State Soil Geographic (STATSGO) database, is 0.18 inches. The average soil permeability is 1.54 inches per hour. Appendix A provides additional information on these soil properties.

Table 2-1 – Summary of Soil Properties

Unit	Unit Name	Percent of Watershed	Depth to Restrictive Layer	AASHTO Rating	Drainage Class	Hydrologic Soil Group	Average Slope
2A	Fluvaquents-Histosols complex, 0 to 1 percent slopes	0.80%	114	A-7	Very Poorly Drained	D	0.5
13B	Waldport, thin surface-Heceta fine sands, 0 to 5 percent slopes	0.40%	>200	A-8	Excessively Drained	A	3
20D	Klootchie-Necanicum complex, 5 to 30 percent slopes	0.20%	>200	A-8	Well Drained	B	18
20E	Klootchie-Necanicum complex, 30 to 60 percent slopes	9.00%	>200	A-8	Well Drained	B	45
21F	Necanicum-Ascar-Klootchie complex, 60 to 90 percent slopes	0.50%	>200	A-8	Well Drained	B	75
29D	Templeton-Klootchie complex, 5 to 30 percent slopes	18.90%	150	A-8	Well Drained	B	18
29E	Templeton-Klootchie complex, 30 to 60 percent slopes	70.2%	150	A-8	Well Drained	B	45

Source: Natural Resource Conservation Service, Tillamook County Soil Survey, Version 2 (August 12, 2009)

Geology

Jetty Creek is located in the Coast Ranges geologic province of Oregon. Area geology in this discussion was derived using the *1994 Geologic Map of the Tillamook Highlands, Northwest Oregon Coast Range* by Ray E. Wells, Parke D. Snavely, Jr., Norman S. MacLeod, Michael M. Kelly, and Michael J. Parker. A map of the area geology is shown in Figure 2-8.

Geological materials found in the watershed include volcanic and sedimentary rocks and are listed in Table 2-2. These rocks were formed during the Eocene and Oligocene ages of the Tertiary period. The volcanic rocks are mainly basaltic lavas and tufts with sedimentary rocks consisting of shale, claystone, sandstone, and siltstone at shallower depths.

Table 2-2 – Rock Type Descriptions

Rock Unit	Rock Name	Age	Description
TN	Nestucca Formation	Upper Eocene	Thin bedded, laminated dark gray tuffaceous mudstone with fine- to coarse-grained, graded arkosic and basaltic sandstone interbeds, locally glauconitic and fossiliferous, thin tuff beds and calcareous concretions are common. Locally contains arkosic sandstone dikes and exhibits soft sediment deformation. Unit is bleached and hydrothermally altered over large areas adjacent to Miocene and Eocene basalt intrusions.
Tigr	Grande Ronde Basalt	Middle Miocene	Dark gray to light gray, aphyric, tholeiitic basalt, as columnar jointed subaerial flows, submarine pillow basalt, and isolated pillow breccia; includes interbedded palagonitic hyaloclastite breccias, commonly cemented by clays, zeolite, or calcite; locally includes interbeds of basalt conglomerate and micaceous, carbonaceous mudstone and sandstone. Flows include low MgO and high MgO chemical types and belong to the N2 and upper R2 magnetozones of the Grande Ronde Basalt of the Columbia Plateau and lower Columbia River (Swanson and others, 1979; Niem and Niem, 1985; Wells and others, 1989; Tolan and others, 1989).

Source: Geologic Map of the Tillamook Highlands, Northwest Oregon Coast Range by Ray E. Wells, Parke D. Snavely, Jr., Norman S. MacLeod, Michael M. Kelly, and Michael J. Parker (1994)

More detailed information on the specific geology of the project area is presented in Section 3, "*GEOLOGICAL INVESTIGATION*".

Vegetation

The study area and associated watershed lies completely within the temperate coniferous rain forest belt. Jetty Creek sustains a healthy riparian area dominated by red alder with smaller amounts of western red cedar, Sitka spruce, and western hemlock. Understory species are predominantly salmonberry, elderberry, sword fern, and miscellaneous herbs.

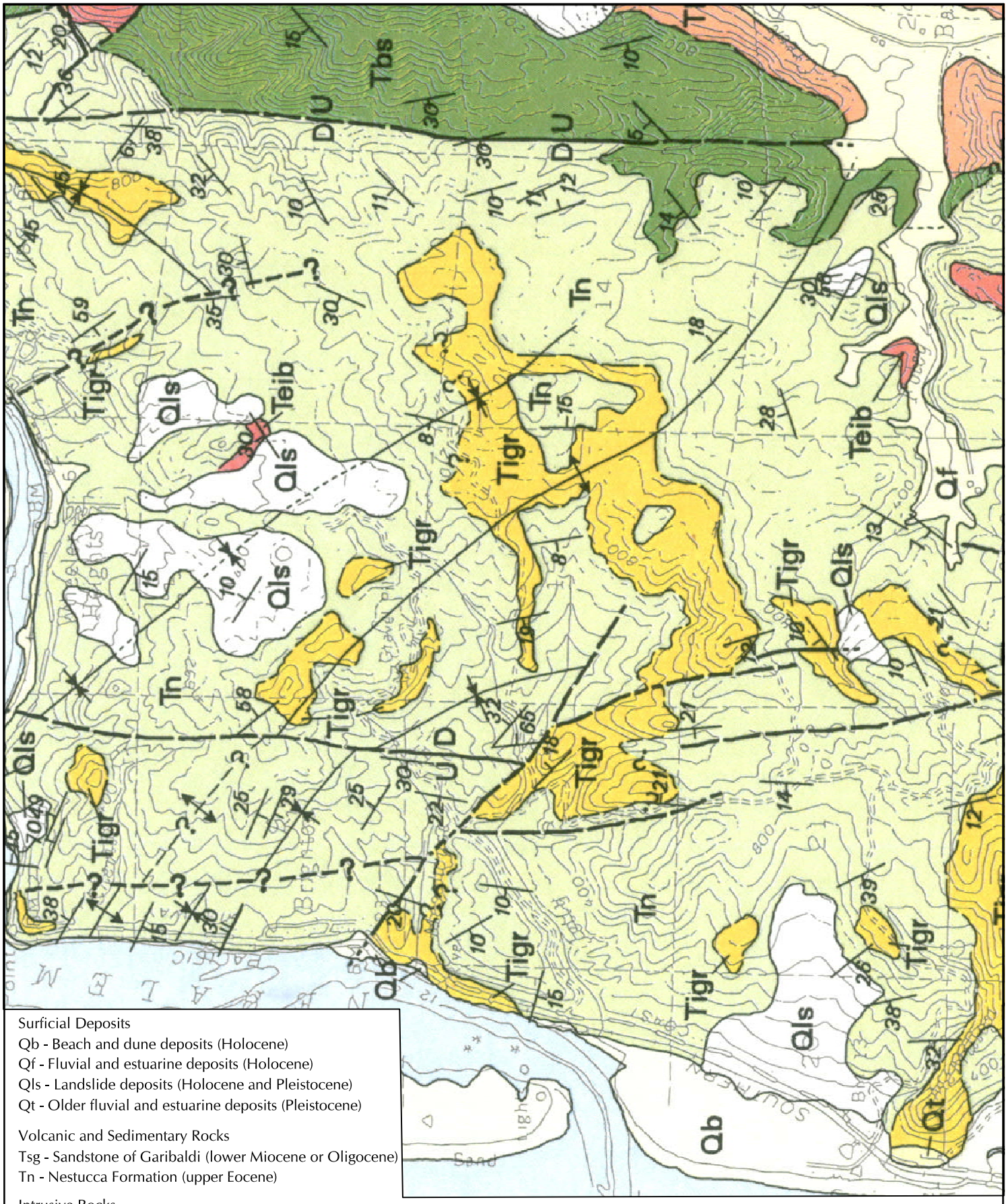
Historically, the basin was dominated by old growth coniferous ecosystems with marshlands in the lower gradient areas and estuaries. Now the majority of the area's vegetation consists of broadleaf species or are mixed broadleaf and medium sized (25-50 cm diameter) conifers. Clearcuts are observed throughout the area.

Land Use

The land in the Jetty Creek watershed is privately owned and closed to public access. Forestry is the major land use activity in the watershed. No change in current land use is anticipated in the foreseeable future; however, based on conservation with City staff, no logging within the boundary of the watershed is expected within the next two years.

INFORMATION ON THIS MAP WAS OBTAINED FROM THE NATURAL RESOURCE CONSERVATION SERVICE (NRCS) TILLAMOOK COUNTY SOIL SURVEY (AUGUST 2009).

H B H Consulting Engineers	City of Rockaway Beach *JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM REHABILITATION FEASIBILITY STUDY*	SOILS MAP	FIG. 2-7



Surficial Deposits
Qb - Beach and dune deposits (Holocene)
Qf - Fluvial and estuarine deposits (Holocene)
Qls - Landslide deposits (Holocene and Pleistocene)
Qt - Older fluvial and estuarine deposits (Pleistocene)

Volcanic and Sedimentary Rocks
Tsg - Sandstone of Garibaldi (lower Miocene or Oligocene)
Tn - Nestucca Formation (upper Eocene)

Intrusive Rocks
Tigr - Grande Ronde Basalt (middle Miocene)
Teib - Basalt sills (late Eocene)

Geologic Map of the Tillamook Highlands, Northwest Oregon Coast Range by Ray E. Wells, Parke D. Snavely, Jr., Norman S. MacLeod, Michael M. Kelly, and Michael J. Parker (1994)

H B H Consulting Engineers	City of Rockaway Beach *JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM REHABILITATION FEASIBILITY STUDY*	GEOLOGY MAP	FIG. 2-8

2.2 Project Site Description

The project site includes the City's existing impoundment, Jetty Creek, and the relict creek channel. The entire project is located on land recently purchased by Olympic Resource Management. The City maintains an easement to the area for the impoundment and water treatment plant.

Figure 2-10 shows the existing conditions within the project site. A preliminary layout for the proposed project is provided in Figure 1-1[1].

Existing Impoundment

The Jetty Creek raw water impoundment is located north of the City of Rockaway Beach, adjacent to the City's water treatment plant (see picture below) and approximately 700 feet east of Highway 101. The impoundment consists of an excavated earthen basin. Water level within the impoundment is maintained using a low concrete dam. Raw water is pumped from a screened raw water intake in the impoundment and delivered to the City's water treatment facility.

PHOTO: Existing impoundment site

[1] The preliminary layout provided in this Feasibility Study is only intended to provide a general concept for future design elements and is subject to change.

The impoundment was created by excavating into a relatively wide and flat area. The eastern border is delineated by a steep embankment, which is composed, in part, by fill. The impoundment's western side is border by a relatively level, un-vegetated terrace. The maximum width of the valley bottom in the impoundment area is approximately 180 feet.

Based on site survey information, the City's impoundment has a maximum surface area of roughly 3,000 square feet or 0.07acres. The bottom of the impoundment is at an approximate elevation of 38 feet. The water level in the impoundment is maintained by a concrete dam. The top of the impoundment dam spillway is at an approximate elevation of 42 feet giving the impoundment a maximum depth of approximately 4 feet. The existing impound has a maximum volume of approximately 50,000 gallons.

An attempt was made to provide for fish passage through the City's diversion by constructing a fish ladder within the foot print of the diversion dam (see photo below). However, in actuality the fish ladder is undersized and too steep to allow for successful passage through the impoundment structure.

The proposed project would increase the volume of the impoundment. This would be achieved by increasing the surface area. The impoundment would be expanded westerly by excavating into the unvegetated bench located adjacent to the impoundment (see following photo).

The new impoundment surface area would increase to approximately 10,300 square feet or 0.24 acres. Initial plans also investigated increasing the volume by raising the top of the existing dam structure. However, this proved to be infeasible due to the elevation of the WTP pump station. Therefore, no changes to the existing dam structure are expected as part of this project. The approximate volume of the new impoundment would be nearly 300,000 gallons, or 6 times the existing holding capacity.

PHOTO ABOVE: Existing dam structure spillway and fish ladder

PHOTO RIGHT: Unvegetated bench adjacent to existing impoundment

Relict Creek Channel

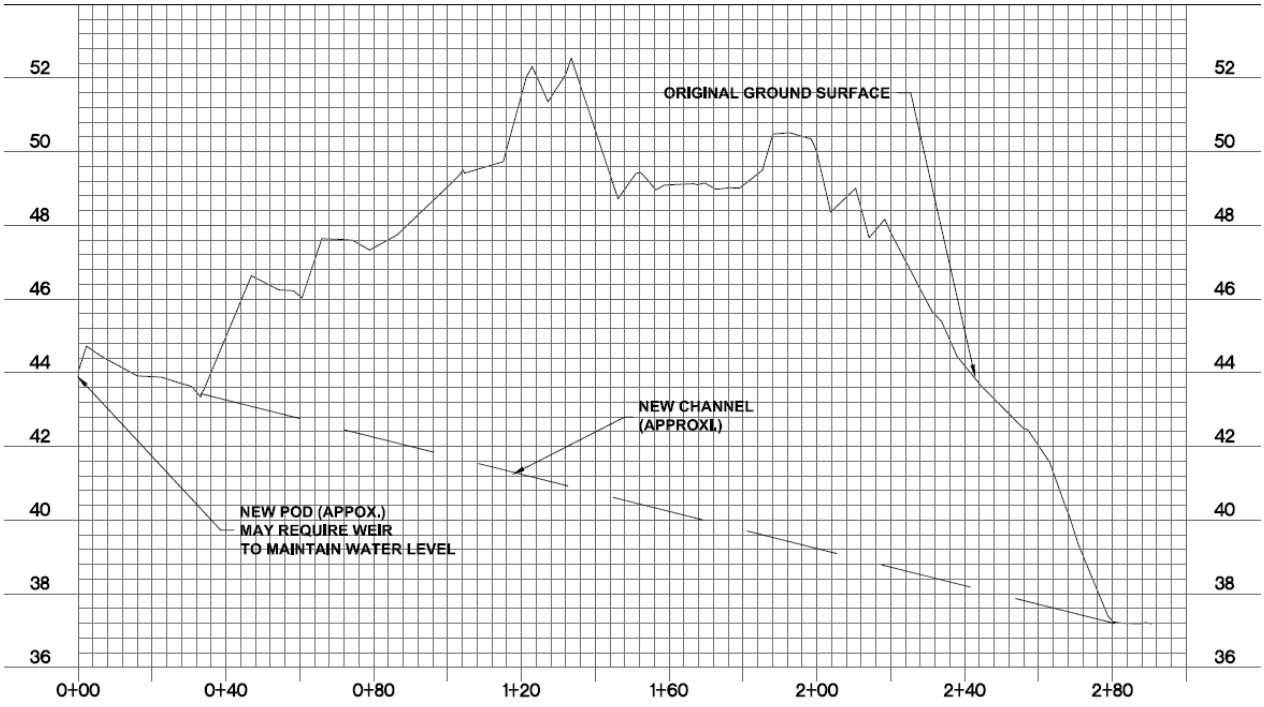
Due to the area's alluvial material and topography, it is believed that prior to the construction of the existing impoundment Jetty Creek likely migrated back and forth across the valley floor. As a result, there is evidence of relict channel beds situated east of the City's impoundment. However, with the construction of the City's impoundment, Jetty Creek was altered and permanently re-routed to flow through the City's diversion. The relict channel was subsequently plugged and abandoned.

A relict channel is now observed as a linear but discontinuous topographic swale east of the City's impoundment. The variable and irregular surface topography of the relict channel is primarily due to the fact that the City has used the area to place and dewater sediment removed during the annual dredging of the impoundment.

The proposed project would rehabilitate approximately 300 feet of the relict creek channel. As a result of the City's practice of disposing fill materials in the area, portions of the new alignment would require extensive excavation. The existing topography of the area of the relict channel is shown in Figure 2-9. Based on this data the maximum depth of required excavation required to establish the restored creek bed is approximately 11 feet.

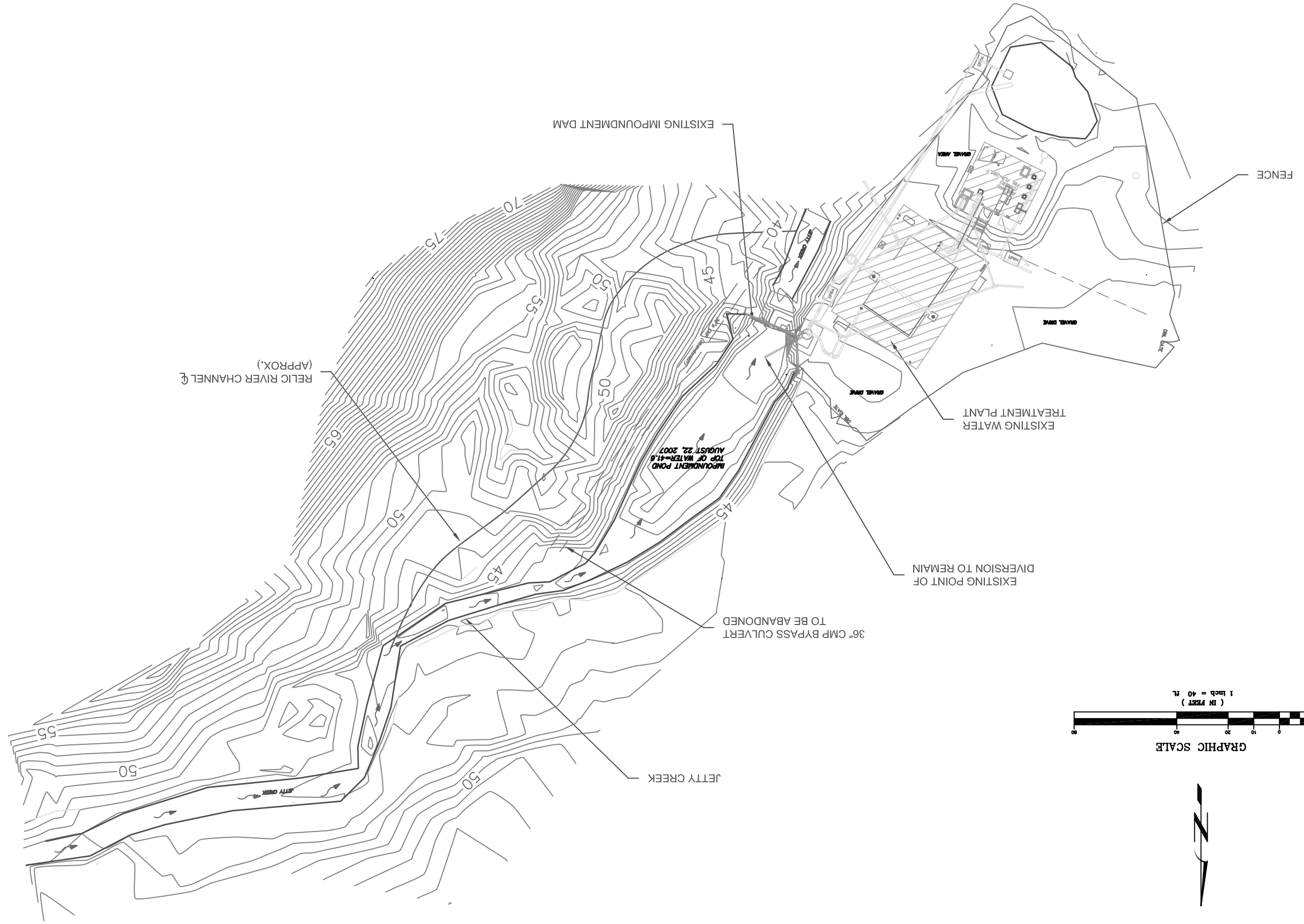
PHOTO: View across impoundment of relict channel (Courtesy PBS Engineering & Environmental)

Figure 2-9 – Existing and Proposed Surface of Relict Creek



Providing essential aquatic habitat is crucial to the stream restoration element of the project. The restoration design will likely include a combination pool and riffles as well as the placement of large wood debris and boulders. The goal of the restoration effort is to restore this section of Jetty Creek to matches both the hydraulic function and habitat value of the upstream channel.

PHOTO: Jetty Creek upstream City's impoundment



EXISTING CONDITIONS

City of Rockaway Beach
JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM REHABILITATION FEASIBILITY STUDY

H B H Consulting Engineers

DRAWN BY: CLL
DATE: November 2009

FIG. 2-10

EDGE OF
EXPANDED IMPOUNDMENT

DIVERSION STRUCTURE
W/ FISH SCREEN AND
FLOW MONITOR

EXISTING DIVERSION CHANNEL
TO BE FILLED IN AND PLANTED (TYP)

EXISTING 36" CMP
OVERFLOW CULVERT
TO BE REMOVED

EXISTING DIVERSION
CHANNEL FLOW

EXISTING POINT OF
DIVERSION TO REMAIN

EXISTING
IMPOUNDEMNT

BEGIN JETTY CREEK
CHANNEL RESTORATION

HIGH WATER FLOW CHANNEL

FISH PASSAGE CHANNEL
RESTORED IN RELIC CREEK BED

IMPOUNDMENT POND
TOP OF WATER=41.6
AUGUST 22, 2007

EXISTING WATER TREATMENT PLANT

GRAVEL DRIVE

GRAVEL AREA

FILL DIRT FROM DIVERSION POND
TO BE REMOVED

RELIC RIVER CHANNEL ℄

WOODY DEBRIS TO BE REMOVED
AND USED IN CREEK AS FISH HABITAT

RELIC CREEK CHANNEL
RE-ENTERS EXISTING
CREEK CHANNEL

EXISTING DIVERSION DAM TO REMAIN
WITH THE EXISTING WALL TO BE RAISED 2'

EXISTING FISH LADDER TO
BE REMOVED

GRAPHIC SCALE

20 0 10 20 40 80

(IN FEET)
1 inch = 40 ft.

H B H Consulting Engineers

City of Rockaway Beach
JETTY CREEK IMPOUNDMENT iMPROVEMENTS &
STREAM RESTORATION FEASIBILITY STUDY

PRELIMINARY LAYOUT

DRAWN BY: CLL

DATE: DEC 2009

FIG.
2-11

SECTION 3

GEOLOGICAL INVESTIGATION

A preliminary geological investigation of the site geology was conducted by PBS Engineering & Environmental. The purpose of this investigation was to determine the general feasibility of the proposed project in terms of the site's geologic conditions. A summary of their observations and recommendations is presented below. More details on site geology can be found in the Technical Memorandum authored by PBS, which is provided in Appendix B.

3.1 Geologic Setting

Material

The existing impoundment was constructed by excavating the alluvial sediments that are present in the valley bottom. The gently-sloping valley bottom and terrace surfaces are underlain by alluvium of undetermined thickness that overlies bedrock. Exposures in the cut bank along the terrace surface on the eastern side show coarse-grained channel sediments that are overlain by several feet of fine-grained overbank sediment. Colluvium derived from erosion of the side slope may be present.

The Jetty Creek channel is comprised of gravels with variable percentages of silt and sand and trace to some cobble sized clasts to 6 inches.

Bedrock

As previously noted, Jetty Creek is located in the Coast Ranges geologic province of Oregon. According to published geologic mapping by Wells and others (1994), bedrock at the site consists of the Nestucca Formation of upper Eocene age (map unit Tn). This marine sedimentary rock unit is generally described as tuffaceous mudstone that is thin-bedded, laminated, and dark gray. This formation includes interbeds of graded arkosic and basaltic sandstone. The other local bedrock unit is the more recent intrusive basalt of the Grand Ronde Basalt of middle Miocene age (map unit Tigr). This basalt is not mapped along Jetty Creek; however a large outcrop of basalt is present along the northern side of the treatment plant.

Except for the abovementioned outcrop of hard, widely-jointed basalt bedrock on the slope immediately west of the treatment plant, bedrock is not observed in the site vicinity. The depth to bedrock is unknown. According to Shawn Vincent, Public Works Director for Rockaway Beach, bedrock was not encountered during the construction of the original water intake facility at Jetty Creek, which excavated to a depth of approximately 8 feet beneath the creek channel. Drills logs for the ODOT's Jetty Creek Culvert Replacement project (located approximately 1,000 feet downstream from impoundment) reported bedrock depth greater than 40 feet. Copies of these logs are provided in Appendix B.

Slope Stability

Landslides are common in the Coast Range due to the weak and deeply-weathered sedimentary bedrock or colluviums found in the region. Regional scale geologic hazard mapping by Schlicker and Deacon

(1972) identified "landslide topography" along the southeastern slope in the Jetty Creek valley from the mouth up past the treatment plant area.

The location of the centerline of the relict channel at the closest point is approximately 20 feet from the toe of the valley side slope. The valley side slope above the terrace ranges approximately between 20 and 30 degrees. The slope is hummocky, in part, and localized small scarps are present indicating marginal slope stability. For the most part, conifer trees are straight; although some trees are bowed or pistol butted, indicating local movement or soil creep is present. There is also evidence of localized, relatively shallow slumping and soil creep on the side slope above the terrace.

3.2 Geotechnical Recommendations

A summary of the observations from this site visit as well as general geologic information were used to determine whether or not the proposed project would be geologically feasible. Based on its study, PBS concluded that the proposed plans for the impoundment appear feasible. Additional subsurface explorations and geotechnical engineering studies are recommended to provide detailed information on soil and groundwater conditions, evaluate slope stability, complete engineering analysis, and provide recommendations required for design and construction. These tests should include the following:

- Test Pits - Subsurface exploration by test pits and possibly drilling will be needed to obtain data including depth to bedrock and rock quality characteristics, which will be important to foundation design for the diversion structure or possible retaining walls. A series of test pits should also be excavated along the proposed alignment and in the adjacent valley side slope to evaluation conditions. Test pits in the channel should be excavated to a minimum depth of about 5 feet below the channel grade.

- Slope Stability - Analysis is necessary to evaluate whether construction of the creek channel in the terrace or enlargement of the channel as a result of erosion over time significantly reduces the factor of safety on the valley slope. Failure of the slope could block the channel resulting in a damaging debris flow to the City's facilities.

SECTION 4

HYDRAULIC ANALYSIS

Hydrologic characterization and hydraulic assessment of Jetty Creek are essential to developing project feasibility and design. Watershed and site hydrology provide important information for establishing key design criteria and develop a hydraulic model of the proposed project. Hydraulic analysis provides the foundation for river restoration and fish passage design and is the basis for further analyses such as sediment transport and conveyance.

4.1 Site Hydrologic Characteristics

Information on site hydrology was obtained from a number of sources. These sources include site visits, topographical surveys, US Geological Services (USGS), and hydraulics report for the ODOT Jetty Creek Culvert Replacement project.

Jetty Creek Watershed

Basic basin characteristics for Jetty Creek are summarized in the following table. This information was obtained from the USGS StreamStats website (http://streamstats.usgs.gov/orstreamstats/).

Table 4-1 –Basin Characteristics[1]

Parameter	Minimum	Mean	Maximum
24 Hr – 2 Year Precipitation (inches)	2.52	4.11	5.79
Average Soil Permeability (inches per hour)	0.72	1.53	4.76
Mean Maximum January Temperature (°F)	42.40	48.90	53.90
Available Water Capacity (inches)	0.10	0.17	0.23

[1] Generated using USGS StreamStats

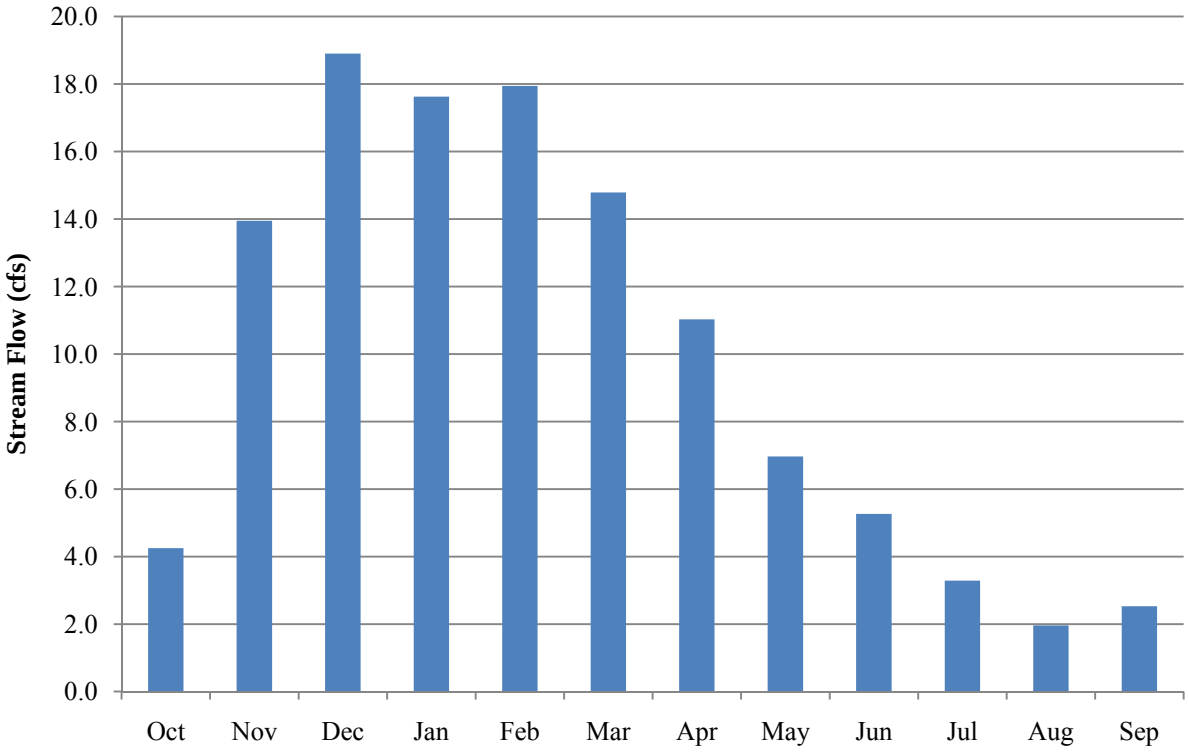
Stream Flow Analysis

Stream flows have a direct impact on stream velocities, shearing force, stage, and a host of other factors that affect final design and operation. For this project it is important to characterize peak stream flows as well as determining expected low summer stream flows.

A USGS gage station (ID14301250) is located approximately 115 feet hundred feet upstream from the City's existing impoundment. Stream flow data from this station is available for nearly a 20-year period from November 1975 through September 1995. This data was used to perform stream flow analysis of Jetty Creek.

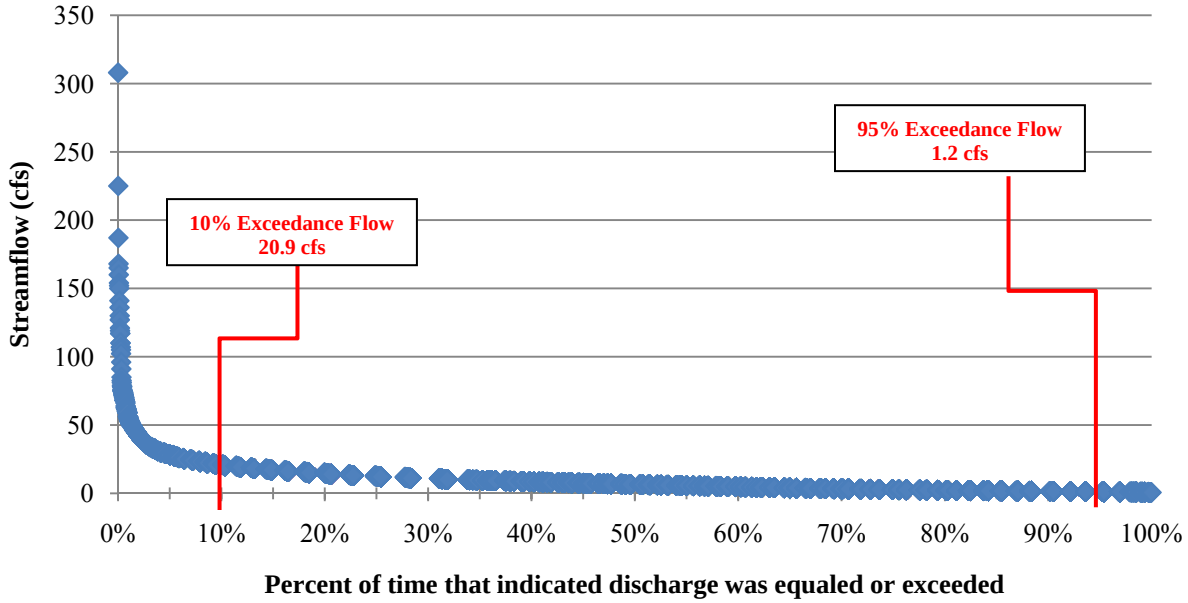
Jetty Creek provides year-round stream flow; however, there is great variation in the magnitude of flow throughout the year. Figure 4-1 shows the average daily flow for each month observed for the period of record. As this figure shows, high stream flows occur during winter months. The highest average daily stream flow of 18.9 cfs was observed in the month of December. The largest single day flow occurred on January 23, 1982 equaling 308 cfs. As rainfall in the area decreases, so too do the flows in Jetty Creek. Typically, the lowest stream flow occurs in August when the daily stream flow averages just 2.0 cfs. The minimum flow of 0.57 cfs was observed on September 28, 1994.

Figure 4-1 – Monthly Average Daily Steam Flows (Nov 1975 - Sept 1995)



Designs for diversion structures and fish passage facilities are based on operational requirements under a large range of stream flows. A flow duration curve (FDC) shows the percentage of time that flow in a stream is likely to equal or exceed some specified value of interest and is a useful tool to establish operating design flows. The FDC for the entire data set is show in Figure 4-2. Monthly FDCs are provided in the appendix.

Figure 4-2 - Flow Duration Curve (Nov 1975 - Sept 1995)



Typically the low flow design is based on the 95% exceedance flow for the migration period of the fish species of concern. Similarly, the high flow design discharge equals the flow that is not exceeded more than 10% of the time during the months of migration. Coastal coho span from November to January. Fry emerge in March or April. Hence, these are the months for which hydrologic estimates are needed.

Table 4-2 – Jetty Creek Monthly Stream Flow Statistics[1]

	Daily Stream Flows (cfs)			Flow Duration (cfs)	
	Average Flow	Minimum Flow	Maximum Flow	95% Exceedance	10% Exceedance
October	4.2	0.8	62.0	0.9	10.0
November	13.9	0.8	117.0	1.3	27.0
December	18.9	1.8	187.0	4.4	33.1
January	17.6	2.5	308.0	4.3	31.3
February	17.9	2.5	150.0	3.9	34.5
March	14.8	2.9	107.0	5.1	25.8
April	11.0	2.9	96.0	4.5	18.0
May	7.0	3.0	22.0	3.5	11.0
June	5.3	1.5	53.0	2.3	9.4
July	3.3	1.1	56.0	1.4	5.2
August	2.0	0.9	9.2	1.1	3.1
September	2.5	0.6	19.0	0.8	5.3

[1] Statistical analysis based on data obtained from USGS gage 14301250 from 1976 to 1995

The structural designs of in-stream structures (e.g. division gates, fish screen, etc.) as well as stream stability and flood control are dependent on determining peak design flows. The peak flows for the drainage area were estimated by ODOT using USGS regression equations and are shown Table 4-3.

Table 4-3 – Peak Flows for Jetty Creek[1]

Recurrence Interval	Peak Flow (cfs)
Q_2	110
Q_5	160
Q_{10}	190
Q_{25}	230
Q_{50}	260
Q_{100}	290
Q_{500}	370

[1] Source: Oregon Department of Transportation, Jetty Creek Culvert Replacement, Hydraulic Report (1/18/2007)

4.2 Hydraulic Model

A preliminary hydraulic model of the project was developed using HEC-RAS 4.0. This model was developed for ***preliminary investigation only*** in order to provide estimates of potential hydraulic characteristics at the new diversion structure and through the restored creek channel. A more detailed model will be needed as part of the final design process.

HEC-RAS

HEC-RAS was developed by the US Army Corps of Engineers' Hydraulic Engineering Center as an integrated package of hydraulic analysis programs. This software is capable of modeling a network of channels, a dendritic system, or a single river reach. The basic computational procedure of HEC-RAS for steady flow is based on the solution of the one-dimensional energy equation. Energy losses are evaluated by friction and contraction/expansion. The momentum equation may be used in situations where the water surface profile is rapidly varied. These situations include hydraulic jumps, hydraulics of bridges, and evaluating profiles at river confluences.

Model Development & Assumptions

For the purposes of this report, a one-dimensional, steady-state model was developed for the restored Jetty Creek channel. Geometric information for the restored creek channel was developed, in part, using topographic survey data. Cross-sections of the creek were modeled at 50-foot increments. The configuration of the each section varies to assess the impact of creek channel geometry on stream flow characteristics. A total of eight cross-sections were analyzed.

The following assumptions and simplifications were used in model development:

- Steady-State
- Peak flows as determined in Table 4-3
- Uniform channel slope (see Table 4-4)
- Channel cross-sections in restored channel were developed based (in part) on data used in ODOT's Jetty Creek project
- Uniform Manning's *n*-values for main channel and overbanks (see Table 4-4)
- Mixed flow regime
- Upstream and downstream boundary conditions based on normal depth with slope of 2%.

Table 4-4 – Restored Channel Characteristics

Restored Creek Channel Upstream Elevation (estimated)	45 feet
Restored Creek Channel Downstream Elevation (estimated)	37 feet
Restored Creek Channel Length (estimated)	25 feet
Average Restored Creek Channel Slope	2.8%
Manning's *n* – Main Channel[1]	0.06
Manning's *n* – Overbanks[2]	0.07

[1] Natural stream –winding, some weeds & stones, low stage, some pools and shoals
[2] Overbanks are vegetated with trees and brush

Results

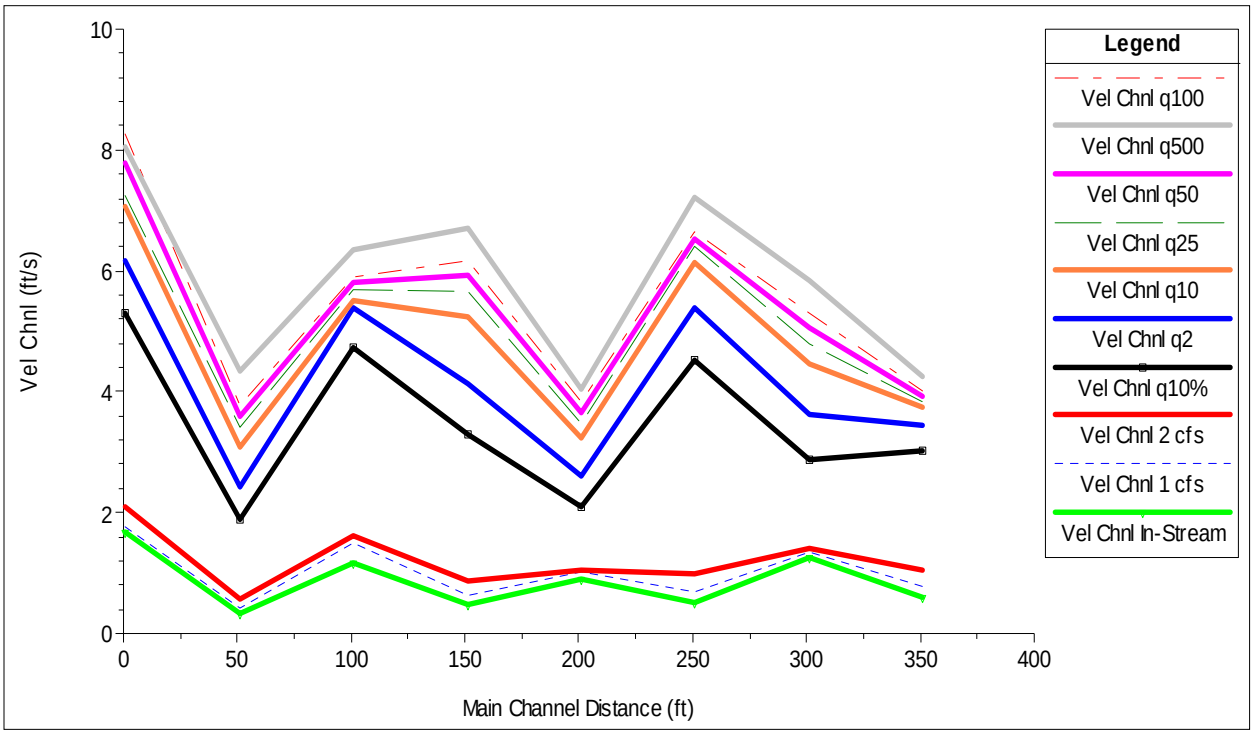
The purpose of this model is to provide preliminary hydraulic estimates for the restored creek channel. These preliminary figures provide a starting point for final design and identify potential problems with respects to bank stabilization and fish passage requirements. A more robust model will need to be developed as part of the upcoming design efforts.

HEC-RAS was used to calculate a number of hydraulic parameters for the proposed Jetty Creek restored creek channel under various hydrologic conditions. Some of the parameters included:

- Velocity
- Critical, Normal, Maximum, Hydraulic Depths
- Channel Width

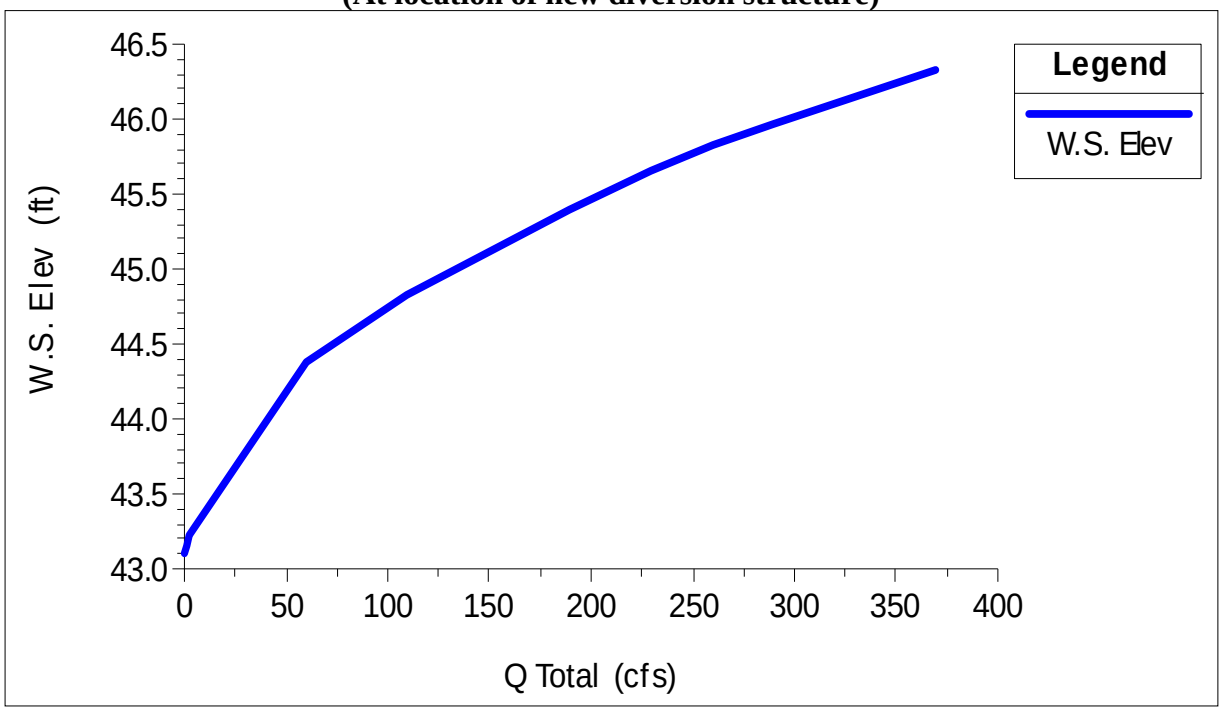
Stream velocities have a direct impact on bank erosion and stability as well as fish passage. Figure 4-3 shows the velocity profiles of the restored creek channel during various design flow conditions. Again, these velocities are only intended to provide project designers a general idea of expected hydraulic conditions of the rehabilitated stream.

Figure 4-3 – Creek Velocities



Stream stage at various flows is also an important design consideration. This will be particularly vital in the design of the new diversion structure. An estimate of the stream stage at the site of the new diversion structure during low and peak flow events is depicted in Figure 4-4.

Figure 4-4 – Water Surface Elevation vs. Stream Flow
(At location of new diversion structure)



General results from this analysis indicate the following:

- Average channel velocities range from 0.3 fps (0.5 cfs) to 8.0 fps (Q_{100}). Maximum velocities occurred at downstream boundary.
- During low flows, channel depth was typically less than 0.5 feet. During peak flows, maximum water depth ranged from 1.8 feet (Q_2) to 3.1 feet (Q_{100}) with an average maximum depth of 2.4 feet.
- Peak flows generate channel widths ranging from 20.7 feet (Q_2) to 53.1 feet (Q_{100}) with an average of 30.1 feet.
- Shear force in the channel ranged from 0.5 psf (Q_2) to 5.2 psf (Q_{100}).

For more detailed results generated by HEC-RAS for the restored channel, see Appendix D.

SECTION 5

BIOLOGICAL RESOURCES

As part this *Feasibility Study*, an initial biological assessment of potential impacts from the proposed project, has been performed[2]. This assessment plays a vital role by identifying important plant and animals that may be impacted from the project or during its construction. In particular, this assessment focuses on potential impacts to special-status species.

Once special-status species within the project vicinity are identified, potential impacts are evaluated. Factors considered in evaluating project impacts include the species' primary constituent elements (PCEs) in the project vicinity, distribution and population levels of the species, the possibility of direct impact, the degree of impacts to habitat, and the potential to mitigate any adverse effects.

As part of this biological assessment, a variety of Federal, State, and local agencies have been contacted for consultation. A list of all contacted agencies and related correspondence is found in Appendix E.

5.1 Special-Status Species

Special-status species are defined as plants and animals that are legally protected under the Endangered Species Act (ESA), Oregon Endangered Species Act, and species that are considered sufficiently rare by the scientific community. The State of Oregon and the Federal government maintain separate lists of threatened and endangered species.

The National Oceanic and Atmospheric Administration (NOAA) Fisheries Division (NMFS) and the U.S. Fish and Wildlife Service (USFWS) share responsibility for implementing the Federal Endangered Species Act of 1973 (Public Law 93-205, 16 U.S.C. § 1531). NOAA Fisheries has jurisdiction to implement ESA requirements for anadromous (salmonid) species that migrate from the ocean to freshwater for spawning and rearing. The U.S. Fish and Wildlife Service has jurisdiction with respect to freshwater species, plants and animals.

The USFWS and NMFS maintain lists of all federally listed ESA species. USFWS identify species for each count in Oregon including listed species, proposed species, delisted species and other species of concern and is updated on a weekly basis. ESA species under NMFS authority are found online at http://www.nmfs.noaa.gov/pr/species/esa. Special-status species for Tillamook County can be accessed at http://www.fws.gov/oregonfwo/Species/Lists/Documents/County/TILLAMOOK%20COUNTY.pdf. Copies of these lists are included in the appendix.

Under State law (ORS 496.171-496.192) the Fish and Wildlife Commission through the Oregon Department of Fish and Wildlife (ODFW) makes policy decisions under the Oregon ESA regarding animal and fish species. The Department of Agriculture makes plant species determinations. Insects and butterflies are monitored by the Natural Heritage Program at Oregon State University.

[2] Much of the information in this section was obtained from the Batch Biological Assessment for US 101 Jetty Creek Culvert Replacement submitted by ODOT on May 8, 2008 and the corresponding Biological Opinion written by NOAA NMFS dated July 23, 2008.

The Oregon Natural Heritage Information Center (ORNHIC) acts as a repository for data on all sensitive, threatened and endangered species in Oregon. The ORNHIC identified all rare, threatened and endangered plant and animals within a 2 mile radius of the project site. These special-status species are listed in Table 5-1.

Table 5-1 – Special-Status Species in Project Vicinity

Species	Federal Status	State Status
Western snowy plover (*Charadriuss alexandrines nivosus)*	Listed - Threatened	Listed - Threatened
Chum salmon (*Oncorhynchus keta)*	None	Sensitive-Critical
Oregon Coast coho salmon (*Oncorhynchus kisutch)*	Listed - Threatened	Sensitive-vulnerable
Steelhead – Winter Run (*Oncorhychus mykiss)*	Species of Concern	Sensitive-vulnerable
Purple martin (*Progne subis)*	Species of Concern	Sensitive-Critical

Of the identified species listed in Table 5-1, the Oregon Coast coho salmon is the only species listed by the Federal ESA that has the potential to be impacted by the proposed project[3].

5.2 Oregon Cost Coho Salmon

The Oregon Coastal (OC) coho salmon was listed as threatened under the Federal ESA on February 11, 2008 and habitat critical to their survival and recovery was designated. This species includes all naturally spawned population of coho salmon in Oregon coastal streams south of the Columbian River and north of Cape Blanco, and progeny of five artificial propagation programs. The Oregon Coast Technical Recovery Team (OC-TRT) identified 56 historical populations, grouped into five major "biogeographic strata," based on historical distributions, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity.

OC coho are anadromous with significant juvenile freshwater residence, and require low-silt habitat in which to spawn and rear. OC coho salmon spawn from November to January, concentrated in riffle or gravel deposits at the downstream ends of pools. Fry emerge in March or April, then move into shallow stream bank areas. During summer, coho fry prefer pools and riffles with sufficient cover. Juvenile coho prefer to over-winter in large main stem pools, backwater areas, and secondary pools with significant cover. Juveniles rear in freshwater for up to 15 months before migrating out to estuaries.

[3] Project is too far inland to provide suitable habitat for Western snowy plovers.

The general factors contributing to the ESA listing for OC coho salmon include:

1. Habitat loss and degradation caused by water diversion and withdrawals for agriculture, flood control, domestic, and hydropower purposes
2. Habitat fragmentation and simplification caused by forestry, agriculture, mining, and urbanization
3. Sedimentation of spawning areas and loss of pool-forming structures such as boulders and large wood
4. Loss and degradation of riparian areas that provide stream shading, cover, nutrients, and other riparian functions
5. Destruction and modification of estuarine areas and wetlands that provide rearing and migration habitats
6. Historic overfishing
7. Introduction of non-native predatory species and habitat modification that result in increased predator populations
8. Predation by native seabirds and marine mammals
9. Introduction of exotic parasites and diseases through hatchery programs, and habitat modification (i.e. low water flows and high water temperatures) that exacerbate salmonid susceptibility to diseases.

More information about these factors, as well as detailed life history, can be found in the Federal Register documents that proposed and listed the OC coho salmon under the Federal ESA (60 FR 38011).

Distribution & Population Levels

The Nehalem River population of OC coho are classified as "functionally independent" within the North Coast Stratum[4].

The Jetty Creek population appears to represent a very small segment of the Nehalem River population of OC coho. In the 2003-2004 spawning survey season, it was surveyed 11 times with no fish observed. During this same season, fifty-seven other steams in the Nehalem River basin were found to have an average of 32 OC coho salmon adults per mile (from "Estimated Coho Spawner Abundance 2003-2004" on ODFW's Research Division website: http://oregonstate.edu/dept/ODFW/).

A significant reason for the low OC coho population counts in Jetty Creek is the historic presence of fish barriers. At the time of the 2003-2004 survey, a 7 foot perched culvert at Highway 101 impeded fish passage. In 2009, ODOT replaced this culvert with a bridge and new restored open channel. Due to this project, fish passage up Jetty Creek was extended approximately 1,000 feet upstream. At this point fish passage is again barred due to the City's impoundment, which is the last remaining fish barrier on Jetty Creek for nearly two miles.

Since Jetty Creek has characteristics making it suitable habitat for OC coho salmon to spawn, rear, and migrate, it is likely that removal of fish passage barriers will increase fish populations in the stream.

[4] A "functionally independent" population is one that would have had a high likelihood of persisting in isolation from neighboring populations for 100 years.

Primary Constituent Elements (PCEs) in Project Vicinity

The biological requirements of Oregon coastal coho salmon have been identified and categorized by the NMFS into primary constituent elements (PCEs) used in the designation of critical habitat. In making these critical habitat designations, NMFS considers those physical or biological features that are essential to the conservation of given species. In general features include space for individual and population growth and for normal behavior; food, water, air, light, minerals, or other nutritional or physiological requirements, cover or shelter; sites for breeding, reproduction, and rearing of offspring; and habitats that are protected from disturbance or are representative of the historical geographical and ecological distribution of a species.

Specific PCEs developed by NMFS for salmonid critical freshwater habitat include:

Table 5-2 –PCEs & Affected Life History Event in All OC Coho Salmon Critical Habitat

	Essential Physical & Biological Features	Affected Life History Event
Freshwater Spawning	Water quality, water quantity, and substrate	Spawning, incubation, and larval development
Freshwater Rearing	Water Quantity and floodplain connectivity	Juvenile growth and mobility
	Water quality and forage	Juvenile development
	Natural cover[1]	Juvenile mobility and survival
Freshwater Migration	Free of artificial obstructions, water quality and quantity, and natural cover[2]	Juvenile and adult mobility and survival

[1] Natural cover includes shade, large wood, log jams, beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

[2] Forage includes aquatic invertebrate and fish species that support growth and maturation.

Both upstream and downstream of project site, Jetty Creek provides suitable habitat for OC coho salmon to spawn, rear, and migrate. The NMFS Critical Habitat Analytical Review Team (CHART) rated the Lower Nehalem River/Cook Creek 5th field HUC ***high*** for conservation and corridor value due to:

- A complex mixture of pool and riffle habitats, gravel bars, and an abundance of gravel substrates suitable for spawning, especially for adult OC coho salmon that are able to surmount the passage barriers posed by the existing impoundment dam.

- Water temperatures which remain cool and clear throughout the summer, providing favorable thermal conditions for resident cut throat trout, first-year OC coho fry, sculpin, crayfish, and lamprey.

Potential Direct Impacts of Project

The restoration of the relict channel on Jetty Creek will reconnect the upstream and downstream reaches of Jetty Creek within the vicinity of the WTP. With proper design and construction, the relict channel will provide enhanced structural complexity and aquatic habitat in the vicinity. This will be accomplished by:

- Placement of large wood and rock structures
- Establishment of pool-riffle or step-pool morphology
- Re-establishment of transport capacity including the movement and sorting of gravels.

As a result of the restoration of the relict channel on Jetty Creek, an immediate benefit will be provided by removing a significant fish passage barrier and opening up 1.8 miles of stream channel to salmonid and other fish species.

Although this project is expected to have an overall beneficial impact, there may be some temporary and short-term adverse impacts that should be addressed.

The PCEs potentially affected by the proposed project are water quality, riparian vegetation, cover/shelter, food resources, water velocities, substrate, spawning gravel, and safe passage. The likely effects of the project on these essential features are listed below:

Water Quality

Excavation of impoundment and restoration of historic channel will likely elevate suspended sediments temporarily in Jetty Creek. As a result, water quality will suffer localized, temporary degradation during the first few fall storms when sediment derived from site erosion and re-suspension of deposited sediment from in-water work is entrained into stream flow. Decreasingly small pulses of sediment (re-suspension lasting a few hours to a day) may continue for the next several months during bankfull flows until all disturbed materials in the construction area settle into place.

The potential for increased TSS and turbidity should be localized and brief, and the probability of mortality is negligible. OC coho salmon that are not within isolated work area will likely have exposure to very low levels (if any) of turbid water associated with the construction since the work area will be isolated. In-water work will take place during the low flow period, which corresponds with the time of year that we expect fewer OC coho salmon.

As with all construction activities, accidental release of fuel, oil, and other contaminants may occur. The probability of this occurring is very low, but no discountable. Petroleum based contaminants, such as fuel, oil, and some hydraulic fluids, contain polycyclic aromatic hydrocarbons, which can kill salmon at high levels of exposures and can also cause sublethal adverse effects at lower concentration.

Riparian Vegetation and Cover/Shelter

This project will require removal of some existing trees and vegetation in order to re-establish the relict creek channel. Site restoration will include planting native trees and vegetation in all areas affected by construction to maintain sufficient coverage to ensure water temperatures are not adversely affected. The upper temperature limit for coho is approximately to 77 °F. Large wood will also be placed in restored creek to increase habitat value.

Food Resources

Sedimentation will temporarily reduce food resources of juvenile OC coho salmon, but impacts would overlap potential OC coho salmon presence for only approximately 2 months the first year after construction. After the isolation area is re-watered, macroinvertebrates would be expected to quickly re-colonize the area from upstream sources.

If a large chemical spill occurred, it would affect invertebrate communities, but the effects would be insignificant by the time juveniles moved into the area in the fall due to the spill control and cleanup plan.

Water Velocities

Upper limits for water velocity are 6.6 ft/sec for adults and 2.0 ft/sec for juveniles. Restoration of the relict Jetty Creek channel will result in water velocities appropriate for adult and juvenile OC coho salmon. This will provide beneficial stream flow conditions during migration periods, enabling OC coho salmon to have easier access to spawning and rearing habitat. Boulder and large wood placement will create hydraulic shadow, which will be beneficial for OC coho salmon adult and juvenile migration and rearing.

Substrate and Spawning Gravel

As a likely effect of sedimentation due to construction and erosion, filling of interstitial spaces and increased interstitial flow due to the channel restoration from September to November of the first year may be expected. Impacts to spawning gravel are likely to be minimal because deposited sediment is likely to be carried away in October and November. Most spawning occurs in December and January.

Safe Passage

Upstream passage does not currently exist because of the City's impoundment dam. Restoring the historic channel bed to bypass the City's impoundment will significantly improve fish passage and access to 1.8 miles of spawning and rearing habitat on Jetty Creek. Beneficial stream flow conditions during migration periods will enable OC coho salmon to have easier access to spawning and rearing habitat. Placement of large wood and boulders will reduce water velocities through the project area, allowing for easier migration, additional rearing habitat, and significantly improve fish passage. Using rocks for grade control will reduce the potential formation of scour pools as well as reducing the risk of head-cut formation and a passage barrier.

Although some PCEs will be adversely affected, these effects will be temporary and are not likely to meaningfully change the conservation value of Jetty Creek. Effects to water quality, food resources substrate, spawning gravel, and safe passage are all localized and short-term. The cover/shelter, food resources, substrate and spawning gravel, and water velocity PCEs will have long-term benefits because of the fish passage improvements. None of the impacts are expected to measurably change the water temperature or water chemistry.

Mitigation

The proposed project is reasonably likely to have the following direct and indirect effects on ESA listed salmon.

1. Short-term elevation of turbidity and sediment within and immediately downstream from the construction areas.
2. Disturbances of the bed and banks of the wetted stream channels
3. Potential chemical contamination from fuel and lubricant spills within the wetted channels.

Mitigations measures will need to be incorporated into final design and construction to minimize any detrimental effects on OC coho salmon. These may include the following:

- **Work Area Isolation** – All in-water construction activities should be isolated from the main creek system by means such as coffer dams. Work isolation is intended to reduce potential effects to water quality and fish from in-stream construction. However, if fish are present within isolated work areas, these fish should be captured handled, and released. If pumps are used for temporary water management, NMFS screening guidelines will be used. The risk of death or injury is very low due to work-area isolation.

- **Scheduling** – In-water work for this project will be completed during the period of July 1 to September 15, when the fewest OC coho salmon are expected to be present, therefore limiting exposure to few individuals. Restoration work on the relict channel should be done while all Jetty Creek is still diverted through the City's impoundment.

- **Revegetation** – Site restoration, which will include planting native trees and vegetation in all areas affected by construction.

- **Channel Restoration** - Channel restoration will need to be completed to the re-establish relict channel. Rock will be used for grade control to minimize the risk of a head-cut. This will reduce the potential for scour fool formation, but will benefit migration and passage to the spawning and rearing areas upstream. The proposed project will affect two limiting factors (sediment and loss of large wood) in the Lower Nehalem River/Cook Creek watershed. Adding large wood for rear habitat and reestablish and restoring the historic stream channel will have beneficial effects due to a larger channel opening improving large wood transport.

- **Pollution Control Plan (PCP)** – Intended to reduce the risk of contamination due to chemical spills.

- **Sedimentation and Erosion Control Plan (SECP)** - A SECP is intended to reduce the amount of sedimentation and erosion occurring at a project site due to construction activities. A SECP will incorporate appropriate best management practices (BMPs) and require various monitoring reports to be completed throughout constructions.

Additional avoidance, minimization, and conservation measures may be agreed upon by government representatives, as conditions of the resulting Federal and State consultations. Failure to meet these conditions may have repercussions to the project.

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SECTION 6

WATER RIGHTS ANALYSIS

Under Oregon law, all water is publicly owned. With some exceptions, cities, farmers, factory owners, and other water users must obtain a permit or water right from the OWRD to use water from any source; whether it is underground, or from lakes or streams.

Oregon's water laws are based on the principle of prior appropriation. This means the first person to obtain a water right on a stream is the last to be shut off in times of low stream flows. In water-short times, the water right holder with the oldest date of priority can demand the water specified in their water right regardless of the needs of junior users. If there is a surplus beyond the needs of the senior right holder, the water right holder with the next oldest priority date can take as much as necessary to satisfy needs under their right and so on down the line until there is no surplus or until all rights are satisfied. The date of application for a permit to use water usually becomes the priority date of the right.

6.1 Existing Water Rights

Existing City Water Rights

The City of Rockaway Beach has a number of water rights under which they are permitted to divert and use water for municipal purposes. Of these sources, surface water from Jetty Creek supplies the majority of water to meet the City's water demands. Water Right Permit Numbers S34498 and S46245 allow the City to withdraw up to 2.0 cubic feet per second (896 gallons per minute) from Jetty Creek. The City also utilizes water rights from three wells to supplement stream flows, particularly in summer.
Table 6-1 gives a summary of Rockaway Beach's water rights.

Table 6-1 – Summary of the City of Rockaway Beach's Water Rights

Source	Certificate Number	Permit Number	Water Right CFS (gpm)	Year Issued
Jetty Creek	**47952**	**S 34498**	**1.00 (448)**	**1969**
Jetty Creek	**None**	**S 46245**	**1.00 (448)**	**1981**
McMillan Creek	26097	S 17176	0.26 (116)	1946
McMillan Creek	30421	S 25396	0.26 (116)	1958
McMillan Creek	30423	S 26296	0.50 (224)	1959
Heitmiller Creek	2201	S 925	2.50 (1,120)	1911
Heitmiller Creek	38987	S 27861	0.50 (224)	1962
Spring Creek & Steinhelber Creek	936	S 1081	0.50 (224)	1912
Rock Creek	2386	S 51	5.00 (2,240)	1909
Well No. 1 (West)	**82449**	**G 9365**	**0.39 (175)**	**1981**
Well No. 2 (East)	**82449**	**G 9365**	**0.39 (175)**	**1981**
Well No. 3 (Manhattan)	**None**	**G 15325**	**0.22 (100)**	**2002**

**Bolded indicates sources is presently used by City

As noted above, the City of Rockaway Beach has two surface water rights granted on Jetty Creek, each allowing for a maximum withdrawal of 1.0 cfs. Only one of these water rights has been certified by the State. Copies of these permits are available in the appendix.

OWRD has characterized the City's raw water impoundment on Jetty Creek as a "settling pond" due to the relatively small size of the facility. For this reason, the City is not required to have a storage water right for its water holding. After reviewing the proposed changes to the City's impoundment, OWRD has determined that the expansion would not constitute a large enough increase to water storage capability to require the City to obtain a storage water right permit. This determination was made during a meeting between the City and OWRD in June of 2010.

In-Stream Water Right

In 1968, legislation was passed to allow minimum stream flow requirements to be established in some reaches of rivers and streams in Oregon to protect fish and other wildlife. In-stream water rights have a priority date and are regulated in the same way as other water rights.

An in-stream water right to support aquatic life was established for Jetty Creek in May of 1981 (Certificate 59625). The minimum flow requirements and seasonal time frames are shown in Table 6-2.

Table 6-2 - Seasonal In-Stream Water Right

Time Period	Minimum Flow (CFS)
Oct 1 - Oct 15	2.0
October 16 – March 31	5.0
April 1 – September 30	0.5

Based on priority dates, the in-stream water right is junior to the City's certified water right (priority date 12/8/1696), but senior to the City's second water right permit on Jetty Creek (priority date 6/24/1981). This means that flows in Jetty Creek must be sufficient to meet the in-stream water right before the City may withdraw water under its second water right for general municipal use. However, language on the in-stream water includes the following:

> "This in-stream water right shall not have priority over the right to use water for human consumption, livestock consumption, or the use of waters legally released from storage."

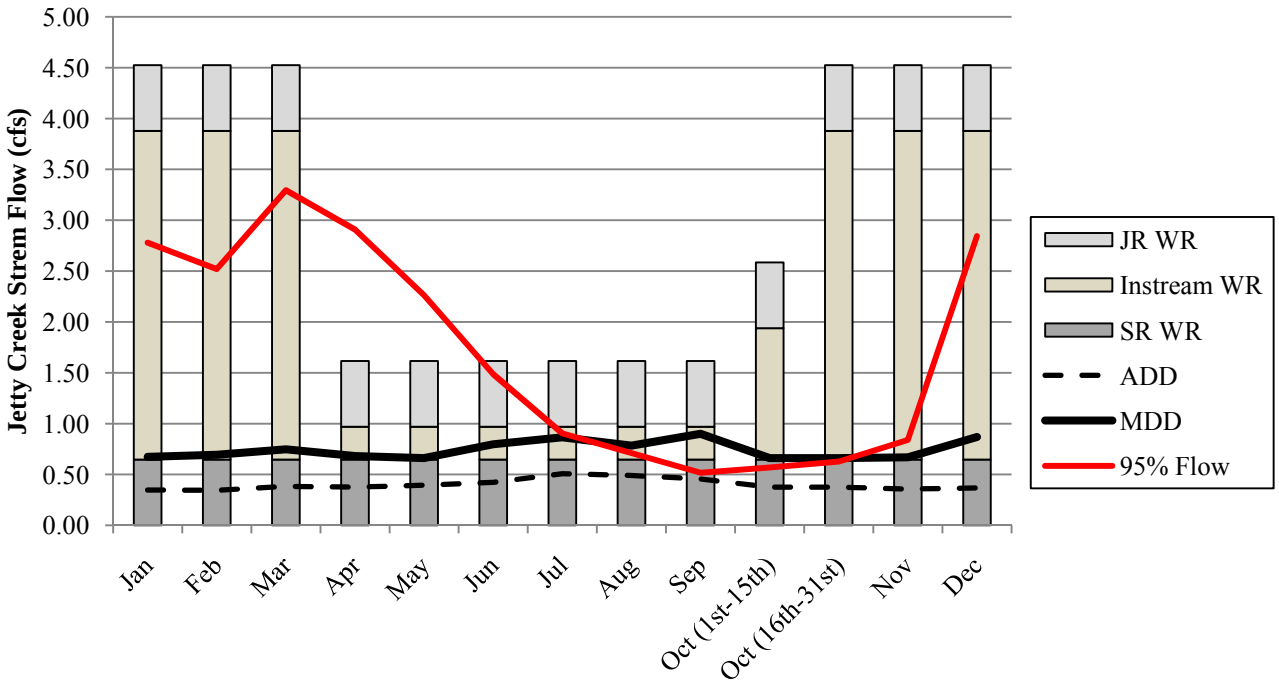
Therefore, the City may divert water from Jetty Creek flows if the water is only used for human consumption. To do so would require a ban on all water not specifically used for human consumption. The City has already adopted a Water Curtailment Plan, which could be used to implement such a ban.

6.2 Jetty Creek Source Adequacy & Reliability

Currently, the City's maximum daily demand (MDD), which typically occurs in July, is 0.866 mgd. The projected MDD for the year 2028 is estimated at 1.15 mgd. Although the City's Jetty Creek water rights allowance is more than sufficient to meet future peak demand, actual stream flows are often insufficient to meet the City's full water demand.

Figure 6-1 compares the City's average daily demand (ADD) and MDD to the 95% exceedance flows in Jetty Creek as determined in Section 4.1 of this report. This figure also notes the City's and in-stream water rights.

Figure 6-1 – Jetty Creek Stream Flows vs. Water Demands



Additional detailed information on water rights, available flow, and water demands is provided in the following table.

Table 6-3 – Summary of Water Demands & Jetty Creek Reliability

	Water Rights		Available Water for Municipal Use		City's Daily Demand[1]	
	Req. Flow for full WR (mgd)	Req. Flow Met	Average Flow (mgd)	95%Flow (mgd)	ADD. (mgd)	MDD (mgd)
January	4.524	82.1%	1.293	0.646	0.347	0.673
February	4.524	84.3%	1.293	0.646	0.344	0.694
March	4.524	85.5%	1.293	0.646	0.383	0.747
April	1.616	100.0%	1.293	1.293	0.375	0.681
May	1.616	100.0%	1.293	1.293	0.394	0.662
June	1.616	90.5%	1.293	1.163	0.423	0.796
July	1.616	52.8%	1.293	0.646	0.508	0.866
August	1.616	14.3%	0.944	0.711	0.490	0.784
September	1.616	28.0%	1.293	0.517	0.456	0.900
October (1^{st}-15^{th})	2.585	18.2%	0.646	0.569	0.376	0.661
October (16^{th}-31^{st})	4.524	22.6%	0.646	0.627	0.376	0.661
November	4.524	71.1%	1.293	0.646	0.357	0.669
December	4.524	85.6%	1.293	0.646	0.367	0.869

[1] Based on the City's 2007 Water Master Plan

- *Water Rights* – This column quantifies the total flow required to meet the City's two water rights as well as the corresponding in-stream water right based on Table 6-2. Because one of the City's water rights is junior to the in-stream right, this required flow indicates the minimum flow that needed for the City to withdraw its full 2.0 cfs water right. This column also includes the percentage of days this minimum flow requirement is met.

- *Available Water for Municipal Use*– This column shows the average and 95% exceedance of water available for the City's diversions. Available water is determined based on the following equations:

$SF \leq 1.0$ cfs	→	AW = SF
1.0 cfs < SF ≤ 1.0 cfs + IWR	→	AW = 1.0 cfs (0.646 mgd)
1.0 cfs + IWR < SF ≤ 2.0 cfs + IWR	→	AW = SF – IWR
2.0 cfs + IWR ≤ SF	→	AW = 2.0 cfs (1.293 mgd)

Where:

SF = Jetty Creek stream flow (see Section 4.1 for analysis)
IWR = In-stream water right (see Table 6-2)
AW = Available water for City diversion

- *City's Daily Water Demand* – This column lists the City's average daily demand (ADD) and maximum daily demand (MDD) for each month based on information from the City's Water Master Plan.

Information from Table 6-3 and Figure 6-1 can be used to determine the adequacy of the City's Jetty Creek water rights to meet the municipal water needs for Rockaway Beach. Key findings of this analysis include:

- *Average Available Water* and *95% Available Water* in Jetty Creek is sufficient to meet current ADD for all months.
- *Average Available Water* in Jetty Creek is sufficient to meet current MDD for all months.
- *95% Available Water* is **not** sufficient for most monthly MDD. April, May, and June are the only months with sufficient flows 95% or more days.
- Limitations on available water in winter months (November – March) are typically a result of the high in-stream water right requirement rather than low stream flows.

The City will need to supplement its Jetty Creek source using a combination of water from other sources as well as raw and treated water storage supply.

6.3 Impact of Project on Water Rights

The proposed project will require the City to make modifications to its existing water rights on Jetty Creek. Based on conversations with the regional Water Master and OWRD Water Rights Specialist, constructing a diversion structure upstream of the existing impoundment will constitute a change in the point of diversion (POD). As a result, the City will be required to modify its existing water rights or apply for new rights.

Transferring Water Rights

The use of water under a water right is restricted to the terms and conditions described in the water right certificate including place of use, point of diversion, and type of use. When a water right holder plans to make changes to these conditions, a transfer application must be filed with OWRD.

To approve a transfer application, the OWRD must determine that the proposed change will not injure other water rights. A public comment period is initiated to allow other users and agencies an opportunity to protest and a hearing may be held. As a result, conditions of approval may be included in order to eliminate potential injury to other water rights. If conditional approval will not eliminate injury, the application is denied. The proposed change cannot occur until after the transfer order is issued from the State

Once transfer is approved, the proposed change may be implemented. After the modification is completed, the water right may be certified following standard procedures and a new water right certificate will be issued to confirm the modified water right.

The major benefit of a water transfer is that there would be no change in the City's existing priority dates: however, the City's junior water right permit authorization date expired in October 1998. As a result, the City must file for a permit extension prior to submitting an application to transfer the water right. Review and approval of a permit extension may take between 2 to 3 years, which could seriously delay this project.

New Water Right

The City may consider applying for a new water right at the new point of diversion. However, rights are not automatically granted. Opportunities are provided for other water right holders and the public to protest the issuance of a permit. Water users can assert that a new permit may injure or interfere with their water use, and the public can claim that issuing a new permit may be detrimental to the public interest.

The major disadvantage of this approach is that a new priority date would be assigned to the City's water rights on Jetty Creek. Consequently, both of the City's water rights would be junior to the in-stream water right, meaning that no municipal diversion would be allowed until the full in-stream water was met. This could significantly reduce the amount of water available for City's use.

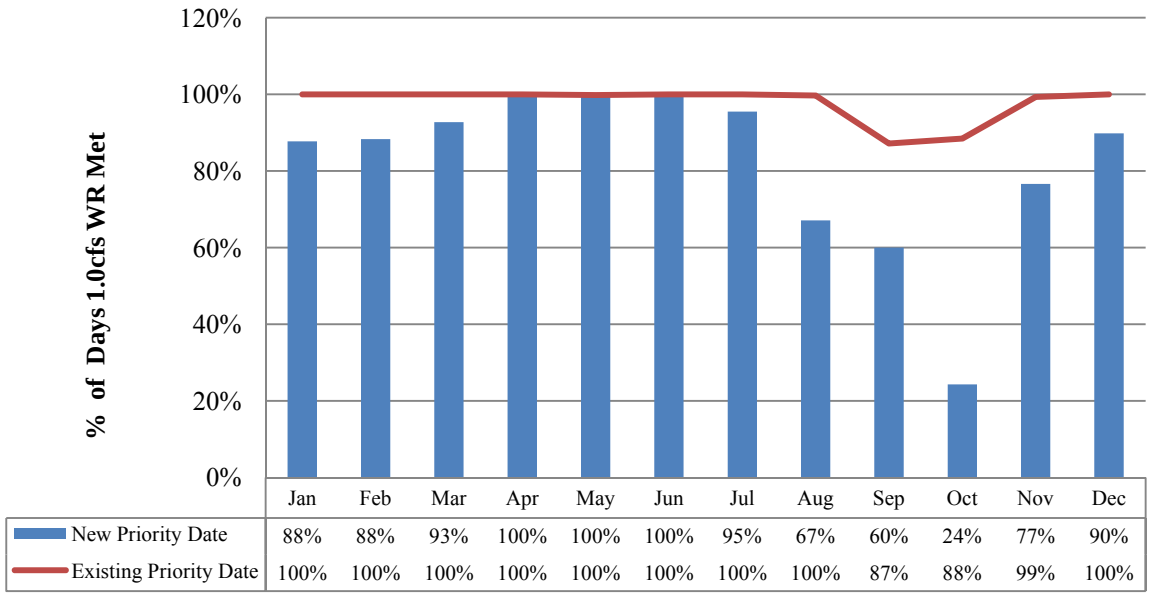
The impact of changing the City's priority date is displayed in the following table. This table shows the amount of water available to the City currently as well as what could be withdraw if the City's water rights' priority dates changed. Months when available flow decreases as a result of the priority date change are highlighted. Bold values indicate when stream flows are insufficient to meet in-stream flow requirements, therefore, no water would be available for the City's use.

Table 6-4 – Impact of New Water Right Priority

	Jetty Creek Stream Flows		Available Water for Municipal Use (Current Priority Date)		Available Water for Municipal Use (Changed Priority Date)	
	Average Flow (mgd)	95%Flow (mgd)	Average Flow (mgd)	95%Flow (mgd)	Average Flow (mgd)	95%Flow (mgd)
January	11.393	2.779	1.293	0.646	1.293	**-1.099**
February	11.598	2.521	1.293	0.646	1.293	**-1.357**
March	9.557	3.296	1.293	0.646	1.293	**-0.582**
April	7.127	2.908	1.293	1.293	1.293	1.293
May	4.501	2.262	1.293	1.293	1.293	1.293
June	3.402	1.487	1.293	1.163	1.293	1.163
July	2.126	0.905	1.293	0.646	1.293	0.582
August	1.267	0.711	0.944	0.711	0.944	0.388
September	1.635	0.517	1.293	0.517	1.293	0.194
October (1^{st}-15^{th})	1.811	0.569	0.646	0.569	0.518	**-0.724**
October (16^{th}-31^{st})	3.623	0.627	0.646	0.627	0.391	**-2.605**
November	9.015	0.840	1.293	0.646	1.293	**-2.391**
December	12.217	2.844	1.293	0.646	1.293	**-0.388**

Figure 6-2 shows the percentage of days each month where available water in Jetty Creek meets or exceeds the City's currently certified 1.0 cfs water right. As the graph shows, with the current priority date of 12/8/1969, this water right is met 100% except for the months of September through November. Early October had the fewest days meeting the required stream flow. By changing the City's water right priority date, the City's ability to withdraw 1.0 cfs from Jetty Creek greatly diminishes.

Figure 6-2 – Percent of Days where Stream Flows meet City's 1.0 cfs Water Right



Partial Perfection of Water Right

Under Oregon water law, a municipality may partially perfect water authorized by a permit in 25% increments. OWRD would then issue a certificate under ORS 537.250 for only the amount of water perfected. The "unperfected" portion of the permit could be certified in the future.

In order to partially perfect the junior water right, the City would need to hire a certified water right examiner (CWRE) to survey the extent of water use and within submit a map and claim of beneficial use to OWRD. OWRD will review to ensure that water use and development conform to the terms and conditions of the permit. If so, a water right certificate is issued.

The City's existing water treatment plant has a design capacity of 700 gpm or 1.56 cfs. Based on this capacity, the City should be able to certify at least 0.5 cfs or 50% of its junior water right.

Once a water right certificate for the City's junior water right was obtained, the City could apply to transfer the POD to the new diversion structure. The OWRD's review process to certify a water right is much quicker than the one for permit extensions because water right certification does not require review by the public and other agencies.

The City would need to apply for an extension for the remaining "unperfected" portion of the junior water right. Once this extension was granted, a permit transfer could take place. This would require that initial diversion structure to have a maximum diversion rate of 1.5 cfs with the ability to divert more water once the City can transfer the full 2.0 cfs water rights to the new location.

Recommendation

The proposed project cannot move forward until the issues involving the City's water rights are resolved. Based on the analysis of option available to the City the following would be advised:

1. Transfer Senior Water Right (47952). The City should first apply to transfer its senior water right POD to the new diversion location. This is the minimum requirement in order to legally re-route Jetty Creek and construct the new diversion structure. Once the transfer is complete, the City will only be allowed to divert 1.0 cfs until the junior water right is transferred.

2. Partially Perfect 50% of Junior Water Right (S46245). The City should begin the process of partially certifying its junior water right permit. It is believed that 50% of this right could be perfected.

3. Transfer Partially Certified Junior Water Right (S46245). Once the junior water right is partially certified, the City will need to apply to transfer the POD to the new diversion structure. Once this is approved, the City can begin diverted the additional amount of water perfected.

4. Apply for Permit Extension (S46245 partial). The City will still need to deal with the issue that the junior water right permit has expired. A permit extension application for the "unperfected" water of the junior water right will need to be submitted to OWRD for approval.

5. Permit Transfer (S46245 partial). Once the junior water right extension is approved, it will need to be transferred to the new POD location. Once this transfer is approved, the City can divert the full 2.0 cfs authorized by OWRD.

6. Certify Remaining Portion of Junior Water Right (S46245 partial). As water demand grows in the City, the City will need to increase its production capabilities. Once demands and treatment capabilities are sufficient, the City can certify the remaining portion of the junior water right.

Standard review times may result in substantial delay of the project. The City can reduce these times through the OWRD Reimbursement Authority (RA). The RA provides the OWRD with the ability to enter into a voluntary agreement with an applicant for expedited agency action on an application or other request for regulatory action. Under such an agreement, the applicant pays the cost to hire additional staff, contract for services, or provide additional services to the applicant not otherwise available.

The OWRD RA program works by incorporating both internal staff and pre-qualified contractors into the review process. The Water Right Certificate Program uses internal staff that are paid through the RA program. The Transfer Program uses contractors which work directly for the Department. The contractors work on a rotational basis and prepare draft documents reflecting appropriate agency action.

It is expected that utilizing the RA program could increase the cost of a water right actions by $1,000 per action. For more information on expediting a water right certificate, contact Bob Rice at (503) 986-0927. For information on expediting a transfer application, contact Dorothy Pedersen at (503) 986-0890.
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SECTION 7

ALTERNATIVE ANALYSIS

7.1 Design Development

Design Objectives

The key to selecting the most appropriate design is to develop clear objectives for the project's outcome. The following objectives have been developed for this project:

- Fish Protection. A key element of this new structure will be the fish screen that will be necessary to ensure fish are not entrapped and/or harmed within the City's diversion facility or impoundment. The design must meet all Federal & State requirements for fish screening and passage.

- Diversion Capacity. The structure needs to be designed so that the City's full 2.0 cfs water right is able to pass through the diversion and into the City's impoundment. Furthermore, due to complications with the City's existing water rights, the diversion's capacity will need to be adjustable to ensure the City conforms to withdrawal restrictions.

- Flow Regulation. The structure should be designed so that the City can regulate the amount of water entering the diversion. This is needed to ensure that the City conforms to restrictions imposed by the in-stream water right. Additionally, the City should have the option to completely shut off the diversion particularly during high flow events that cause spikes in turbidity levels. Ideally, the City should be able to perform flow regulation remotely by connecting to the City's existing SCADA system.

- Minimal O&M Requirements. The design of the diversion structure must take into considerations the City's limited financial and personnel resources. Optimal design should require little to no manual cleaning and low operational costs.

- Capital Cost. The design should be economically feasible for the City to construct.

- Maximize Available Water for Diversion. The City's highest summer water demands occur when flows in Jetty Creek are at their lowest. The new diversion structure should be capable of diverting the maximum allowable water from Jetty Creek to the City's impoundment.

- Maintain Minimum In-Stream Water Right Flow. The design of the new diversion structure needs to incorporate some mechanism to ensure the in-stream water right is maintained as required.

- Flow Monitoring Capabilities. The design should be able to monitor flows entering the diversion structure, discharging through the bypass (if present), and total stream flow. The purpose of this monitoring program is to help the City "prove up" on its water rights as well as ensuring the in-stream water right is maintained.

State & Federal Fish Passage Requirements

State and Federal agencies are responsible for protecting and managing fishery resources. These agencies play a regulatory role in identifying fishery protection needs as well as reviewing and approving proposed designs. Consequently, many of these agencies have established design criteria and design guidelines.

Fish passage requirements in Oregon are set forth in Oregon Administrative Rules (OAR) 635-412. Northwest Region NMFS have published screening and protective design criteria (NMFS, 2008), which are widely accepted standards in the field. These rules require screening of intakes to protect fish.

When *listed, threatened, or endangered* fish species are present (as in the case of Jetty Creek), the selection criteria will be based on effectively protecting the listed species. Exclusion requirements for threatened and endangered fish are often specified base on a set of minimum body length. Passage criteria focus on the specified species in their most vulnerable life stage and under adverse environmental conditions.

Current State and Federal fish passage and screening criteria are presented in the appendix. A brief summary of current Northwest Region NMFS screening criteria for juvenile salmon is presented in Table 7-1. These criteria are constantly evolving and will always need to be verified with the appropriate regulatory agencies.

Table 7-1 - Summary of Fish Screen Criteria (Juvenile Salmonids – NMFS Northwest Region)

Design Feature	Variations	Criteria
Approach velocity (Measured 3 inches from screen face)		Not to exceed 0.4 ft/s for fry or 0.80 ft/s for fingerling. Uniform flow required
Sweeping velocity		Greater than approach velocity
Screen material and maximum opening	Perforated plate	**Fry** – 3/32" – 2.38 mm **Fingerling –** 1/4" – 6.35 mm
Fry – minimum open area 27%	Profile bar	**Fry** – 0.0689" – 1.75 mm **Fingerling** – 1/4" – 6.35 mm
Fingerling – minimum open area 40%	Woven wire	**Fry** – 3/32" – 2.38 mm **Fingerling** – 1/4" – 6.35 mm
Structural features		• Unimpeded fish movement parallel to screen and into bypass • Oriented at angle up to 45° to the flow • Piers and walls flush with screen face • Screen placed at an angle to flow, and downstream end terminates in bypass entrance
Bypass	Layout	• Multiple bypasses are needed when fish exposure time is more than 60 seconds. • Entrance and all components sized to minimize potential for debris blockage • Training walls may be placed at an angle to the screen to aid fish movement toward the bypass and for intermediate bypasses.
	Entrance	• Bypass entrance has independent flow control capability • Entrance velocity is greater than or equal to maximum flow velocity vector near screen • Good ambient light • Bypass entrance extends from floor to water surface
	Conduit	• No pumps, free fall, valves, or hydraulic jumps within the conduit. • Smooth pipe surfaces • Pipe bends shall have radius/diameter > 5Pipe velocity> 2 ft/s • 24" minimum diameter with 9" minimum flow depth
	Outfall	• Ambient river velocities of at least 4 ft/s • 25 ft/s maximum outfall impact velocity • Locate to minimize predation
Operation and maintenance		• Automatic screen cleaning to prevent accumulation of debris • Head differential on screen of 0.1 ft triggers screen cleaning • Screen and bypass evaluated for biological and hydraulic effectiveness

7.2 Fish Protection Screen Alternatives

Fish protection screens are devices installed at surface water diversions to physically preclude passage of fish into the intake. General guiding principles for fish protection screen design include:

- Assume worst conditions of size of fish present and water temperature
- Use positive exclusion screening to approach 100% effectiveness
- Use voluntary guidance for migratory fish
- Use exclusion for non-migrating fish; must be able to voluntarily return upstream
- Return fish to channel

Positive barrier screens are the most widely used and accepted by fishery resource agencies to protect fish at water diversions. They provide a physical barrier that prevents fish from being entrained into the diversion. There are many types of positive barrier fish screens, designed for varying water withdrawal situations with applications ranging from simple to complex. Table 7-2 provides a list of a number of positive barrier screen alternatives. Additional information on these screens follows.

Table 7-2 – Positive Barrier Screen Alternatives

Screen Type	Typical Location	Comments
Flat Plate Screen	river, canal, diversion pool	Widely used in rivers and canals. Wide range of diversion flow rates.
Drum Screen	canal, diversion pool	Suitable where water level is stable (controlled to 0.65-0.85 drum screen diameter). Currently used mostly for small flows, although has been used for large flows.
Traveling Screen	secondary screen in bypass, river	Because of expense, usually used for small flows.
Cylindrical Screen	river, diversion pool	Typically applied at intakes to pumping plants.
Inclined Screen	secondary screening in bypass, canal, diversion pool, river	Adverse slope – suitable where water level is controlled Inclined plate – best applied along river banks
Horizontal Flat Plate	canal, river	Typically applied in river with good sweeping flow. Currently used for small diversions
Coanda Screen	river, canal	Limited to small diversions.

Source: *Fish Protection at Water Diversions*. U.S. Department of the Interior (April 2006).

An alternative to physical barriers (e.g. screens) for fish protection at diversions, are behavioral barriers. Behavioral barriers require volitional action on the part of the fish to avoid entrainment. These devices are typically viewed as experimental from the regulatory perspective and their performance capabilities may not be well documented. For the purpose of this study, only positive barrier screens are considered.

Flat Plate Screen

Modern flat plate screens consist of a series of flat plate screen panels set between support beans or guides. The screen is fixed and does not move. Diverted flow passes through the screen excluding fish and debris. Screens may be placed on a diagonal across the flow, parallel to the flow, or in a "V" configuration. For small diversions, these screens can be installed on the bank of a river and, therefore, require no bypass.

Flat plate screens require a mechanical cleaning system for debris removal. Depending on the screen size and debris loads, cleaning systems may be manually or mechanically driven. Commonly used cleaning systems include traveling brush cleaners and hydraulic backspray systems.

Advantages:

- Effective barriers to fish entrainment.
- Do not require a controlled operating water depth.
- Proven cleaning capability that removes debris from the screen.
- The screen itself has no moving parts, thus simplifying screen and screen support structure and reducing screen costs.
- Widely applied; have an excellent performance record; and are accepted by fishery resource agencies.

Disadvantages:

- Mechanical screen cleaners require maintenance and add to both the capital and operating cost of the structure.
- Shallow depths caused by low flow rates can result in excessively long screens to meet screen area requirements.

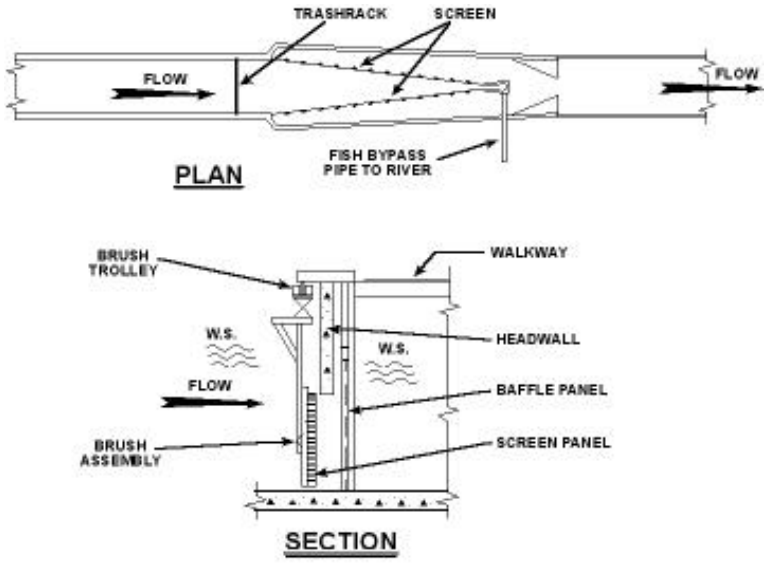


Figure 7-1 - Flat plate screen "V" configuration
Source: *Fish Protection Guidelines for Washington State (Draft).* Washington State Department of Fish & Wildlife (2000).

Drum Screen

Drum screens consists of screen covered cylindrical frames that slowly rotate about their horizontal axis. The rotation carries any debris up on the drum, which is washed off on the backside as the flow passes through the screen and into the diversion channel or pipe. To provide sufficient fish screen area and optimize debris handling, drum screens must strictly operate with 65 to 85 percent submerged.

A screen installation can consists of a single screen at smaller diversion sites or a series of screen cylinders placed end-to-end. Screen rotation is achieved by an electric motor, paddlewheel, solar drive, or hydraulic motor. Drum screens have excellent debris handling and self-cleaning characteristics. Rarely are supplemented cleaning systems are required.

Due to the specific submergence requirements, drum screens are typically not used for in-river sites. Drum screens are most often used with in-canal installations and have been used in the pool of some in-diversion sites.

Advantages:

- Very effective in protecting juvenile fish.
- Considered self—cleaning and have excellent debris handling characteristics.
- Proper cleaning is independent of the bypass flow.
- Widely applied; have an excellent performance record; and are accepted by fishery resource agencies.

Disadvantages:

- More complex design.
- Bypass channel required.
- Applicable only to sites with well-regulated and stable water surface elevations such as canals, in-diversion pool, and reservoir sites where water surface elevation can be controlled.
- The seals at the bottom and sides of the drum require maintenance and special attention to prevent undesirable openings where fish may pass.
- Moving parts require maintenance. Special attention is needed for the bearings and drive chains because they operate in submerged conditions.
- Continuous rotation (operation) of the drum screen and flow by-pass is required for proper cleaning.

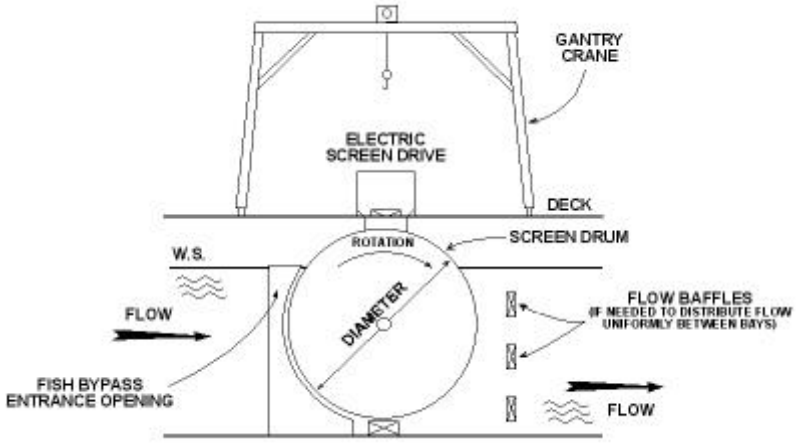


Figure 7-2 – Sectional View of Drum Screens
Source: *Fish Protection Guidelines for Washington State (Draft)*. Washington State Department of Fish & Wildlife (2000).

Traveling screens

Traveling screens are mechanical screens installed vertically or on an incline. These screens are driven by electric motors through a drive shaft at the top and rotate around a parallel idler shaft at the bottom. The mesh of vertical traveling screen rotates to remove debris collected on the screen face, depositing it on the downstream side. Because the screen lifts vertically, there is no limitation on minimum or maximum screen submergence to be effective.

Types of vertical traveling screens commonly used include panel-type screens, which have individual mesh panels, and belt-type vertical traveling screens which have a continuous belt mesh. However, panel-type screens are not typically used in fish protection applications.

Traveling screen installations are normally configured with the screen face placed parallel to or at a shallow angle to the flow. As with other concepts, this generates good sweeping flow and provides fish guidance along the screen face, thus reducing fish contact with the screen.

Because of the relatively high costs, traveling screen application would most likely be limited to small and moderate sized facilities.

Advantages:

- Excellent debris handling characteristics.
- Commercially available reducing design costs.
- Do not require a controlled operating water depth for proper cleaning as require for drum screens.
- Widely applied; have an excellent performance record; and are accepted by fishery resource agencies.

Disadvantages:

- Not as economically viable for large diversions.
- The seals require maintenance and special attention to prevent undesirable openings where small fish may pass. The traveling screen spray water pump, and conveyor have moving parts which require maintenance.

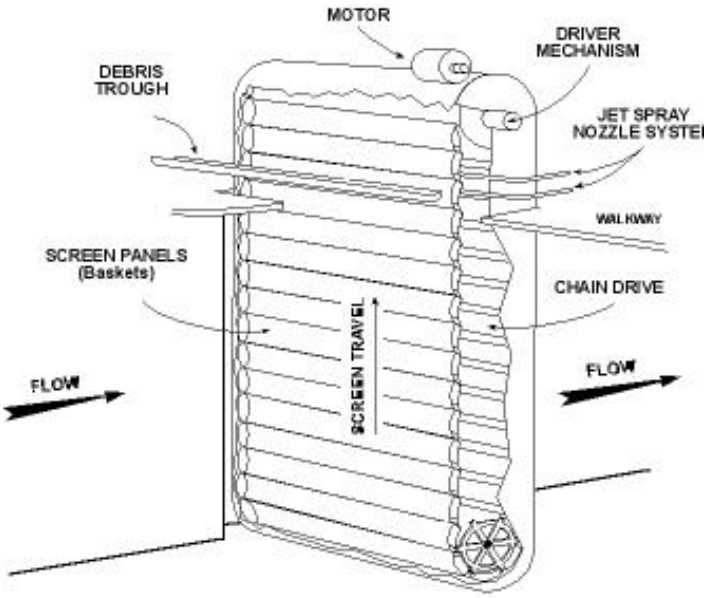


Figure 7-3 – Traveling Screen
Source: *Fish Protection Guidelines for Washington State (Draft)*. Washington State Department of Fish & Wildlife (2000).

Submerged Inclined Screens

A submerged inclined screen consists of a flat plate screen with a profile that increases with the direction of flow. The screen is backwatered from below rather than water dropping through the screen. Water drops over the downstream end of the screen creating the fish and debris bypass. The downstream end of the screen might narrow gradually to reduce the bypass flow. This style of screen is generally used for gravity diversions.

With an incline screen, debris is not automatically swept off the screen. It must be scraped off the screen into the bypass. The most common methods used to clean the screens are a brush cleaning system (either manual or mechanically operated) or a cleaning system that uses compressed air or spray water for back-flushing.

Bypass design issues vary with the screen configuration applied. Fish may reject the screen, which is often due to the low depth at the upstream of the screen. Typically a depth of at least a foot is needed to keep fish from rejecting the bypass.

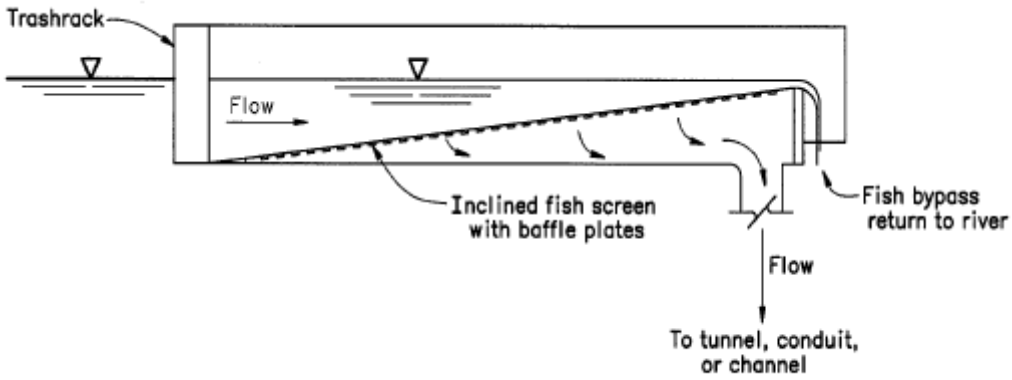


Figure 7-4 – Fixed Incline Screen
Source: *Fish Protection at Water Diversions.* U.S. Department of the Interior (April 2006).

Advantages:

- Provide effective screen surface areas even with shallow flow applications.
- Simple design with few or no moving components, thus minimizing maintenance and reducing capital and O&M costs.
- Proven cleaning capability that removes debris off the screen.

Disadvantages:

- Sediment and debris (large trees and boulders) may be a major problem, because the inclined screen is a bottom type screen.
- If a cleaning system is used, it will have moving parts that require maintenance.
- The diverted flow rates may vary as a function of water surface and screen fouling.
- The intake channel may require dewatering capability for maintenance.
- Further fishery resources agencies criteria may limit the calculated screen based on the vertically projected height.
- The concept may be considered developmental by fishery resource agencies.

Horizontal Flat Plate Screens

The horizontal flat plate screen concept uses a horizontal face screen placed near the bottom of a natural channel. This allows placement of a screen with significant active surface area in a shallow stream. The horizontal screen concept is, consequently, more applicable at shallow river diversion sites compared to flat screens, which require greater river depths. Water enters the screen at a high velocity (4 to 6 feet per second) while water moves very slowly through the screen vertically (0.1 to 0.4 feet per second, after correcting for net open area). These velocities keep the fish and debris moving across the screen while keeping impingement from occurring. Components of horizontal flat plate screens include the screen, tapered wall to ensure uniform velocities weir wall to maintain water depth, and attenuation bay where diverted water is collected.

Horizontal screens can be designed to fully comply with fishery resource agency screen approach velocity criteria. Resource agencies should be consulted to ensure acceptable screen area is provided and other criteria are properly satisfied.

These screens are considered to be self-cleaning and proven to have good debris and sediment handing characteristics. If necessary they can be designed with air burst or back spray cleaners, although cleaning

systems have not been installed on any of the screens installed to date. The biggest fouling problems encountered are algal growth on the bottom of the perforated plate. This growth traps fine sediment and leads to screen fouling.

Figure 7-5 – Horizontal Flat Plate Screen
Source: *Fish Protection at Water Diversions*. U.S. Department of the Interior (April 2006).

Advantages:

- Effectively applied at shallow in-river diversion sites.
- Simple design with no moving parts.
- Modular design decrease construction costs.
- Low maintenance requirements.

Disadvantages:

- Debris and sediment handling characteristics are not fully proven and may be a problem.
- Diversion flow rates will vary as a function of water surface elevation and screen fouling.
- Application is likely limited to relatively small diversions.
- The concept may be considered developmental by fishery resource agencies.
- There may be high exposure to bottom-oriented fish to the screen surface.
- Requires continuous by-pass flow.

Coanda Screens

The Coanda screen is a non-traditional design where relatively shallow; high velocity flows occur on the screen face. The screen is typically installed on the downstream face of an overflow weir. Flow passes over the crest of the weir, down a solid acceleration plate, and then across the screen panel. Diverted flow, passing through the screen is collected in a conveyance channel below the screen and the overflow, which may include fish and debris, passes off the downstream end of the screen.

Coanda screens are very efficient at diverting large quantities of flow for their size. They are essentially self-cleaning and have the ability to exclude very fine debris and small aquatic organisms. Additional biological testing is still needed to demonstrate fish survival and evaluate other side effects of fish passage over the screen.

Advantages:

- Good self-cleaning characteristics that minimize maintenance requirements.
- Relatively compact and include no moving parts.
- Effectively used to exclude sediment from the diversion.

Disadvantages:

- Commercially available designs require several feet of head drop, which may be restrictive where there is insufficient available head.
- To satisfy minimum flow depths at the bottom of the screen, a substantial amount of bypass flow may be required.
- Fish injury and mortality characteristics of the screen have not been fully evaluated and documented.
- The concepts may be considered developmental by fisheries resource agencies.
- Applications are likely limited to relatively small diversions.

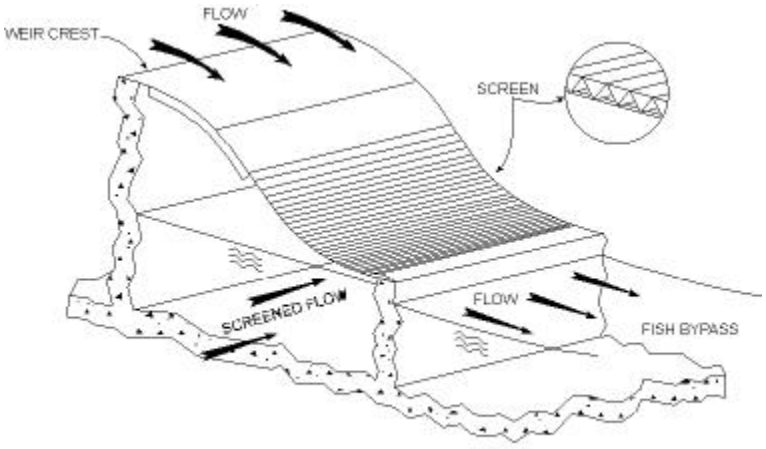


Figure 7-6 –Coanda Screen
Source: *Fish Protection Guidelines for Washington State (Draft)*. Washington State Department of Fish & Wildlife (2000).

Summary

Table 7-3 provides a summary of the advantages and disadvantages of each of the discussed screen alternatives.

Table 7-3 – Summary of Screening Alternatives

	Advantages	Disadvantages
Flat Plate	• Effective barriers to fish entrainment. • Do not require a controlled operating water depth • Proven cleaning capability that removes debris from the screen. • No moving parts, thus minimizing maintenance and reducing capital and maintenance costs. • Widely applied and proven and is accepted by fishery resource agencies.	• Mechanical screen cleaners required maintenance and add to both the capital and operating cost of the structure. • Shallow depths caused by low flow rates can result in excessively long screens to meet screen area requirements.
Drum	• Considered self-cleaning and have excellent debris handling characteristics. • Proper cleaning is independent of the bypass flow. • Widely applied; have an excellent performance record; and are accepted by fishery resource agencies.	• More complex design and bypass structure increasing capital cost. • Requires well-regulated and stable water surface elevations • Increased maintenance requirements due to moving parts and seals • Power requirements.
Traveling	• Excellent debris handling characteristics. • Are commercially available with reduces design costs. • Do not require a controlled operating water depth for proper cleaning • Widely applied; have an excellent performance record; and are accepted by fishery resource agencies.	• Increased maintenance requirements due to moving parts and seals • Special fabrication may be required to prevent fish passage between the screening trays or baskets and to prevent fish from being trapped on the lips of the basket frames. • Power requirements.
Inclined	• Provide effective screen surface areas even with shallow flow applications. • Simple design with few or no moving components, thus minimizing maintenance and reducing capital and maintenance costs. • Proven cleaning capability that removes debris off the screen.	• Sediment and debris may be a major problem because the inclined screen is a bottom type screen. • The diverted flow rates may vary as a function of water surface and screen fouling. • The intake channel may require dewatering capability for maintenance. • The concept may be considered developmental by fishery resource agencies.
Horizontal Flat Plate	• Effectively applied at shallow in-river diversion sites. • Simple design with no moving parts, thus minimizing maintenance and reducing capital and maintenance costs. • Offer a cost effective positive barrier screen concept that complies with fishery resources.	• Debris and sediment handling characteristics are not fully proven and may be a problem. • Diversion flow rates will vary as a function of water surface elevation and screen fouling. • The concept may be considered developmental by fishery resource agencies.
Coanda	• Good self-cleaning characteristics that minimize maintenance requirements. • Relatively compact and includes no moving parts. • Effectively used to exclude sediment from the diversion.	• Required several feet of head drop. • A substantial amount of bypass flow may be required. • Fish injury and mortality characteristics of the screen have not been fully evaluated and documented. • The concepts may be considered developmental by fisheries resource agencies.

7.3 Screen Location

The placement of a diversion structure will limit the type of fish protection screen that can be used, will influence O&M requirements of the design, and strongly influence both capital and maintenance costs. Careful selection can lead to simplification of the structure, improved fish exclusion and fish guidance, reduced maintenance demands, and lower costs.

The general preference of fishery resource agencies is to maintain fish in the natural water body and not draw them into the diversion. Issues such as shallow depths; high river gradients; heavy sedimentation; potential for damage by large debris and ice; and construction difficulties (cofferdams, site dewatering, and construction windows) often force placement of exclusion screens in the diversion canal. When this is the case, the fish are diverted through a "bypass" that safely returns the excluded fish to the water body from where the water was diverted.

Placement of the structure and configuration of transition structures will strongly influence generated flow patterns. The overall hydraulic features of the location, including flow patterns, velocity magnitudes, and fish guidance at and past the screen and bypass, are of paramount importance in the design. These features are critical to ensuring effective fish and debris movement as well as reducing the risk of predation. Objectives typically are to sustain uniformly directed, eddy-free flows that efficiently guide fish pass the screen.

Site selection considerations will need to address:

- Hydraulic requirements
- Minimization of predation from all fish, two and four legged animals, and birds
- Operation and maintenance costs
- Injury to fish
- The need to keep fish in the river or return fish to the river as soon as possible

Because the City does not own the area where the new diversion structure will be constructed, the issue of easements must be addressed. The City recently secured an easement for its water treatment plant and impoundment area from the Olympic Resource Company. This easement included the area for the expanded area of the impoundment. The new diversion should be constructed within this easement to ensure the City has legal access to the site for construction and O&M requirements.

Siting Options

In general, there are four siting options available for placement of fish exclusion. These alternatives include in-canal, in-river, in-diversion pool, and closed-conduit. Each siting alternative includes specific features that are required to make the site functional. Table 7-4 provides a brief description of each of these siting alternatives as well as their respective advantage and disadvantages.

Table 7-4 – Summary of Diversion Site Alternatives

	Description	Advantages	Disadvantages
In-Canal	Water is generally diverted from a stream or river using a diversion dam. Fish entering the canal are then guided through a bypass fish exclusion facility where they are returned to the river.	• Operates in a controlled environment away from floods, heavy debris, and heavy sediment loads. • Provides for an isolated construction site using cofferdams or diversion channels, depending on the water diversion season. • Provides in-canal fish rearing opportunities for canals with year-round water. • Provides maintenance access if there is a non-operating period.	• Fish are taken from their natural habitat and diverted with the flow and then returned to the stream. • If the diversion season does not allow sufficient shutdown to allow construction, a parallel isolated canal may have to be constructed to allow continued diversions during the construction period.
In-River	Fish exclusion facility is the first element of the diversion that the fish encounter. The facility may be placed in the river channel but, more likely, at the river bank. Since fish remain in the river, a bypass structure is normally not required.	• Fish remain in river, consequently, required fish handling and fish contact with the facility is minimized. • A fish bypass may not be required. • It is possible to leave all encountered debris in the river, thus minimizing debris handling and transport. • A trash rack structure may not be required.	• The design must be more robust and allow for operating under a broader range of river flow conditions and severe loading. • Construction may require use of a cofferdam with site dewatering. • The screen structure will be difficult to dewater for maintenance access.
In-Diversion Pool	As with an in-river placement, the in-division pool fish exclusion facility is the first element the fish encounter during the water diversion.	• Fish remain in their natural habitat in the pool and/or river. Consequently, fish guidance structures may not be required. • Debris encounter in the pool can often be flushed downstream. • A deeper flow section in the pool can provide a more compact design of the fish exclusion facility.	• The design must be more robust and allow for operating under a broader range of river flow conditions and severe loading. • Construction may require use of a cofferdam with site dewatering • The facility could require a special configuration to generate effective sweeping flow across the screen face for fish guidance and debris transport to the bypass.
Closed Conduit	Consist of a flat screen panel placed on a diagonal to the flow within a circular or rectangular cross-sectional conduit. The fish intercepted by the screen are guided to a fish bypass conduit that releases them to the river below the diversion dam.	• The screen is compact, which can reduce screen structure cost. • The back-flush cleaning design to-date has been proven effective and mechanically simple. • Cost associated with maintaining and operating the facility is low. • Typically, the site can be isolated and dewatered for construction and maintenance by closing existing gates.	• The concept is still considered experimental by some fishery resource agencies. • Construction likely will require suspension of diversion. • Access to the screen for inspection or maintenance is limited and requires dewatering of the conduit. • Fish exclusion is not provided during the back-flush screen cleaning process.

Source: *Fish Protection at Water Diversions*. U.S. Department of the Interior (April 2006).

7.4 Alternative Design Development

The preceding section described six screening devices including a brief discussion of the advantages and disadvantages of each alternative. Although all of these screens could likely be effective in meeting the operational needs of the City, some would be more appropriate for this specific application and thereby better achieve the overall goals of the project.

This purpose of section is to identify the screen alternatives that are the most appropriate for this specific application and develop three alternatives for the City's diversion structure, including preliminary designs and cost estimates for designs. A recommendation for the final design will be made based on a comparison of these developed alternatives.

Initial Assessment

In order to identify which screen alternatives to furthered considered, an initial assessment of the six screening options was performed. This assessment evaluated each option with respect to their ability to meet project goals. To a large degree, this initial assessment based on the generalized advantages and disadvantages of each screen as discussed in Section7.2 in the context of the project site conditions as described in previous sections of this report.

A matrix evaluation, that includes a variety of weighted design criteria, is used to rank each of the screen alternatives. The most important selection criteria received the most weight while less important criteria received less weight.

A brief summary of the criteria used in this analysis is provided below:

1. Fish Protection (25 pts) – The purpose of including the fish screen as part of the diversion structure is to protect Coho salmon and other fish from entering the City's impoundment, which could result in possible harm to the fish. All six screens are designed to meet State and Federal screen criteria, however, some screens have a longer track record and are considered to be an accepted fish screening device by the fisheries resource agencies. Other screens are view to be developmental by fisheries resource agencies, which may make approval of design more difficult. Also, some screens require more careful design and maintenance to ensure effective fish protection.

2. Capital Costs (25 pts) – The City has limited financial resources. The final design must provide a cost-effective solution to achieving the City's operational goals while meeting State and Federal design criteria. Screens that are likely to have the lowest capital cost are given the highest score.

3. O&M Requirements (20 pts) – It is desirable for the final design to have relatively low O&M requirements. O&M requirements include both personnel and cost factors, both of which are limited resources to the City. Factors affecting O&M include cleaning mechanism, power requirements, maintenance and wearing parts, and accessibility. Screens with low probable O&M requirements are weighted higher.

4. By-Pass Requirements (20 pts) – The City wishes to divert as much water as permitted for its municipal usage. Low summer flows often limit these diversions. Additionally, some of the screen alternatives require a significant amount of continuous by-pass water for proper operation. This would reduce the already limited stream flows.

5. Land Requirements (10 pts) – Any alternative must be able to fit within the limited area available for the new diversion. Furthermore, part of the overall objective of this project is to increase the volume of the impoundment. Screening devices that require large footprints will reduce the available area to expand the impoundment.

The initial assessment matrix is presented in Table 7-5. Based on the methodology used, the top ranked screening alternatives are Flat Plat (93 pts), Traveling Belt (89 pts) and Horizontal Flat Plate (83 pts). In order to make the final recommendation for screen design, preliminary designs, and cost estimates are developed for each of these screens.

Table 7-5 – Initial Assessment Matrix

Design Criteria	Max. Pts.	Weighted Scores for Each Screen Alternative					
		Flat Plate	Drum	Traveling Belt	Inclined Floor	Horizontal Flat Plate	Coanda
Fish Protection	25	25	24	25	22	22	20
Capital Costs	25	23	17	18	20	21	18
O&M Requirements	20	16	13	17	15	18	18
Bypass Requirements	20	20	15	20	15	15	15
Area Requirements	10	9	6	9	6	7	6
Total	**100**	**93**	**75**	**89**	**78**	**83**	**77**

Alternative 1 - Flat Plate Screen

The flat plate fish screen scored the highest of all possible alternatives in the initial assessment (Table 7-5). A preliminary design incorporating this type of screen is shown in Figure 7-7.

The diversion structure would consist of a concrete wall and abutment located along and parallel to the creek bank. To improve screen hydraulics, the bank opposite the screen may be reconfigured with a riprap revetment to create a natural scour pool adjacent to the structure. The flat plate screen draws flow from the side of the pool, perpendicular to the normal direction of stream flow, regardless of stage. Downstream grade control would maintain minimum pool elevation. This design does not require fish or flow by-pass. Debris, including large wood debris, will also pass much more readily pass by the structure.

Flat plate screens may be aligned vertically or on an incline. Both the vertical and inclined flat plate screens are fixed and function identically, however inclined flat plate screens are typically better to operate in areas having high debris loads. This is because debris rides up on the screen much more readily than a vertical screen making them fairly easy to clean using a simple rake, manual brush or with air burst nozzles.

An adjustable head gate will be provided and installed directly behind the screen. This gate will not only act to regulate flows entering the diversion, but also help generate uniform flow across the screen. The gate will be automated and connected to the City's SCADA system for remove operation.

Table 7-6 provides a detailed cost estimate for this alternative. As this table shows, the total cost for the new diversion is estimated at $76,500. In addition to the flat plate fish screen, this cost also includes required site work, dewatering, electrical, controls, and necessary piping to deliver diverted water to the City's impoundment. These costs are for preliminary planning used as a basis to compare the economic impact of various design alternatives and are subject to change.

Table 7-6 – Flat Plate Screen Cost Estimate

Item	Description	Unit	Quantity	Unit Cost	Total
1	Mobilization, Bonding, & Insurance	LS	1	$ 4,000	$ 4,000
2	Site Work	LS	1	$ 2,000	$ 2,000
2	Dewatering & Coffer Dam	LS	1	$ 5,000	$ 5,000
3	Diversion Structure**	LS	1	$ 30,000	$ 30,000
4	Electrical & Controls	LS	1	$ 5,000	$ 5,000
5	Diversion Pipe to Impoundment & Outfall	LS	1	$ 3,500	$ 3,500
6	In-River Water Level Control	LS	1	$ 1,500	$ 1,500
		Subtotal			$ 52,200
		Contingency (20%)			$ 10,440
		Construction Subtotal			$ 62,640
		Engineering (20%)			$ 12,528
		Administration & Legal (5%)			$ 3,132
		Total			**$ 76,500**

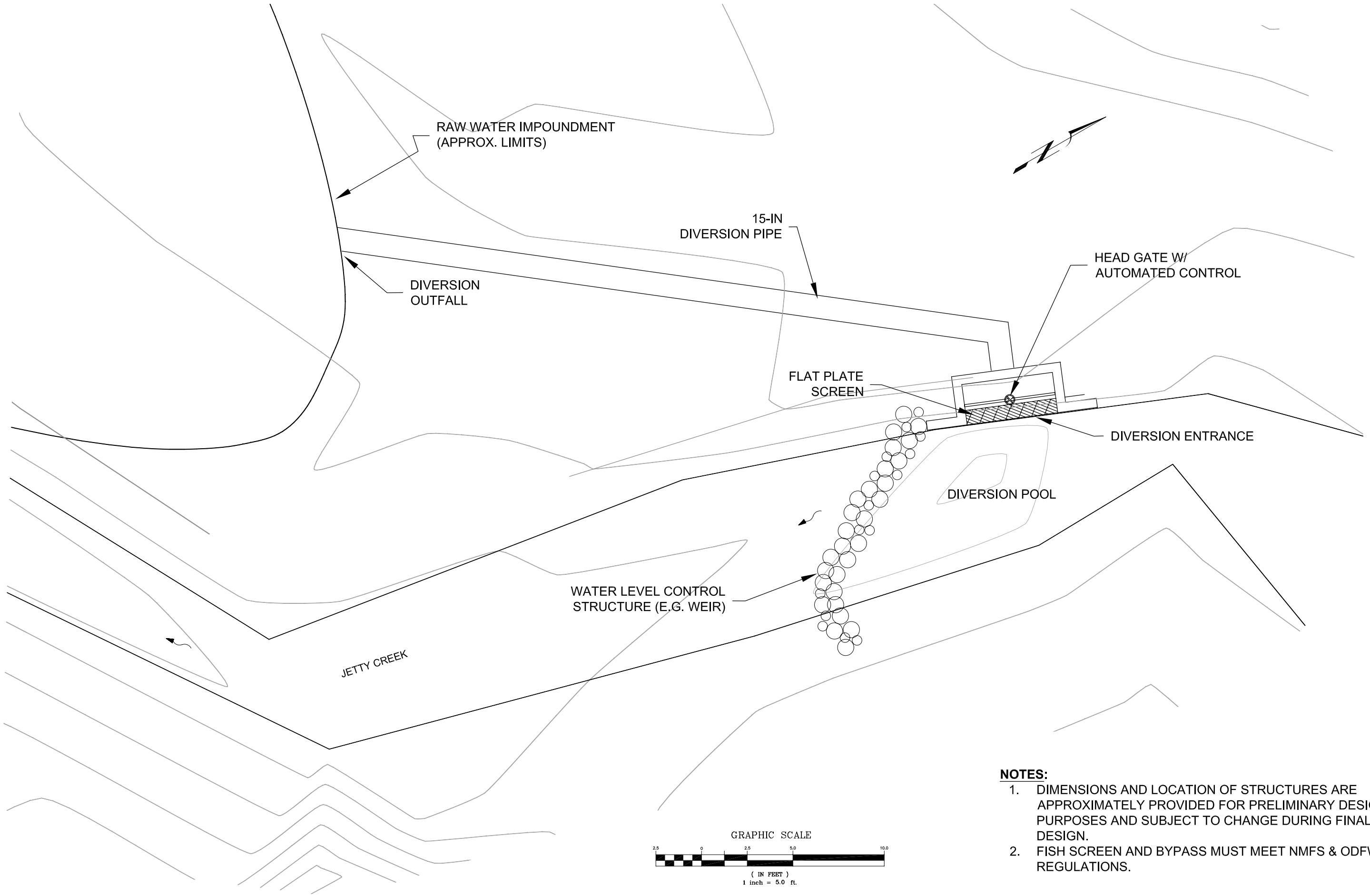
** Including flat plate screen, gate, cleaning system

Flat Plate Screen Advantages:

- Low operation and maintenance requirements
- Small footprint
- Considered a proven technology by regulatory agencies
- Low construction costs
- Does not require fish bypass
- Excellent debris handling capabilities

Flat Plate Screen Disadvantages:

- Requires electrical and mechanical components, increases construction costs
- Mechanical components will require some additional maintenance



GRAPHIC SCALE

2.5 0 2.5 5.0 10.0

(IN FEET)
1 inch = 5.0 ft.

NOTES:

1. DIMENSIONS AND LOCATION OF STRUCTURES ARE APPROXIMATELY PROVIDED FOR PRELIMINARY DESIGN PURPOSES AND SUBJECT TO CHANGE DURING FINAL DESIGN.
2. FISH SCREEN AND BYPASS MUST MEET NMFS & ODFW REGULATIONS.

H B H Consulting Engineers

City of Rockaway Beach
JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM RESTORATION FEASIBILITY STUDY

ALT #1 FLAT PLATE SCREEN

DRAWN BY: CLL

DATE: AUG 2010

FIG. 7-7

Alternative 2 - Traveling Belt Screen

The second alternative investigates incorporating a traveling belt screen to prevent fish from entering the City's new diversion structure. The design includes installing a traveling belt screen on the upstream side of the concrete diversion structure, parallel to the direction of flow and as flush as possible with creek banks. This design will keep fish in the creek, therefore no bypass structure will be required. A preliminary design for this alternative is present in Figure 7-8.

Similarly to the flat plate screen, flow is drawn from the creek by gravity through the traveling belt screen and into the City's impoundment. The rate of flow will be controlled via a sluice gate situated immediately downstream of the screen. This gate will also have the added benefit of helping to generate uniform flow across the screen by creating backwater conditions. The gate can be completely closed during peak storm events to prevent high turbidity creek water from entering the City's impoundment. By placing the gate behind the screen eliminates possibly trapping fish when the screen is closed. Operation of this gate could be performed manually or incorporated into the City's SCADA system.

A trashrack will be installed ahead of the traveling belt screen to provide screen protection from large debris while maintaining an effective near-bank sweeping flow across the screen face. To keep the trashrack clear of debris, the racks will require either manual hand raking or a mechanical type cleaning system. Smaller debris will be removed from diverted water by the traveling screen itself. Debris will be lifted out of the water as the screen rotates and then flushed by a water jet system into a trough. Both the trash rack and screen cleaning systems may include a debris conveyance system to transport the debris flushed from the trash trough to a desired deposit location.

Other design components of this alternative include: flow monitoring, water level sensors, telemetry, and alarms. Additionally, an in-river water level control structure (i.e. weir) will be constructed downstream of the screen to ensure that the City is able to divert its senior water right before allowing flows to pass downstream. The weir structure will be configured so that as flows increase beyond the City's water right, excess flows will spill over the structure to provide for the in-stream water right.

The estimated cost for this alternative is $93,000. A detailed cost estimate for the Traveling Belt Screen and its other design components is provided in the following table. These costs are for preliminary planning used as a basis to compare the economic impact of various design alternatives and are subject to change.

Table 7-7 – Traveling Belt Screen Cost Estimate

Item	Description	Unit	Quantity	Unit Cost	Total
1	Mobilization, Bonding, & Insurance	LS	1	$ 5,000	$ 5,000
2	Site Work	LS	1	$ 4,000	$ 4,000
3	Dewatering & Coffer Dam	LS	1	$ 5,000	$ 5,000
4	Diversion Structure **	LS	1	$ 36,000	$ 36,000
5	Electrical & Controls	LS	1	$ 7,000	$ 7,000
6	Diversion Pipe to Impoundment & Outfall	LS	1	$ 3,500	$ 3,500
7	In-River Water Level Control	LS	1	$ 1,500	$ 1,500
		Subtotal			$ 61,700
		Contingency (20%)			$ 12,340
		Construction Subtotal			$ 74,040
		Engineering (20%)			$ 14,808
		Administration & Legal (5%)			$ 3,702
		Total			**$ 93,000**

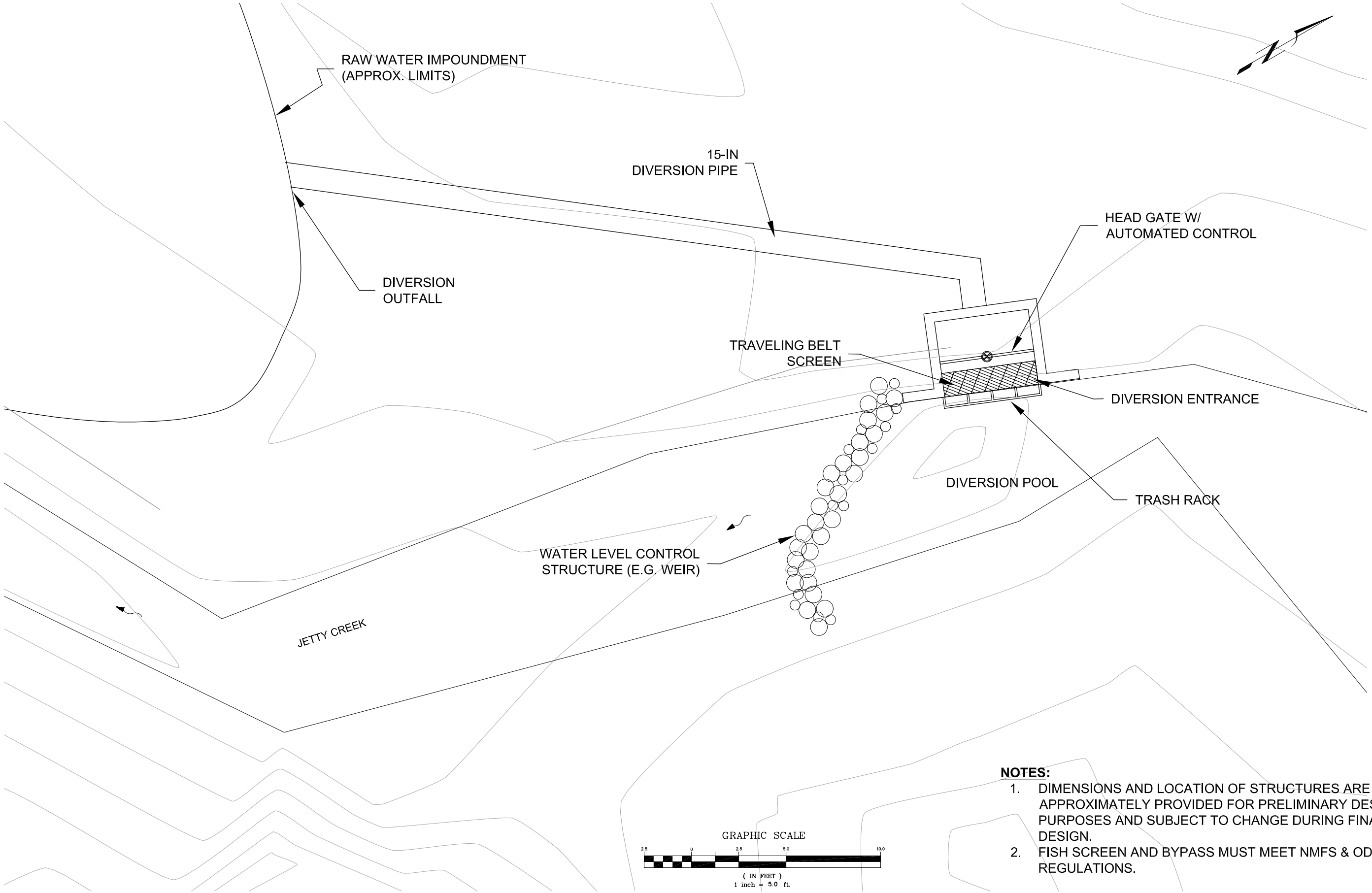
** Including traveling belt screen, gate, trash rack, cleaning system, etc.

Traveling Belt Screen Advantages:

- Does not require bypass
- Considered a proven technology by regulatory agencies
- Small footprint

Traveling Belt Screen Disadvantages:

- Higher capital costs
- Higher O&M requirements
- Mechanical components will require some additional maintenance
- Larger potential of damage from large debris



GRAPHIC SCALE

2.5 0 2.5 5.0 10.0

(IN FEET)
1 inch = 5.0 ft.

NOTES:

1. DIMENSIONS AND LOCATION OF STRUCTURES ARE APPROXIMATELY PROVIDED FOR PRELIMINARY DESIGN PURPOSES AND SUBJECT TO CHANGE DURING FINAL DESIGN.
2. FISH SCREEN AND BYPASS MUST MEET NMFS & ODFW REGULATIONS.

H B H Consulting Engineers

City of Rockaway Beach
JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM RESTORATION FEASIBILITY STUDY

ALT #2 TRAVELING BELT SCREEN

DRAWN BY: CLL

DATE: AUG 2010

FIG. 7-8

Alternative 3 - Farmers Screen

The second screen alternative investigated for the City's new diversion is a horizontal flat screen design patented by FCA. The screen would be situated in a diversion channel, which will require a fish bypass. A preliminary layout of this alternative is provided in Figure 7-9.

FCA provides prefabricated screens for diversions of 3 cfs or less. These screens are 3 feet wide and 20 feet long. In order to generate uniform flow across the screen, a 10-ft flume section will need to be installed immediately upstream of the screen. A head gate and trash rack would also be installed at the channels point of diversion from Jetty Creek.

This screen requires a constant bypass flow in order to maintain good cleaning characteristics and to ensure that fish passage is maintained. Minimum required bypass flow is approximately 0.5 cfs in order to provide the minimum 6-inch water depth over the screen. Fish are returned to the creek on the downstream end of the screen though a 10-inch conduit, which would be designed to meet NMFS bypass requirements.

The farmers screen is considered to be self cleaning, however, a trash rack would be provided to protect the screen from large debris. Since the entrance of the screen would be off channel, less large debris would be expected, and therefore, cleaning may be performed manually (with regulatory approval).

As with the other screen, an in-river control structure will need to be constructed to maintain required operating water level at the inlet of the screen. This design will include other components such of flow monitors, automated head gate, etc.

A detailed cost estimate for the farmers screen alternative is provided in Table 7-8. These costs are for preliminary planning used as a basis to compare the economic impact of various design alternatives and are subject to change.

Table 7-8 – Farmers Screen Cost Estimate

Item	Description	Unit	Quantity	Unit Cost	Total
1	Mobilization, Bonding, & Insurance	LS	1	$ 4,000	$ 4,000
2	Site Work	LS	1	$ 4,000	$ 4,000
3	Dewatering & Coffer Dam	LS	1	$ 5,000	$ 5,000
4	Diversion Structure**	LS	1	$ 28,000	$ 28,000
5	Fish Bypass Conduit & Outlet	LS	1	$ 1,500	$ 1,500
6	Electrical & Controls	LS	1	$ 2,500	$ 2,500
7	Diversion Pipe to Impoundment & Outfall	LS	1	$ 1,500	$ 1,500
8	In-River Water Level Control	LS	1	$ 1,500	$ 1,500
		Subtotal			$ 46,000
		Contingency (20%)			$ 9,200
		Construction Subtotal			$ 55,200
		Engineering (20%)			$ 11,040
		Administration & Legal (5%)			$ 2,760
		Total			**$ 72,000**

** Including FCA horizontal screen, gate, trash rack, etc.

Horizontal Flat Screen Advantages:

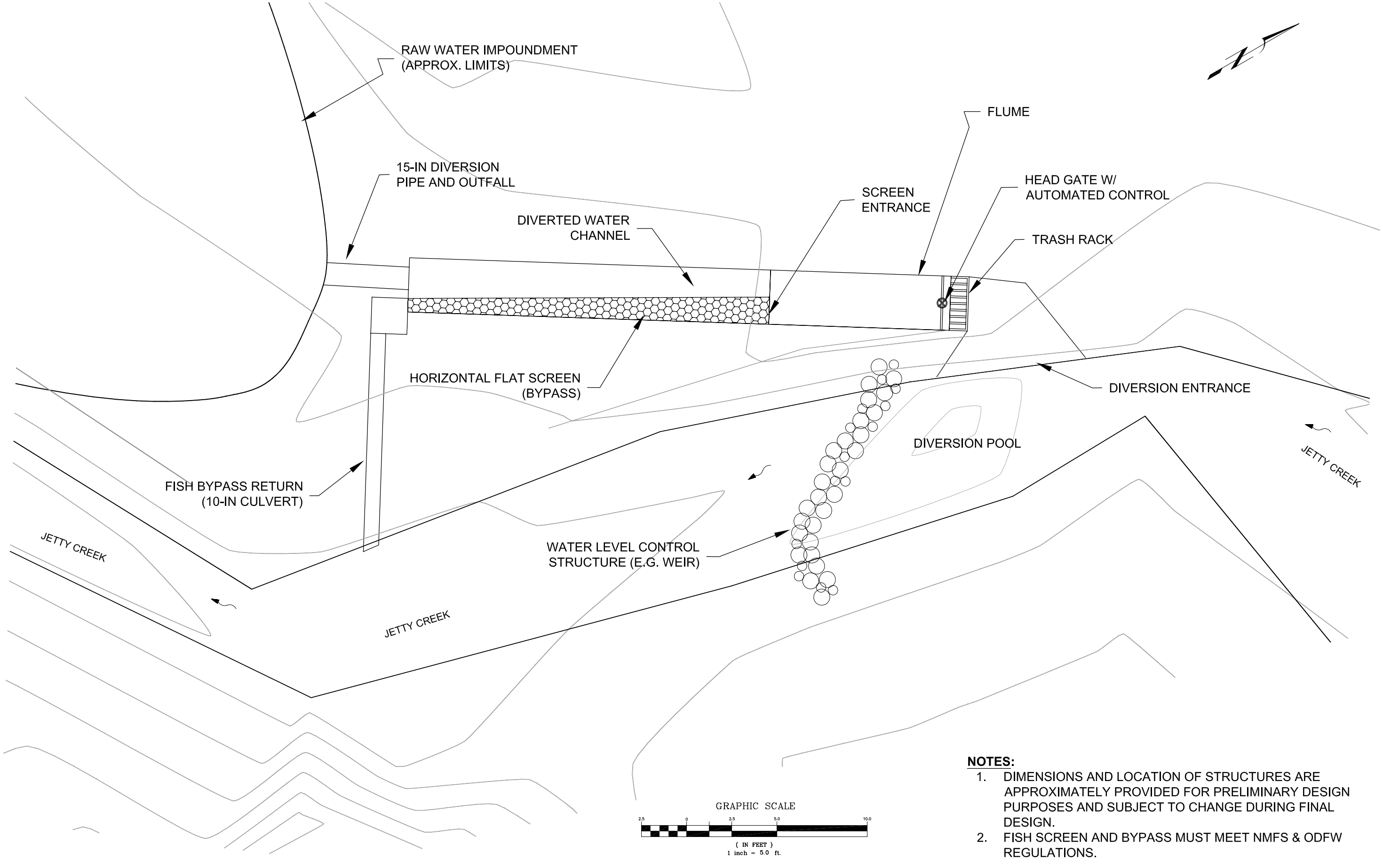
- Lowest capital cost.
- Low O&M requirements.
- No moving parts.

Horizontal Flat Screen Disadvantages:

- Requires continuous bypass flow, limiting available water for diversion.
- Requires fish bypass.
- Less operational flexibility.
- Low flows may limit City's diversion in order to maintain bypass requirements.
- Viewed as a developing technology by agencies.

Alternative Recommendation

Of the three design alternatives considered, flat plate screen, traveling belt screen, and horizontal screen; the flat plate screen is recommended for final design development. Although the horizontal fish screen has a lower capital cost, its approval by regulatory agencies is questionable. Overall, the flat plate screen meets all of the City's operational needs as well as State and Federal fish protection criteria in the most cost effective manner.



GRAPHIC SCALE

2.5 0 2.5 5.0 10.0

(IN FEET)
1 inch = 5.0 ft.

NOTES:

1. DIMENSIONS AND LOCATION OF STRUCTURES ARE APPROXIMATELY PROVIDED FOR PRELIMINARY DESIGN PURPOSES AND SUBJECT TO CHANGE DURING FINAL DESIGN.
2. FISH SCREEN AND BYPASS MUST MEET NMFS & ODFW REGULATIONS.

H B H Consulting Engineers

City of Rockaway Beach
JETTY CREEK IMPOUNDMENT IMPROVEMENTS & STREAM RESTORATION FEASIBILITY STUDY

ALT #3 HORIZONTAL FLAT SCREEN

DRAWN BY: CLL

DATE: AUG 2010

FIG. 7-9

SECTION 8

CONCLUSION

8.1 Summary of Findings

This *Feasibility Study* has investigated various considerations to the design and construction of the proposed *Jetty Creek Impoundment & Stream Restoration Project.* Some of the key findings of this report include the following:

Site Conditions & Constraints

- Proposed improvements could increase the holding capacity of the City's raw water impoundment from approximately 6,000 gallons to 300,000 gallons.

- The project will include restoration of approximately 280 feet of stream. Extensive excavation of relict streambed will be required due to accumulation of fill material deposited in the area.

- Soils primarily consist of alluvial sediment material.

- Depth to bedrock is unknown, however, core samples downstream of the project indicate depth to bedrock will likely exceed required depth for excavation.

Hydrology

- Stream flow in Jetty Creek display a high degree of fluctuation. Average monthly flows range from 2.0 cfs to 17.9 cfs. Flow duration curves for the period of record show the 10% exceedance probability flow is 20.9 cfs and the 95% exceedance probability flow is 1.2 cfs.

- A preliminary model for the restored relict creek channel show that fish passage criteria can easily be achieved with proper design. During low flows, channel depth was typically less than 0.5 feet. During peak flows, maximum water depth ranged from 1.8 feet (Q_2) to 3.1 feet (Q_{100}) with an average maximum depth of 2.4 feet.

Impacts on Biological Resources

- The project site is in an area listed as critical habitat for ESA listed Oregon Coast Coho salmon.

- Although this project is expected to have an overall beneficial impact, there may be some temporary and short-term adverse impacts that should be addressed. These potential impacts are related to localized and temporary increase in suspended sedimentation. Erosion control plans and work isolation will need to be integrated into final design to minimize these impacts.

- The restoration of the relict channel on Jetty Creek will reconnect the upstream and downstream reaches of Jetty Creek within the vicinity of the WTP. With proper design and construction, the relict channel will provide enhanced structural complexity and aquatic habitat in the vicinity.

- As a result of the restoration of the relict channel on Jetty Creek, an immediate benefit will be provided by removing a significant fish passage barrier and opening up 1.8 miles of stream channel to salmonid and other fish species.

Water Rights

- The City has two 1.0 cfs water rights on Jetty Creek. There is also an in-stream water right, which is senior to one of the City's permits.

- The City's existing 2.0 cfs water rights on Jetty creek is sufficient to meet current and projected maximum daily demands. However, during end of summer and early fall, water diversions are often limited due to low stream flows. During winter months, diversions are often restricted due to the high in-stream flow requirement.

- Constructing a new diversion would constitute a change in point of diversion as specified in the City's Jetty Creek water rights. Therefore, the City will need to transfer both of its water rights to the new diversion location.

- The City's junior water right is currently expired and needs to be extended. It is recommended that the City partially certify this permit and request a permit extension on the remaining portion.

- Because construction on the new diversion cannot begin until after a minimum of one of the City's water rights is approved. It is recommended that the City utilize the OWRD's Reimbursement Authority to expedite the process.

Final Design

- After an analysis of several fish screen alternatives, it is recommended that the City design its structure using a flat plate fish screen. Key design elements of the screen should include:
    - Screen material should be composed of wedge wire or profile bar material for increased strength and durability.
    - Provide an air burst cleaning system.
    - Concrete 'wall' and abutment adjacent to the channel and paired with a riprap revetment on the opposite bank to create a natural scour pool adjacent to the structure.
    - Head gate located behind fish screen. Gate should be able to be operated manually or remotely by integration into the City's existing SCADA system.
    - Downstream grade control maintains to minimum pool elevation.
    - Piping to deliver diverted water to the impoundment via gravity system.

- The estimated construction and design cost of the recommended diversion structure is estimated at $76,500. This does not include the cost of additional studies or obtaining necessary permits.

8.2 Permitting

State, Federal and local permitting requirements should be integrated into project design considerations as early as possible to avoid "surprises" that may result in project redesign, permitting delays, or construction delays. Understanding how the processes and regulations may affect the project and designing around them, will provide the most assurance of obtaining a permit in the simplest or quickest process possible with the least amount of bureaucracy.

Designing projects to have the least amount of impact (e.g. minimizing area of impact or secondary impacts like redirection of stream flows), utilize the softest approaches (e.g. use of wood, plantings or other natural elements and minimal use of rock or concrete), or provide some degree of environmental benefit (e.g. habitat restoration project) can not only improve the likelihood of permitting success but also facilitate quicker and easier permitting by qualifying for options.

Required permits for this project include:

- Joint Remove-Fill
- Water Quality Certification
- Archeological & Cultural Review
- Tillamook County Permits

More information on these permits is provided below.

Joint Remove-Fill Permit

Oregon Division of State Lands (DSL), under Removal-Fill Law (ORS 196.795-990) and the U.S. Army Corps of Engineers (Corps), under Section 404 of the Clean Water Act, regulate the removal and filling of materials in wetlands and waterways. The ordinary high water (OHW) of non-tidal freshwater stream or flowing water feature, represents the boundary of State and Federal jurisdiction under the State Removal-Fill Laws. Removal and fill activities that occur below the OHW will likely trigger the need for a State or Federal permits.

A Removal-Fill permit is typically required for projects involving 50 cubic yards or more of alteration of streambed, stream banks, or in wetlands. For projects located in essential salmon habitat waterways or State scenic waterways, any quantity of alteration requires a removal-fill permit. There are three forms of Removal-Fill authorizations:

- Individual Permit: Applies to projects with potentially significant impacts to waters.
- General Authorization: Provides expedited review process for certain categories of small projects. GAs are designed to provide simpler, faster review for minimal-impact projects whereas the Individual Permit process can be lengthy and require a lot of detailed information.
- Emergency Authorization: May be issued in very limited circumstances where there is an immediate threat to public health, safety, or substantial property.

This project may qualify for a General Authorization (GA) under the category of *Fish Habitat Enhancement.* The GA permit review provides expedited process for approved types of removal/fill activities that have fairly predictable effects and outcomes with minimal adverse effects to water

resources. If the project does not quality for GA, the City will need to obtain an Individual permit, which will require increased work to show that the proposed project will not have significant negative impacts on the area's waterways.

Wetland Delineation

A wetland determination and wetland boundary delineation will be required to determine what areas of the project site are subject to State Removal-Fill permit requirements and Federal Section 404 permit requirements. *Wetland determinations* assess only the presence or absence of wetlands and other waters of the State within a given site. A *wetland delineation* is a more detailed study that defines the boundaries of the wetland(s) within a site.

DSL was contacted in June 2010 to make a wetland determination for the project area. DSL conducted a site visit and reviewed soil data as well as the National Wetland Inventory (NWI) maps. Based on the site visit and soil information, DSL initial determined that there were not wetlands in the project vicinity. However, NWI maps indicated areas of Palustrine Forested Wetlands at the site and eventually determined that the project would require a wetland delineation.

A private consultant will need to prepare a wetland delineation for the project site. DSL will review and provide comment (as applicable) within 120 days of receiving the study. Because of the significant time involved with preparing, submitting, and DSL wetland delineation review, it is important that the delineation process be initiated early in the planning.

Section 7 Consultation

An ESA Section 7 consultation will be required as part of the removal-fill permit process as the project may affect Federal ESA listed species. It is likely that the project would require preparation of an individual Biological Assessment to evaluate project effects. As part of the CWA Section 404 and Removal-Fill Application, the Biological Assessment will be reviewed by the NMFS and United States Fish and Wildlife Service (USFWS). To avoid delays the consultation process should start as early as possible. It is anticipated that the project effects will result in a *not likely to adversely affect* determination

It may be possible for the City to avoid the timely Section 7 consultation and Biological Assessment requirement. The Standard Local Operating Procedures for Endangered Species (SLOPES IV) contains a programmatic biological opinion and incidental take statement. It is an agreement between the U.S. Army Corps of Engineers (Corps) and NMFS that, if used appropriately, allows projects to be permitted without going through individual Endangered Species Act Section 7 consultation. SLOPES provides a focus for discussion between NMFS, the Corps, and the City regarding ways to reduce or remove the adverse effects of regulated actions on ESA designated critical habitat. It is likely that this project could qualify for a SLOPES IV review; however, NMFS would need to be consulted early in the design process to ensure required elements are addressed.

Oregon Department of Fish and Wildlife Fish Passage

The ODFW is responsible for reviewing and approving projects that may affect fish passage for State Removal-Fill permits. An isolation and fish recovery plan will be required with the Removal-Fill permit submittals and implemented during construction. Fish capture and release efforts require a Scientific Sampling Permit from ODFW and NMFS.

ODFW, under its authority to manage Oregon's fish and wildlife resources, developed the Oregon Guidelines for Timing of In-Water Work to assist the public in minimizing potential impacts to important fish, wildlife, and habitat resources. The guidelines are based on ODFW district fish biologists' recommendations. Primary considerations are given to important fish species including anadromous and other game fish and threatened, endangered, or sensitive species. Time periods are established for in-water work to avoid the vulnerable life stages of these fish including migration, spawning, and rearing.

Clean Water Act (CWA), Section 401 Certification

Prior to issuance of the CWA Section 404 permit, the Oregon Department of Environmental Quality (DEQ) must certify that activities occurring in waters and wetlands comply with Federal water quality standards and requirements. As needed, protective measures would be incorporated into construction and operational plans, such as bank stabilization, treatment of stormwater runoff, spill protection, and fish and wildlife protection. This DEQ certification is processed concurrently with the CWA Section 404 and DSL Removal Fill permit application.

Adherence to the CWA Section 402 requires National Pollutant Discharge Elimination System (NPDES) stormwater (1200-C) and wastewater (1200-CA) permits from DEQ. A NPDES 1200-C is required for clearing, grading, and excavation that disturb one or more acres of land. This project will not likely disturb one or more acres of land, and a NPDES 1200-C permit will not likely be required.

Archeological & Cultural Review

A number of Federal and State laws (including Section 106 of the National Historic Preservation Act of 1966 (NHPA)) protect Oregon's historic properties, such as archaeological sites, historic structures, and other cultural resources. Any State water-related permit must take into account the historic properties that may be affected by the project. When a State agency permits an activity that may affect cultural resources, the agency must consult with the State Historic Preservation Office (SHPO).

SHPO Archaeological Service staff assists State agencies and their applicants in protecting historic properties in Oregon. This consideration process involves identifying if any historic properties exist within the project area, and if so, evaluating the eligibility of the historic properties and determining the effects the proposed project will have on those properties. If the project will have a negative impact on a significant historic property, the applicant and SHPO will explore alternatives to avoid, minimize, or mitigate the effects.

Additionally, federally-recognized tribes must be contacted and consulted regarding the potential impacts of the project on cultural resources in the area.

Tillamook County Permits

The project location is outside the city limits of Rockaway Beach, therefore, activity in the area is under the jurisdiction of Tillamook County. It is anticipated that this project will require obtaining a *Condition Use Permit* and *County Building Permit.* Also, a *Land Use Capability Statement (LUCS)* may need to be obtained. It is possible that these permits may require land use approval by the County. Although since there will be no change in land use, this seems unlikely.

8.3 Final Project Implementation

Final implementation of this project will require extensive coordination between the City, designers, permitting, regulatory, and funding agencies. In order to ensure that this project continues to move forward, it is important to complete addition tasks need for design and permitting requirements, estimate the total project costs, and identify funding sources.

Additional Studies & Tasks

A number of tasks must be completed before the final design of the project can be completed and construction can begin. Some of these tasks are required to provide critical information for project design. Other items are necessary as a result of permitting requirements. These additional studies and/or task include:

- Test Pits
- Slope Stability
- Sediment Transport Analysis
- Wetland Delineation
- Biological Assessment or SLOPES IV
- Water Right Permit Certifications & Transfers

As some of these items are time sensitive or require substantial review periods, it is critical that the City move forward in completing these tasks in a timely manner to avoid possible delays in the design and construction of the project.

Total Project Cost

In order for the City to determine the financial feasibility of the proposed project, a preliminary cost estimate for the entire project has been developed in Table 8-1. This estimate includes the cost for performing the abovementioned tasks and studies, as well as completing the design and construction of the project. The total estimated cost for the *Jetty Creek Impoundment Improvement & Stream Restoration projects* is approximately $295,500. It should be noted that if the City can utilize the GA Removal-Fill permit and SLOPES IV processes, permitting costs could be reduced by as much as $15,000. This would reduce total project cost to $280,500.

Table 8-1 – Total Preliminary Project Cost Estimates

Item	Description	Est. Cost
1	Test Pits & Slope Stability	$ 8,000
2	Wetland Delineation	$ 8,000
3	Water Rights	$ 6,000
4	Permitting[1]	$ 27,000
5	Stream Restoration	$ 120,000
6	Diversion Structure	$ 76,500
7	Impoundment Improvements	$ 50,000
Total		$ 295,500

[1] Assumes City must obtain an Individual Removal-Fill permit and complete a biological assessment

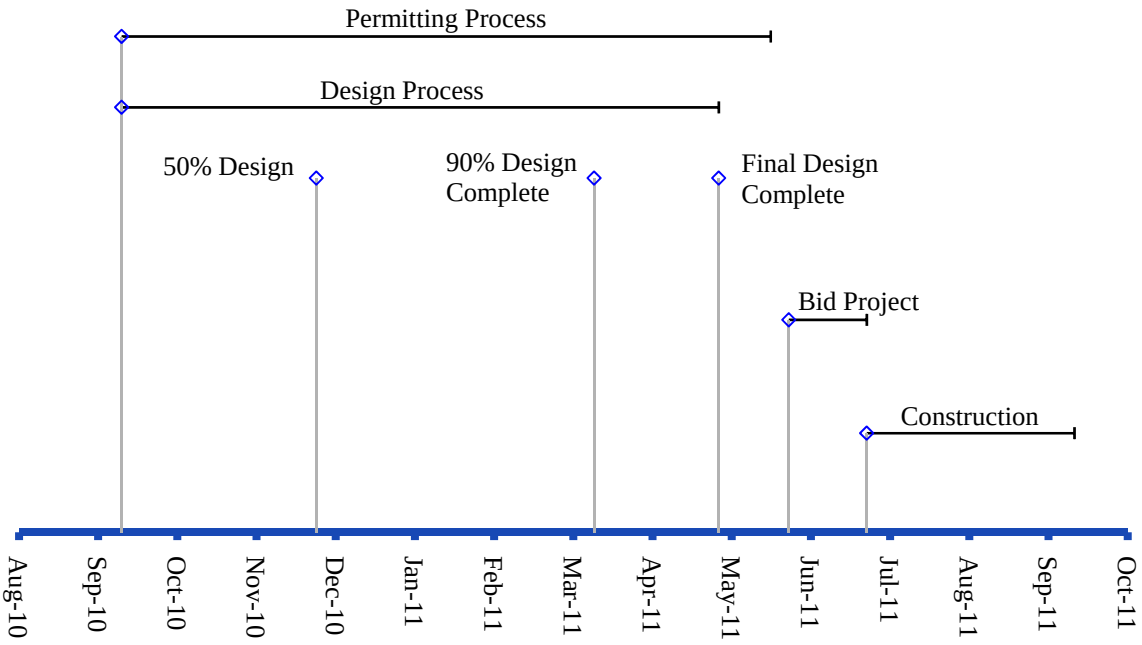
Project Timeline

An estimated timeline for completing the project is provided in Figure 8-1. This timeline assumes that work on both the permitting and design processes begin in October 2010. These phases of the project are expected to take five to six months to complete.

Permitting process timeline is largely dependent on whether or not the project qualifies for a GA Removal-Fill permit and if a Section 7 consultation can be avoided by using the SLOPES IV process. Assuming that both the GA, SLOPES IV, and OWRD RA processes are utilized, permits for the project should be approved by June 2011.

Based on this timeline, project construction could be completed during the summer of 2011. This would correspond to the in-water work period.

Figure 8-1 – Proposed Project Timeline



Project Funding

As mentioned at the beginning of this report, this *Feasibility Study* is partially funded by a grant from OWRD. The Lower Nehalem Watershed Council (LNWC) has also received grant money for the project from the Oregon Watershed Enhancement Board (OWEB) to complete 50% of design and begin the permitting process. Furthermore, the LNWC has recently applied for addition grant money from ODFW to complete project design.

In order to stay within the above timeline, additional funding will need to be obtained. The following table lists potential funding sources for the project. These grants require the City to provide a percent match for funding. However, as was done with the current OWEB grant, these matching funds can be from other grant money. This may allow the City to design, obtain all permits, and complete construction of the project using little of its own financial resources.

Table 8-2 – Potential Funding Sources

Grant	Agency	Maximum Grant	Match Requirements	Application Deadline
Fish Passage Grant	ODFW	$ 75,000	40%	Open
Fish Screening Grant	ODFW	$ 75,000	40%	Open
Open Rivers Initiative	NOAA	$ 3,000,000	50%	November
Restoration Grant	OWEB	Unknown	25%	April/October
Partners for Fish & Wildlife Program	USFW	$ 25,000	50%	Open

APPENDIX A

Soil Properties

United States Department of Agriculture

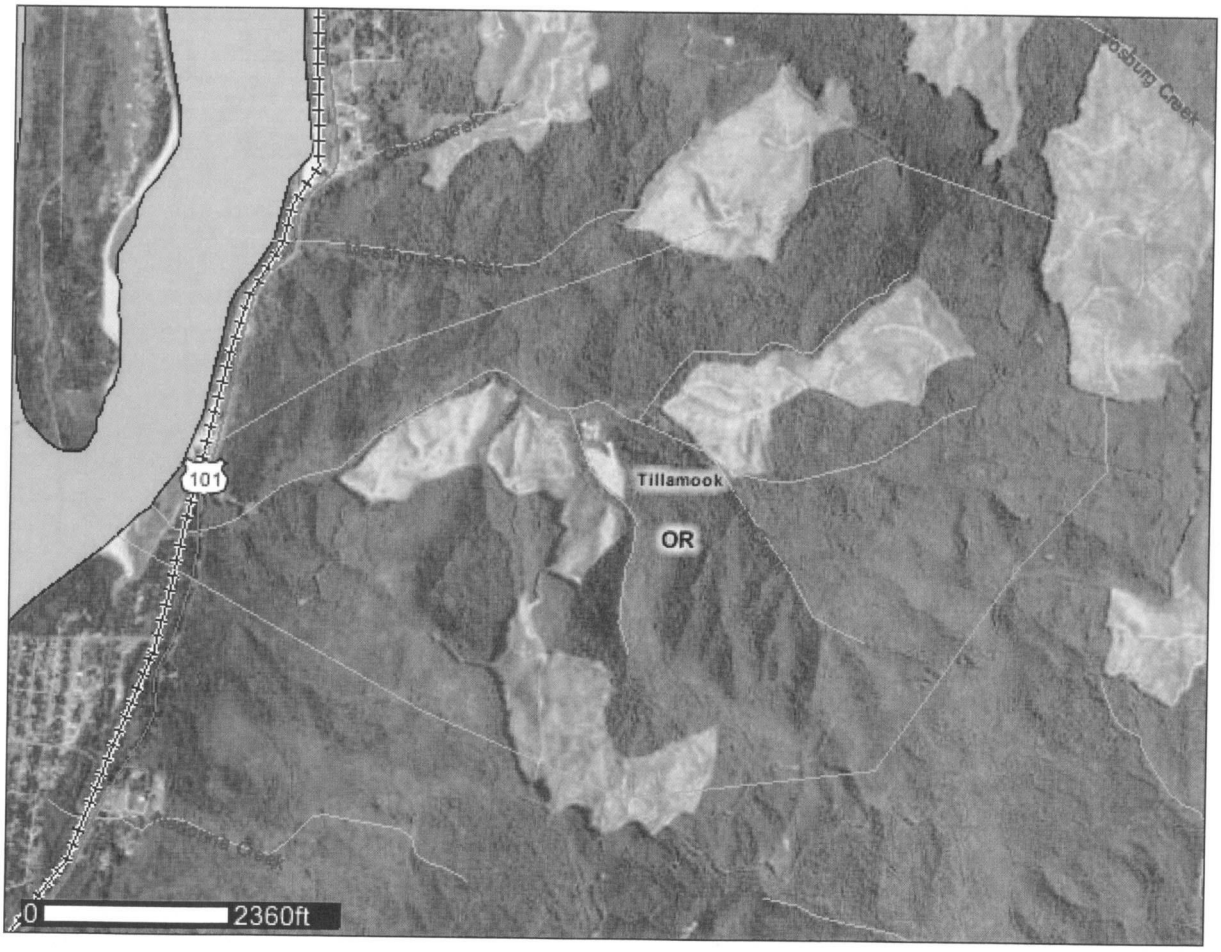
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

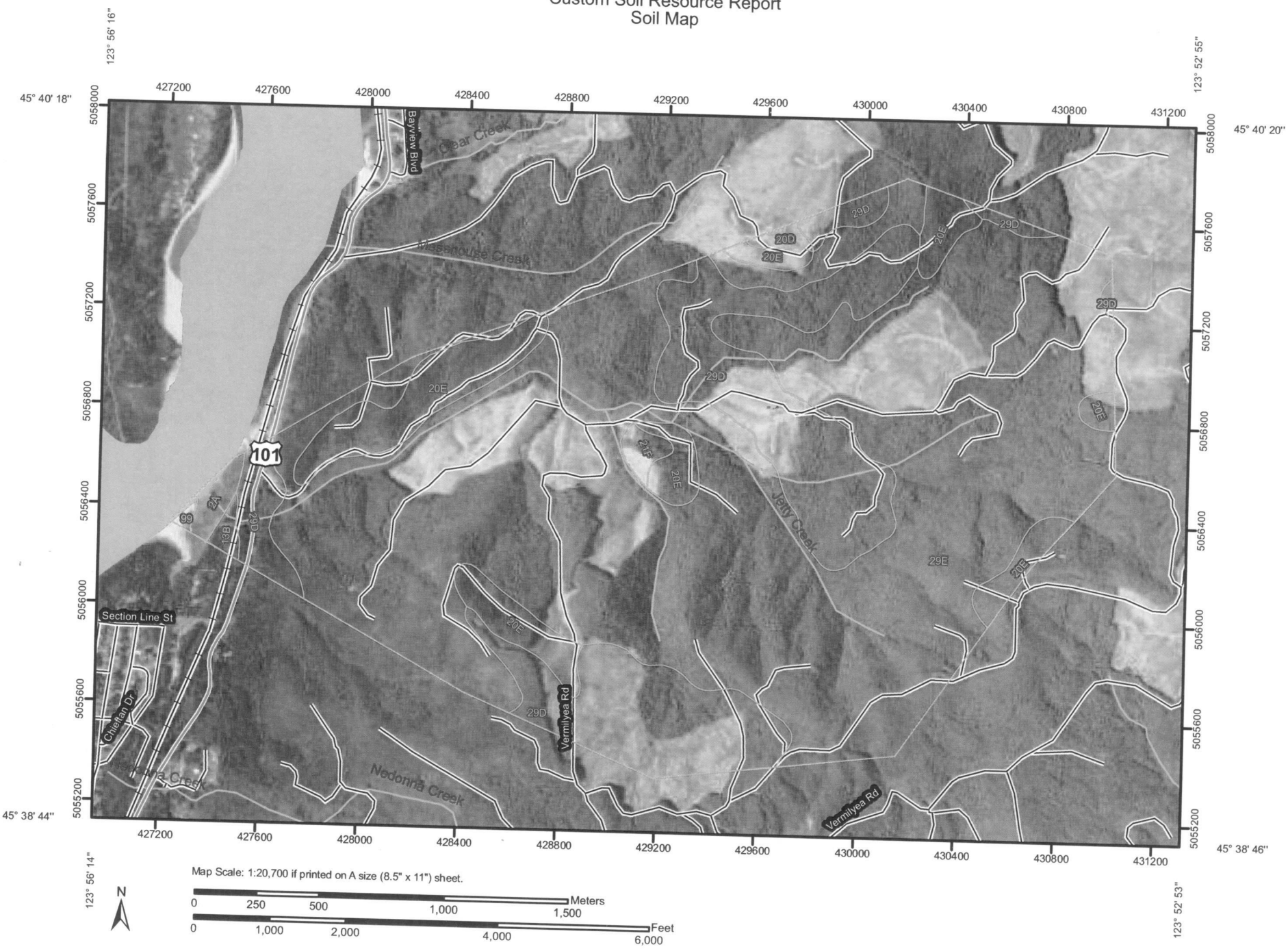
Custom Soil Resource Report for Tillamook County, Oregon

Jetty Creek Watershed



November 2, 2009

Custom Soil Resource Report
Soil Map



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Units

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other

Special Line Features
- Gully
- Short Steep Slope
- Other

Political Features
- Cities

Water Features
- Oceans
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

MAP INFORMATION

Map Scale: 1:20,700 if printed on A size (8.5" × 11") sheet.

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for accurate map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 10N NAD83

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Tillamook County, Oregon
Survey Area Data: Version 2, Aug 12, 2009

Date(s) aerial images were photographed: 7/17/2005

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Tillamook County, Oregon (OR057)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
2A	Fluvaquents-Histosols complex, 0 to 1 percent slopes	8.7	0.6%
13B	Waldport,thin surface-Heceta fine sands, 0 to 5 percent slopes	4.2	0.3%
20D	Klootchie-Necanicum complex, 5 to 30 percent slopes	4.2	0.3%
20E	Klootchie-Necanicum complex, 30 to 60 percent slopes	117.6	8.3%
21F	Necanicum-Ascar-Klootchie complex, 60 to 90 percent slopes	6.9	0.5%
29D	Templeton-Klootchie complex, 5 to 30 percent slopes	274.2	19.4%
29E	Templeton-Klootchie complex, 30 to 60 percent slopes	997.1	70.5%
99	Beaches	1.7	0.1%
Totals for Area of Interest		**1,414.7**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the

contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Tillamook County, Oregon

2A—Fluvaquents-Histosols complex, 0 to 1 percent slopes

Map Unit Setting

Elevation: 0 to 10 feet
Mean annual precipitation: 80 to 100 inches
Mean annual air temperature: 49 to 52 degrees F
Frost-free period: 180 to 300 days

Map Unit Composition

Fluvaquents and similar soils: 60 percent
Histosols and similar soils: 35 percent
Minor components: 3 percent

Description of Fluvaquents

Setting

Landform: Tidal marshes
Landform position (three-dimensional): Rise
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Estuarine deposits

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: 30 to 60 inches to strongly contrasting textural stratification
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 4 inches
Frequency of flooding: Very frequent
Frequency of ponding: Frequent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Available water capacity: Moderate (about 8.1 inches)

Interpretive groups

Land capability (nonirrigated): 5w
Other vegetative classification: Sitka spruce/oxalis, swordfern-moist (902), Sitka spruce/salmonberry-wet (903)

Typical profile

0 to 4 inches: Mucky silt loam
4 to 7 inches: Mucky silt loam
7 to 22 inches: Silt loam
22 to 25 inches: Sandy loam
25 to 45 inches: Loam
45 to 60 inches: Very gravelly sandy loam

Description of Histosols

Setting

Landform: Tidal marshes
Landform position (three-dimensional): Dip
Down-slope shape: Concave

Across-slope shape: Linear, concave
Parent material: Organic material over estuarine deposits; organic material and/or organic materials overlying alluvium and/or stratified organic materials and alluvium

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: About 0 to 7 inches
Frequency of flooding: Very frequent
Frequency of ponding: Frequent
Maximum salinity: Nonsaline to slightly saline (2.0 to 8.0 mmhos/cm)
Available water capacity: Very high (about 17.0 inches)

Interpretive groups

Land capability (nonirrigated): 5w
Other vegetative classification: Sitka spruce/salmonberry-wet (903)

Typical profile

0 to 7 inches: Mucky peat
7 to 13 inches: Muck
13 to 20 inches: Muck
20 to 32 inches: Mucky silt loam
32 to 60 inches: Mucky silty clay loam

Minor Components

Tidal flats

Percent of map unit: 2 percent
Landform: Tidal flats

Humaquepts

Percent of map unit: 1 percent
Landform: Tidal flats

13B—Waldport,thin surface-Heceta fine sands, 0 to 5 percent slopes

Map Unit Setting

Elevation: 10 to 50 feet
Mean annual precipitation: 80 to 100 inches
Mean annual air temperature: 49 to 52 degrees F
Frost-free period: 180 to 300 days

Map Unit Composition

Waldport, thin surface, and similar soils: 70 percent
Heceta and similar soils: 25 percent

Description of Waldport, Thin Surface

Setting

Landform: Dunes on marine terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Eolian sands

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.9 inches)

Interpretive groups

Land capability (nonirrigated): 6e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 3 inches: Fine sand
3 to 60 inches: Fine sand

Description of Heceta

Setting

Landform: Depressions on interdunes
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Eolian sands

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: About 0 to 1 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water capacity: Low (about 4.6 inches)

Interpretive groups

Land capability (nonirrigated): 4e

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 6 inches: Fine sand
6 to 61 inches: Sand

20D—Klootchie-Necanicum complex, 5 to 30 percent slopes

Map Unit Setting

Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days

Map Unit Composition

Klootchie and similar soils: 60 percent
Necanicum and similar soils: 25 percent

Description of Klootchie

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Mountaintop, mountainbase
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Colluvium and residuum derived from igneous rock and tuff

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Sitka spruce/oxalis, swordfern-moist (902), Western hemlock/oxalis-swordfern-moist (1907), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Medial silt loam
9 to 19 inches: Medial silt loam
19 to 44 inches: Medial silty clay loam
44 to 68 inches: Medial silty clay loam

Description of Necanicum

Setting

Landform: Mountain slopes

Landform position (two-dimensional): Summit, footslope
Landform position (three-dimensional): Mountainbase, mountaintop
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous rock and tuff

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.8 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Sitka spruce/oxalis, swordfern-moist (902), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 10 inches: Very gravelly medial loam
10 to 18 inches: Very gravelly medial loam
18 to 27 inches: Very gravelly medial loam
27 to 49 inches: Extremely cobbly medial loam
49 to 71 inches: Extremely cobbly medial loam

20E—Klootchie-Necanicum complex, 30 to 60 percent slopes

Map Unit Setting

Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days

Map Unit Composition

Klootchie and similar soils: 55 percent
Necanicum and similar soils: 30 percent

Description of Klootchie

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Center third of mountainflank, lower third of mountainflank
Down-slope shape: Concave

Across-slope shape: Linear, concave
Parent material: Colluvium and residuum derived from igneous rock and tuff

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Sitka spruce/oxalis, swordfern-moist (902), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Medial silt loam
9 to 19 inches: Medial silt loam
19 to 44 inches: Medial silty clay loam
44 to 68 inches: Medial silty clay loam

Description of Necanicum

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Upper third of mountainflank, lower third of mountainflank
Down-slope shape: Linear, convex
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous rock and tuff

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.8 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Sitka spruce/oxalis, swordfern-moist (902), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 10 inches: Very gravelly medial loam

10 to 18 inches: Very gravelly medial loam
18 to 27 inches: Very gravelly medial loam
27 to 49 inches: Extremely cobbly medial loam
49 to 71 inches: Extremely cobbly medial loam

21F—Necanicum-Ascar-Klootchie complex, 60 to 90 percent slopes

Map Unit Setting

Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days

Map Unit Composition

Necanicum and similar soils: 40 percent
Ascar and similar soils: 25 percent
Klootchie and similar soils: 20 percent

Description of Necanicum

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Center third of mountainflank, lower third of mountainflank
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Colluvium derived from igneous rock

Properties and qualities

Slope: 60 to 90 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.8 inches)

Interpretive groups

Land capability (nonirrigated): 7e
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 10 inches: Very gravelly medial loam
10 to 18 inches: Very gravelly medial loam
18 to 27 inches: Very gravelly medial loam
27 to 49 inches: Extremely cobbly medial loam

49 to 71 inches: Extremely cobbly medial loam

Description of Ascar

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Upper third of mountainflank
Down-slope shape: Concave, linear
Across-slope shape: Convex, linear
Parent material: Colluvium derived from igneous rock

Properties and qualities

Slope: 60 to 90 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.0 inches)

Interpretive groups

Land capability (nonirrigated): 7s
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Extremely gravelly medial loam
9 to 25 inches: Extremely cobbly medial loam
25 to 39 inches: Extremely cobbly medial loam
39 to 43 inches: Unweathered bedrock

Description of Klootchie

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Lower third of mountainflank
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Colluvium and residuum derived from igneous rock

Properties and qualities

Slope: 60 to 90 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability (nonirrigated): 7e

Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Western hemlock/Oregon grape-salal (1906)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Medial silt loam
9 to 19 inches: Medial silt loam
19 to 44 inches: Medial silty clay loam
44 to 68 inches: Medial silty clay loam

29D—Templeton-Klootchie complex, 5 to 30 percent slopes

Map Unit Setting

Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days

Map Unit Composition

Templeton and similar soils: 50 percent
Klootchie and similar soils: 35 percent

Description of Templeton

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Mountainbase, mountaintop
Down-slope shape: Concave, linear
Across-slope shape: Linear, concave
Parent material: Colluvium and residuum derived from sedimentary rock

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 14.9 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Sitka spruce/oxalis, swordfern-moist (902), Sitka spruce/salmonberry-wet (903), Western hemlock/oxalis-swordfern-moist (1907)

Typical profile

0 to 2 inches: Slightly decomposed plant material

2 to 15 inches: Medial silt loam
15 to 28 inches: Silty clay loam
28 to 43 inches: Silty clay loam
43 to 54 inches: Silty clay loam
54 to 59 inches: Paragravelly silty clay loam
59 to 69 inches: Weathered bedrock

Description of Klootchie

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Summit, toeslope
Landform position (three-dimensional): Mountaintop, mountainbase
Down-slope shape: Convex, linear
Across-slope shape: Convex, concave
Parent material: Colluvium and residuum derived from igneous rock and tuff

Properties and qualities

Slope: 5 to 30 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Sitka spruce/oxalis, swordfern-moist (902), Sitka spruce/salmonberry-wet (903)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Medial silt loam
9 to 19 inches: Medial silt loam
19 to 44 inches: Medial silty clay loam
44 to 68 inches: Medial silty clay loam

29E—Templeton-Klootchie complex, 30 to 60 percent slopes

Map Unit Setting

Elevation: 50 to 1,800 feet
Mean annual precipitation: 80 to 110 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 120 to 210 days

Map Unit Composition

Templeton and similar soils: 45 percent
Klootchie and similar soils: 40 percent

Description of Templeton

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Footslope, backslope
Landform position (three-dimensional): Lower third of mountainflank, upper third of mountainflank
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Parent material: Colluvium and residuum derived from sedimentary rock

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: 40 to 60 inches to paralithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very high (about 14.9 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Western hemlock/oxalis-swordfern-moist (1907), Sitka spruce/oxalis, swordfern-moist (902), Sitka spruce/salmonberry-wet (903)

Typical profile

0 to 2 inches: Slightly decomposed plant material
2 to 15 inches: Medial silt loam
15 to 28 inches: Silty clay loam
28 to 43 inches: Silty clay loam
43 to 54 inches: Silty clay loam
54 to 59 inches: Paragravelly silty clay loam
59 to 69 inches: Weathered bedrock

Description of Klootchie

Setting

Landform: Mountain slopes
Landform position (two-dimensional): Backslope, footslope
Landform position (three-dimensional): Center third of mountainflank, lower third of mountainflank
Down-slope shape: Linear, convex
Across-slope shape: Convex, concave
Parent material: Colluvium and residuum derived from igneous rock and tuff

Properties and qualities

Slope: 30 to 60 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water capacity: Very high (about 19.1 inches)

Interpretive groups

Land capability (nonirrigated): 6e
Other vegetative classification: Sitka spruce/salmonberry-wet (903), Western hemlock/oxalis-swordfern-moist (1907), Sitka spruce/oxalis, swordfern-moist (902)

Typical profile

0 to 1 inches: Slightly decomposed plant material
1 to 9 inches: Medial silt loam
9 to 19 inches: Medial silt loam
19 to 44 inches: Medial silty clay loam
44 to 68 inches: Medial silty clay loam

99—Beaches

Map Unit Setting

Elevation: 0 to 10 feet

Map Unit Composition

Beaches: 95 percent

Description of Beaches

Setting

Landform: Beaches

Properties and qualities

Slope: 0 to 3 percent
Depth to water table: About 0 to 72 inches
Frequency of flooding: Very frequent

Interpretive groups

Land capability (nonirrigated): 8

Typical profile

0 to 60 inches: Stratified sand to gravel

APPENDIX B

Geotechnical Report & Drill Logs

PBS | Engineering + Environmental

MEMORANDUM

DATE: December 4, 2009

TO: Mike Henry, PE
HBH Consulting Engineers

FROM: John E. Jenkins, CEG
Rick Thrall, PE

PROJECT NO: 72856.000

RE: Geotechnical Evaluation of the Jetty Creek Impoundment Feasibility Study
City of Rockaway Beach, Oregon

HBH Consulting Engineers (HBH) is working with the City of Rockaway Beach with regard to improvements at the Jetty Creek surface water source (Figure 1 – Site Location Map). Surface water from Jetty Creek is an integral part of the municipal water supply for the City. The attached "Preliminary Layout" (Figure 2) received from HBH shows existing facilities and proposed changes. The main components of the proposed improvements include re-directing Jetty Creek around the existing impoundment into a relict channel and increasing the storage volume in the impoundment.

This memorandum presents the results of the feasibility-level geotechnical evaluation completed by PBS Engineering + Environmental (PBS) for the proposed improvements and was completed as part of the Impoundment Feasibility Study that is currently in progress. As presented herein, PBS concludes that the improvements appear to be feasible, and we provide recommendations required for design-level efforts.

SUMMARY OF EXISTING FACILITIES AND PROPOSED IMPROVEMENTS

Currently, there is an existing diversion dam and fish ladder constructed in the channel of Jetty Creek (see the attached Figure 2 and Photos 1 to 12). The adjacent impoundment was created by excavation in the alluvial sediments that are present in the valley bottom. The treatment plant structures are located immediately downstream of the dam and water intake. The impoundment is prone to sedimentation as a result of storms, and the accumulated sediment reduces storage in the impoundment. PBS understands that sediment is removed on an annual basis in accordance with regulations. An unused and damaged 36-inch culvert is beneath the bank on the eastern side of the impoundment.

We understand the proposed improvements to the Jetty Creek facilities are designed to restore Jetty Creek to a more natural state and allow unimpeded fish passage. The improvements will simultaneously increase the water storage capacity and greatly reduce problems with excess sediment. The main elements include the following:

1. Direct Jetty Creek into a relict creek channel to bypass the impoundment and intake. This will require excavation into an existing terrace where the creek formerly flowed.

2. Construct a new diversion approximately 100 feet upstream of the existing impoundment. When open, the diversion structure will include a fish screen.

1310 Main Street, Vancouver, WA 98660
360.690.4331 Main
360.696.9064 Fax
www.pbsenv.com

3. Enlarge the area of the impoundment to increase the storage volume. Preliminary plans indicate the existing diversion dam will be raised 2 feet. Construction of a berm or wall will be necessary for the segment around the new diversion to be constructed on the gently-sloping surface adjacent to the creek. Retaining walls along the perimeter of the impoundment may also be necessary.

The above elements are depicted on the attached Preliminary Layout (Figure 2). See also Photos 5 through 12 that show the current conditions where these improvements are proposed.

GEOLOGIC SETTING

Jetty Creek is located in the Coast Ranges geologic province of Oregon. According to published geologic mapping by Wells and others (1994),[1] bedrock at the site consists of the Nestucca Formation of upper Eocene age (map unit Tn). This marine sedimentary rock unit is generally described as tuffaceous mudstone that is thin-bedded, laminated, and dark gray. This formation includes interbeds of graded arkosic and basaltic sandstone. The other local bedrock unit is the more recent intrusive basalt of the Grande Ronde Basalt of middle Miocene age (map unit Tigr). This basalt is not mapped along Jetty Creek; however, a large outcrop of basalt is present along the northern side of the treatment plant.

Landslides that form in the weak and deeply-weathered sedimentary bedrock or colluvium are common in the Coast Range's province. Regional scale geologic hazard mapping by Schlicker and Deacon (1972)[2] identified "landslide topography" along the southeastern slope in the Jetty Creek valley from the mouth up past the treatment plant area.

SITE RECONNAISSANCE OBSERVATIONS

Site reconnaissance was completed on November 4, 2009, by John Jenkins, a certified engineering geologist with PBS. The reconnaissance consisted of walking traverses around the existing impoundment and treatment plant and the surrounding area where improvements are proposed. Jetty Creek flows west to southwest in a relatively steep sided valley (Figure 1). The creek channel is approximately 10 feet wide and is cut into gently-sloping flood plains and alluvial terrace surfaces that are bordered by the steeper valley side slopes. The maximum width of the valley bottom in the impoundment area is approximately 180 feet. Except for the treatment plant and the bench that borders the impoundment of the western side, the area is vegetated with mature second-growth trees and underbrush. The bench is constructed, in part, with fill.

Except for an outcrop of hard, widely-jointed basalt bedrock on the slope immediately west of the treatment plant, bedrock was not observed in the site vicinity. The gently-sloping valley bottom and terrace surfaces are underlain by alluvium of undetermined thickness that overlies bedrock. According to Shawn Vincent, Public Works Director for Rockaway Beach, the original water intake at Jetty Creek consisted of collection pipes excavated into the creek alluvium where the existing impoundment is located. Mr. Vincent recalls that the excavation was to a depth of approximately 8 feet beneath the creek channel, and bedrock was not encountered to that depth. The topographic map indicates the bottom of the impoundment at the dam is at an elevation of approximately 293 feet, which is about 10 feet lower than the adjacent constructed bench to the west and 7 feet lower than the creek channel on the upstream side of the impoundment. Visible sediment in Jetty Creek is dominantly sandy gravel and cobbles. Exposures in the cut bank along the terrace surface on the eastern side show coarse-grained channel sediments that are overlain by several feet of fine-grained overbank sediments (see Photos 6 and 7).

The area of the relict channel where the Jetty Creek realignment is proposed consists of an elongated terrace surface that borders the steeper valley side slope. The surface topography is variable and irregular likely due, in

[1] Wells, R. E., Snavely, P. D., MacLeod, N. S., Kelly, M. M, & Parker, M. J. (1994). [Map]. Geologic Map of The Tillamook Highlands, Northwest Oregon Cost Range (Tillamook, Nehalem, Enright, Timber, Fairdale, and Blaine 15 minute Quadrangles), U. S. Geological Survey Open File Report 94-21.

[2] Schlicker, H. G., Deacon, R. J., Beaulieu, J. D., & Olcott, G. W. (1972). [Map]. Engineering Hazard Map of the Nehalem Quadrangle, Oregon, Scale 1:62,500. In *Environmental Geology of the Coastal Region of Tillamook and Clatsop Counties, Oregon.* Oregon Department of Geology and Mineral Industries, Bulletin 74.

part, to placement of fill from excavation of sediments from the impoundment. The western side of this feature is comprised of a ridge of fill that overlies the existing 36-inch culvert that will be removed according to current plans. A linear but discontinuous topographic swale, inferred to be the relict creek channel, runs through the central portion of the terrace. The proposed Jetty Creek diversion and restoration will follow this feature as shown on the Preliminary Layout figure. The maximum elevation along the alignment is approximately 310 feet, a difference in elevation of approximately 12 feet from the existing creek elevation at the point of diversion. Photos 9 through 11 show the terrace surface and location of the relict channel from southwest to northeast as viewed from a point on the side slope.

The location of the centerline of the proposed new channel is approximately 20 feet from the toe of the valley side slope at the closest point. The valley side slope above the terrace surface ranges between approximately 20 and 30 degrees in slope. As noted above, published regional mapping shows this slope to be landslide topography. The slope is hummocky, in part, and localized small scarps are present indicating marginal slope stability. For the most part, conifer trees are straight; although some trees are bowed or pistol butted, indicating local movement or soil creep is present.

GEOTECHNICAL FEASIBILITY ASSESSMENT AND RECOMMENDATIONS

New Jetty Creek Channel

The topographic survey indicates the elevation of the Jetty Creek channel at the upstream point of diversion for the proposed channel is 298 feet and the elevation at the downstream point from the dam is 293 feet. This is a drop of approximately 5 feet over a channel length of approximately 250 feet. Thus, the indicated channel gradient is 2.0% or 1.15 degrees. This is comparable to the existing channel gradient upstream and downstream. As noted above, the maximum current elevation in the proposed creek channel is 310 feet. At this point, the approximate channel bottom elevation will be 295 feet indicating an initial cut of approximately 15 feet. Geologic information indicates that the terrace is underlain by old river alluvium. Colluvium derived from erosion of the side slope may also be present. The depth to bedrock is unknown. It is possible that bedrock will be encountered within the required depth of excavation for the new channel. We infer that a groundwater system within the alluvium is present that is hydraulically connected to surface water in the creek.

Excavation and construction of the proposed Jetty Creek channel appears feasible. Subsurface explorations and geotechnical engineering studies are recommended to provide information on soil and groundwater conditions, evaluate slope stability, and to complete engineering analysis and provide recommendations required for design and construction. A series of test pits should be excavated along the proposed alignment and in the adjacent valley side slope to evaluate conditions. Test pits in the channel should be excavated to minimum depth of about 5 feet below the channel grade.

We have identified the following significant geotechnical issues to address:

- Erosion during high-flow periods: The banks should be stabilized with vegetation or possibly armored with rock to limit excess erosion. We recommend hydraulic analysis be completed to estimate stage and flow velocities for design storm events and identify to segments at greatest risk.

- Slope Stability of Valley Side: There is evidence of localized, relatively shallow slumping and soil creep on the side slope above the terrace. Slope stability analysis is necessary to evaluate whether construction of the creek channel in the terrace or enlargement of the channel as a result of erosion over time significantly reduces the factor of safety on the valley slope. Failure of the slope could block the channel that could result in a damaging debris flow.

Impoundment and New Diversion

According to the topographic map, the elevation in Jetty Creek at the proposed upstream new diversion for the impoundment is 298 feet. The limit of the new impoundment is shown on the Preliminary Layout (Figure 2). As noted, above current plans indicate raising the dam 2 feet. The western side of the proposed impoundment approximately coincides with the steeper valley side slope whereas most of the eastern portion would be

constructed along the edge of the terrace surface. The area encompassing the southwestern part of the proposed impoundment includes the current impoundment and associated un-vegetated bench. The bench is nearly level with a slight slope in the upstream direction. The northeastern (upstream) half of the proposed impoundment encompasses an existing terrace surface and flood plains along the river where the new diversion would be located at the northeastern corner.

The current plans indicate a berm or wall will be necessary for the northeast and north edge of the impoundment where it traverses existing gently sloping terrace surface. These structures need to be designed to resist failure against seepage forces and erosion during high flow periods. Depending on the depth and elevations for the impoundment (not indicated on plans we received) walls and slope stabilization may be necessary on the remaining perimeter of the impoundment to be located at the toe of the steeper valley side slope. Filling the existing diversion channel between the upstream point for the new Jetty Creek channel and the proposed edge of the impoundment will also be necessary.

If the height of the dam is 10 feet or greater or the volume of the impoundment is greater than 9.7 acre feet (3.15 million gallons) the dam safety rules promulgated by the Oregon Water Resources Department will apply.

The proposed plans for the impoundment appear feasible. Subsurface explorations and geotechnical engineering studies will be necessary to provide information to complete engineering analysis and provide recommendations required for design and construction. Subsurface explorations by test pits and possibly drilling will be needed to obtain data including depth and bedrock and rock quality characteristics that may be important to foundation design for the diversion structure or possible retaining walls.

Geotechnical Issues:

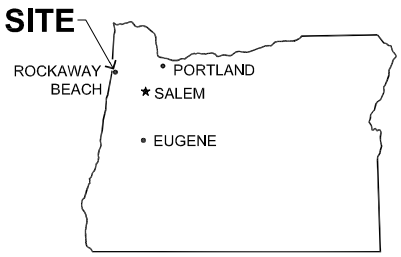
- Materials
- Stability of berms or walls (static and seismic)
- Erosion
- Seepage beneath the embankment

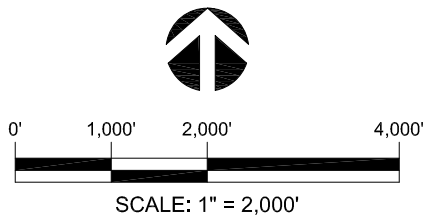
The main initial considerations would be surface preparation and disposal of strippings and borrow. Dealing with the unique issues related to dam design would also be required if the dam falls within the above-indicated statutory limits.

PBS appreciates this opportunity to provide our geotechnical services to you. Please feel free to contact us if you have any questions regarding this geotechnical evaluation.

Attachments: Figure 1 – Site Location Map
Figure 2 – Preliminary Layout
Site Photos 1 through 12

SOURCE: USGS NEHALEM QUADRANGLE, OR 1982, PHOTO REVISED 1985.





SCALE: 1" = 2,000'

Prepared for: CITY OF ROCKAWAY BEACH

PBS

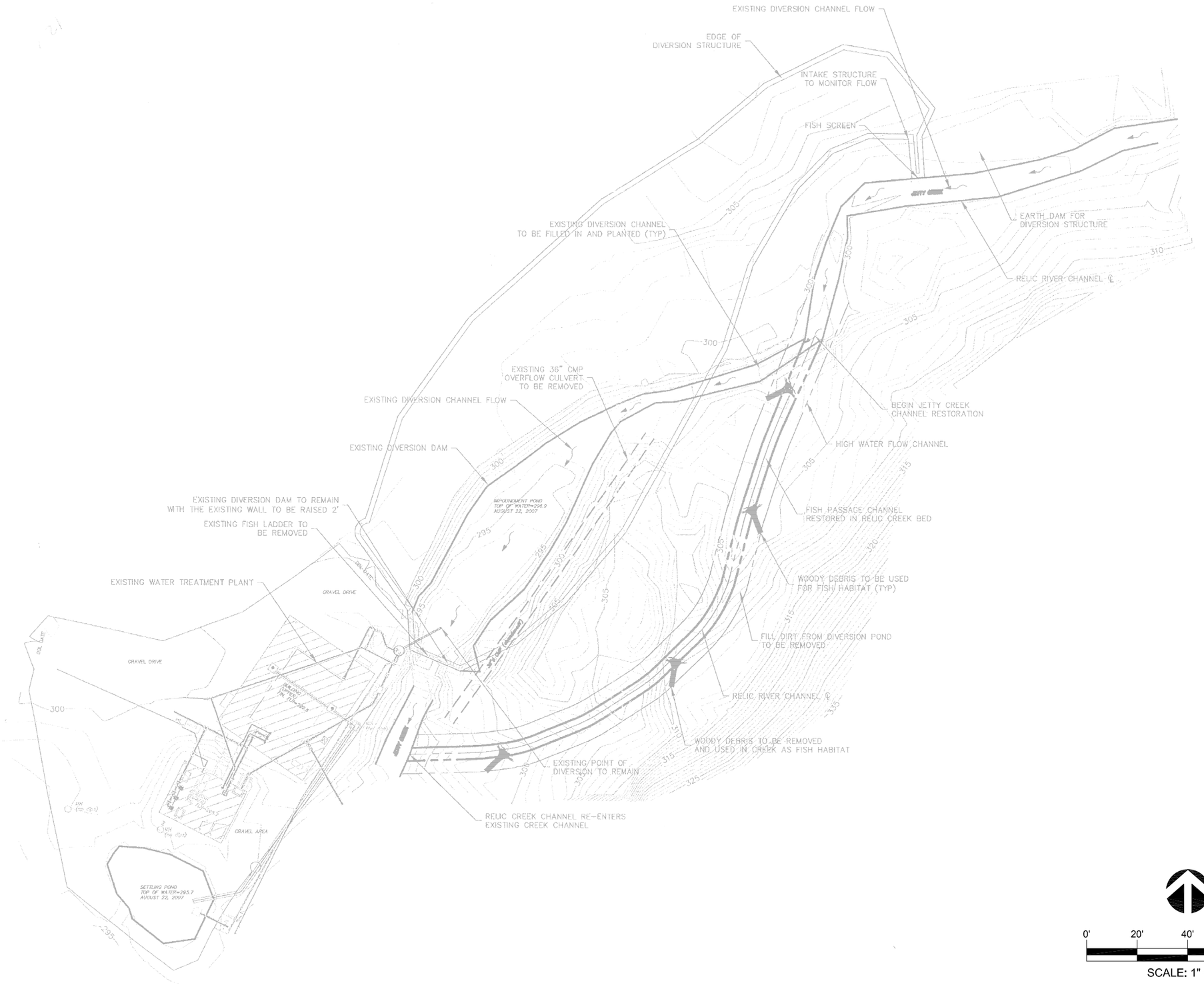
PROJECT #	DATE
72856.000	DEC 2009

SITE LOCATION MAP

JETTY CREEK IMPROVEMENT
ROCKAWAY BEACH, OREGON

FIGURE 1

L:\VANCOUVER\72000\72800-72899\72856_HBH-RockawayBeach WWTP\GeoDwg\72856_Fig1_SiteLoc.dwg Dec 04, 2009 04:48pm



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PRELIMINARY LAYOUT

JETTY CREEK IMPROVEMENT
ROCKAWAY BEACH, OREGON

PROJECT: 72856.000

DATE: DECEMBER 2009

FIGURE: **2**

Photo 1: View downstream in Jetty Creek showing current impoundment. Intake in front of dam structure and blue water treatment plant building. 36-inch culvert visible at lower left of photo (beneath ferns).

Photo 2: View to right of Photo 1 showing bench adjacent to existing impoundment. The proposed impoundment will include this area up to the toe of the valley slope at right of photo.

Photo 3: Current impoundment looking upstream. Proposed Jetty Creek channel to right side (east) of photo on the existing alluvial terrace surface.

Photo 4: Current dam and fish ladder at downstream end of impoundment. Outlet of a 36-inch culvert at middle-right of photo.

Photo 5: View east across current impoundment to old terrace and relict Jetty Creek channel. Ridge in middle-foreground is fill overlying the 36-inch culvert.

Photo 6: Older alluvium in older terrace exposed in bank showing coarse channel gravel and cobbles overlain by fine-grained overbank deposits. Location upstream of Photo 5.

Photo 7: View upstream on Jetty Creek. Proposed channel realignment to the right of fallen tree. New intake for impoundment to the left, past the green stream gauging structure, visible in left middle of photo.

Photo 8: View downstream on Jetty Creek. Blue treatment plant building visible in center background. Jetty Creek diversion to relict channel downstream of green stream gauging structure on left side (eastern) of the creek.

Photo 9: View southwest showing terrace surface where new Jetty Creek channel is proposed. Photo looking down from valley side slope above.

Photo 10: View northwest of central part of terrace surface where new Jetty Creek channel is proposed.

Photo 11: View north-northeast of terrace surface and toe of valley side slope. New Jetty Creek channel proposed on lower surface at left of photo.

Photo 12: Valley side slope above terrace surface. View northeast.

DRILL LOG

OREGON DEPARTMENT OF TRANSPORTATION

Project **US 101: Jetty Creek Culvert Replacement**		Purpose **Bridge Foundation**	Hole No. **DH 13-05**
Highway **Coast Hwy 101**		County **Tillamook**	E.A. No. **PE001114-000**
Hole Location Northing: **744,637.27**	Easting: **7,325,870.99**		Key No. **13807**
Equipment **CME-850**		Driller **Duffy**	Start Card No.
Project Geologist **Kleutsch**		Recorder **Kleutsch**	Bridge No. **20197**
Start Date **November 1, 2005**	End Date **November 1, 2005**	Total Depth **71.0 ft**	Ground Elev. **40.5 ft**
			Tube Height

Test Type
"A" - Advancer
"X" - Auger
"C" - Core
"N" - Standard Penetration Test
"U" - Undisturbed Sample
"D" - Oversize Split Spoon Sample

Rock Abbreviations

Discontinuity	Shape	Surface Roughness
J - Joint	Pl - Planar	P - Polished
F - Fault	C - Curved	Sl - Slickensided
B - Bedding	U - Undulating	Sm - Smooth
Fo - Foliation	St - Stepped	R - Rough
S - Shear	Ir - Irregular	VR - Very Rough

Typical Drilling Abbreviations

Drilling Methods	Drilling Remarks
WL - Wire Line	LW - Lost Water
HS - Hollow Stem Auger	WR - Water Return
DF - Drill Fluid	WC - Water Color
SA - Solid Auger	DP - Down Pressure
CA - Casing Advancer	DR - Drill Rate
HA - Hand Auger	DA - Drill Action

Depth (ft)	Test Type, No.	Percent Recovery	Soil: Driving Resistance / Rock: Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
0	ADV1	0			ADV- 1 (0.0-4.5) No Recovery.	**0.0 - 10.0 Sandy SILT to Clayey SILT with some wood fragments, ML, dark brown to mottled brown, low plasticity, moist to wet, medium stiff.; (Alluvium)**		HWT Advancer.	
5	N1	40	2-2-2	83	N- 1 (4.5-6.0) Sandy SILT with some wood fragments; ML; Dark Brown; Low Plasticity; Moist; Medium Stiff; Alluvium				
	ADV2	0			ADV- 2 (6.0-9.5) No Recovery.			Good Water Return, Brown Color.	
10	U1	100			U- 1 (9.5-10.0) Clayey SILT; Brown mottled; Wet; Torvane=0.45tsf; Alluvium	**10.0 - 18.0 Silty Gravelly SAND, SM, orange brown to mottled brown and grey, nonplastic to low plasticity, medium dense.; (Alluvium)**			
	N2	60	5-6-9	32	N- 2 (10.0-11.5) Gravelly Silty SAND; SM; Orange Brown; Nonplastic; Moist; Medium Dense; Alluvium				
	ADV3	0			ADV- 3 (11.5-14.5) No Recovery.				
15	N3	60	1-10-13	33	N- 3 (14.5-16.0) Silty Gravelly SAND; SM/SC; Grey and brown mottled; Low Plasticity; Wet; Medium Dense; Alluvium				
	ADV4	0			ADV- 4 (16.0-19.5) No Recovery.				
20	N4	53	13-17-20	18	N- 4 (19.5-21.0) Silty GRAVEL with some Sand; GM; Grey; Nonplastic; Wet; Dense; Alluvium	**18.0 - 28.0 Silty GRAVEL with some Sand, GM, grey, nonplastic, wet, medium dense to dense.; (Alluvium)**			
	ADV5	0			ADV- 5 (21.0-24.5) No Recovery.				
25	N5	47	8-10-6	19	N- 5 (24.5-26.0) Silty GRAVEL with some Sand; GM; Grey; Nonplastic; Wet; Medium Dense; Alluvium				
	ADV6	0			ADV- 6 (26.0-29.5) No Recovery.			Good Water Return, Brown Color.	
30	N6	53	3-3-5	77	N- 6 (29.5-31.0) Clayey SILT with some Sand and woody Organics; MH; Grey to dark grey; Medium Plasticity; Wet; Stiff; Alluvium	**28.0 - 35.0 Clayey SILT with some Sand and woody organics, MH, grey to dark grey, medium plasticity, wet, stiff.; (Alluvium)**			
	ADV7	0			ADV- 7 (31.0-34.5) No Recovery.				
35					N- 7 (34.5-36.0) Silty Sandy GRAVEL; GM; Grey;				

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
35	N7	67	6-10-10	23	Nonplastic; Wet; Medium Dense; Alluvium	**35.0 - 38.0 Silty Sandy GRAVEL, GM, grey, nonplastic, wet, medium dense.; (Alluvium)**			
	ADV8	0			ADV- 8 (36.0-39.5) No Recovery.				
40	N8	100	3-4-7	63	N- 8 (39.5-41.0) Clayey SILT to Sandy SILT with some wood to 1.5" size; MH/ML; Grey; Low to medium Plasticity; Wet; Stiff; Alluvium	**38.0 - 54.0 Clayey SILT to Sandy SILT with some to abundant wood locally, MH to OH, grey, nonplastic to medium plasticity, wet, stiff.; (Alluvium)**			
	ADV9	0			ADV- 9 (41.0-44.5) No Recovery.			Lost Water Return.	
45	N9	100	3-4-6	76	N- 9 (44.5-46.0) Clayey SILT to Sandy SILT with some to abundant wood; MH to OH; Grey; Nonplastic to medium plasticity; Wet; Stiff; Alluvium				
	ADV10	0			ADV- 10 (46.0-49.5) No Recovery.				
50	U2	80			U- 2 (49.5-51.5) SILT with Sand and Wood; MH; Grey; Wet; Alluvium				
	ADV11	0			ADV- 11 (51.5-54.5) No Recovery.				
55	N10	100	50/6"	16	N- 10 (54.5-55.0) SILTSTONE; Dark Grey; Fresh; Marine Sedimentary Rocks	**54.0 - 71.0 SILTSTONE, dark grey, fresh, R2 to R3, close to moderate jointed.; (Marine Sedimentary Rocks)**		Driller Reports Contact.	
	C1	100	R2 RQD = 63		C- 1 (55.0-61.0) SILTSTONE; Dark Grey; Fresh; R2; Close to moderate jointed; Unconfined compressive strength 2808 psi at 56', 1286 psi at 59'; Marine Sedimentary Rocks			Switched to HQWL Coring.	
60	C2	44	R3		C- 2 (61.0-66.0) SILTSTONE; Dark Grey; Fresh; R3; Close jointed; Marine Sedimentary Rocks			Drilling Problems, Lost Recovery.	
65	C3	100	R3 RQD = 70		C- 3 (66.0-71.0) SILTSTONE; Dark Grey; Fresh; R3; Close jointed; Marine Sedimentary Rocks				
70						**71.0 End of Hole.**			
75									
80									
85									
88									

ODOT DRILL LOG JETTY CREEK CULVERT.GPJ ODOT_MAN.GDT 1/16/07

DRILL LOG
OREGON DEPARTMENT OF TRANSPORTATION

Project **US 101: Jetty Creek Culvert Replacement**	Purpose **Bridge Foundation**	Hole No. **DH 14-05**	
Highway **Coast Hwy 101**	County **Tillamook**	E.A. No. **PE001114-000**	
Hole Location Northing: **744,747.07**	Easting: **7,325,944.64**	Key No. **13807**	
Equipment **CME-850**	Driller **Duffy**	Start Card No.	
Project Geologist **Kleutsch**	Recorder **Kleutsch**	Bridge No. **20197**	
Start Date **November 2, 2005**	End Date **November 2, 2005**	Total Depth **67.0 ft**	Ground Elev. **37.9 ft**
			Tube Height

Test Type
"A" - Advancer
"X" - Auger
"C" - Core
"N" - Standard Penetration Test
"U" - Undisturbed Sample
"D" - Oversize Split Spoon Sample

Rock Abbreviations

Discontinuity	Shape	Surface Roughness
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Fo - Foliation	St - Stepped	R - Rough
S - Shear	Ir - Irregular	VR - Very Rough

Typical Drilling Abbreviations

Drilling Methods	Drilling Remarks
WL - Wire Line	LW - Lost Water
HS - Hollow Stem Auger	WR - Water Return
DF - Drill Fluid	WC - Water Color
SA - Solid Auger	DP - Down Pressure
CA - Casing Advancer	DR - Drill Rate
HA - Hand Auger	DA - Drill Action

Depth (ft)	Test Type, No.	Percent Recovery	Soil: Driving Resistance / Rock: Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description
0	ADV1	0			ADV- 1 (0.0-5.5) No Recovery.	**0.0 - 6.0 Silty GRAVEL with trace Sand, GM, orange brown and black, wet.; (Fill)**
5	N1	67	4-7-4	25	N- 1 (5.5-7.0) Silty GRAVEL with trace Sand to 6.0' depth; GM; Orange Brown and Black; Nonplastic; Wet; Clayey SILT after 6.0' depth; ML; Low Plasticity; Wet; Fill/Alluvium	**6.0 - 8.0 Clayey SILT; ML; low plasticity; wet; (Alluvium)**
	ADV2	0			ADV- 2 (7.0-10.5) No Recovery.	**8.0 - 16.0 Silty SAND with some Gravel, SM, orange brown, nonplastic, wet, medium dense, gravel angular to subangular.; (Alluvium)**
10	N2	47	13-13-13	42	N- 2 (10.5-12.0) Silty SAND with some Gravel; SM; Orange Brown; Nonplastic; Wet; Medium Dense; gravel angular to subangular; Alluvium	
	ADV3	0			ADV- 3 (12.0-15.5) No Recovery.	
15	N3	80	2-2-4	53	N- 3 (15.5-17.0) SILT with some Sand and wood fragment up to 2"; ML; Grey; Low Plasticity; Wet; Medium Stiff; Alluvium	**16.0 - 17.5 SILT with some Sand and wood fragments, ML, grey, low plasticity, wet, medium stiff.; (Alluvium)**
	ADV4	0			ADV- 4 (17.0-19.0) No Recovery.	**17.5 - 19.0 Solid WOOD; (Alluvium)**
20	C1	50			C- 1 (19.0-22.0) Basalt GRAVEL; GP; Grey; Nonplastic; Wet; fines washed away; subrounded to angular gravel 1/4" to 3" size; Alluvium	**19.0 - 35.5 Silty Gravelly SAND, SM, grey, nonplastic, wet, medium dense, gravel to 3" size.; (Alluvium)**
	C2	14			C- 2 (22.0-27.0) Basalt GRAVEL with some Sand; GP; Grey; Nonplastic; Wet; fines washed away; gravel to 1.5" size; Alluvium	
25	N4	67	7-8-10	27	N- 4 (27.0-28.5) Silty Gravelly SAND; SM; Grey; Nonplastic; Wet; Medium Dense; Alluvium	
	C3	9			C- 3 (28.5-32.0) Silty Gravelly SAND; SM; Grey; Nonplastic; Wet; gravel to 1.5" size; Alluvium	
30	C4	12			C- 4 (32.0-37.0) No Recovery to 35.5' depth, then GRAVEL and WOOD; GP; gravel to 2" size; Alluvium	
35						

Graphic Log | Drilling Methods, Size and Remarks / Water Level/ Date | Backfill/ Instrumentation

HWT Advancer.

Good Water Return, Brown Color.

Lost Most Water Return.

Burned out HWT Bit, Switched to HQWL Coring.

Lost Water Return.

ODOT DRILL LOG JETTY CREEK CULVERT.GPJ ODOT_MAN.GDT 1/16/07

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description
35						**35.5 - 47.0 Clayey SILT to SILT with some Sand and wood fragments, MH, grey, low to medium plasticity, wet, stiff.; (Alluvium)**
	N5	100	2-4-5	66	N- 5 (37.0-38.5) WOOD top 2", then SILT with some Sand and small wood fragments; MH; Grey; Low Plasticity; Wet; Stiff; Alluvium	
	C5	60			C- 5 (38.5-42.0) WOOD top 2", then Clayey SILT with small wood fragments; MH; Grey; Medium Plasticity; Wet; Alluvium	
40						
	C6	0			C- 6 (42.0-47.0) No Recovery.	
45						
	N6	100	6-10-12	120	N- 6 (47.0-48.5) Silty SAND with some GRAVEL, and 0.9' solid WOOD; SM; Grey; Nonplastic; Wet; Medium Dense; Alluvium	**47.0 - 50.0 Silty SAND with some Gravel and large wood fragemnts, SM, grey, nonplastic, wet, medium dense.; (Alluvium)**
	C7	69	R3 RQD = 70		C- 7 (48.5-52.0) WOOD and GRAVEL to 50' depth, then SILTSTONE; Dark Grey; Fresh; R3; Close jointed; Unconfined compressive strength 7604 psi at 50'; Alluvium to Marine Sedimentary Rocks	
50						
	C8	96	R3 RQD = 34		C- 8 (52.0-57.0) SILTSTONE; Dark Grey; Fresh; R3; Close jointed; Unconfined compressive strenght 6890 at 52'; Marine Sedimentary Rocks	**50.0 - 67.0 SILTSTONE, dark grey, fresh, R3, close to moderate jointed.; (Marine Sedimentary Rocks)**
55						
	C9	100	R3 RQD = 62		C- 9 (57.0-62.0) SILTSTONE; Dark Grey; Fresh; R3; Close to medium jointed; Marine Sedimentary Rocks	
60						
	C10	100	R3 RQD = 92		C- 10 (62.0-67.0) SILTSTONE; Dark Grey; Fresh; R3; Medium to close jointed; Marine Sedimentary Rocks	
65						
						67.0 End of Hole.
70						
75						
80						
85						
88						

Graphic Log | Drilling Methods, Size and Remarks | Water Level/ Date | Backfill/ Instrumentation

DRILL LOG

OREGON DEPARTMENT OF TRANSPORTATION

Project **Jetty Creek Realignment**		Purpose **new culvert**	Hole No. **DH9-03**
Highway **Coast Hwy (009)**		County **Tillamook**	E.A. No. **C0291419-011-J13**
Hole Location Northing: **744,716.47**		Easting: **7,325,907.64**	Key No. **10369**
Equipment **CME 850 (track mounted)**		Driller **Ernie Phillips**	Start Card No.
Project Geologist **Kleutsch**		Recorder **Katie Wetherbee**	Bridge No.
Start Date **April 28, 2003**	End Date **April 28, 2003**	Total Depth **42.0 ft**	Ground Elev. **38.8 ft**
			Tube Height

Test Type
"A" - Advancer
"X" - Auger
"C" - Core
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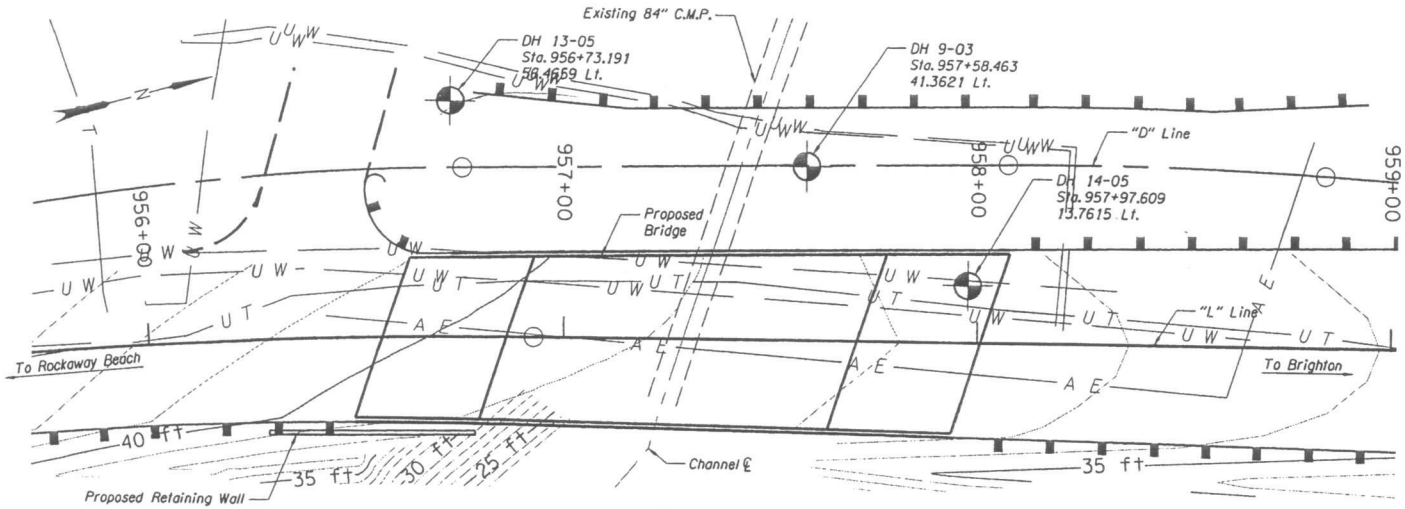
Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description (SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.)	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
0	A1	0			A- 1 (0.0-5.5) No Recovery	**0.0 - 5.7 GRAVEL; GP; dark gray; nonplastic; wet; 3/4 inch minus; (Fill)**		NW advancer with HQ steel.	
5	N1	20	6-6-9	94	N- 1 (5.5-7.0) GRAVEL then Sandy SILT; GP then ML; dark Gray then light Brown; Nonplastic; Wet; Stiff; gravel is 3/4 inch and smaller; (Fill)	**5.7 - 19.5 Sandy SILT to SILT with trace sand and gravel; ML; brown; low to medium plasticity; moist to wet; soft; (Fill)**			
	A2	0			A- 2 (7.0-10.5) No Recovery				
10	N2	53	0-1-1	50	N- 2 (10.5-12.0) Sandy SILT with trace gravel; ML; Brown; Low Plasticity; Moist; Very Soft to Soft; (Fill)				
	A3	0			A- 3 (12.0-15.5) No Recovery				
15	N3	97	0-2-2	51	N- 3 (15.5-17.0) SILT with some sand and trace fine gravel; ML; Brown; Low Plasticity; Moist; Soft; (Fill)				
	A4	0			A- 4 (17.0-20.5) No Recovery				
20	N4	17	5-4-4		N- 4 (20.5-22.0) Sandy GRAVEL up to 2 inch size; GW; dark Gray and Brown; Nonplastic; Wet; Loose; angular; (Fill)	**19.5 - 23.0 Sandy GRAVEL up to 2 inch size; GW; dark Gray and Brown; nonplastic; wet; loose; (Fill)**			
	A5	0			A- 5 (22.0-25.5) No Recovery				
25						**23.0 - 31.5 Organic SILT with some sand; OH; dark brown; medium**		Wood in bit when pulled	

ODOT DRILL LOG JETTY CREEK DH9.GPJ ODOT_MAN.GDT 1/16/07

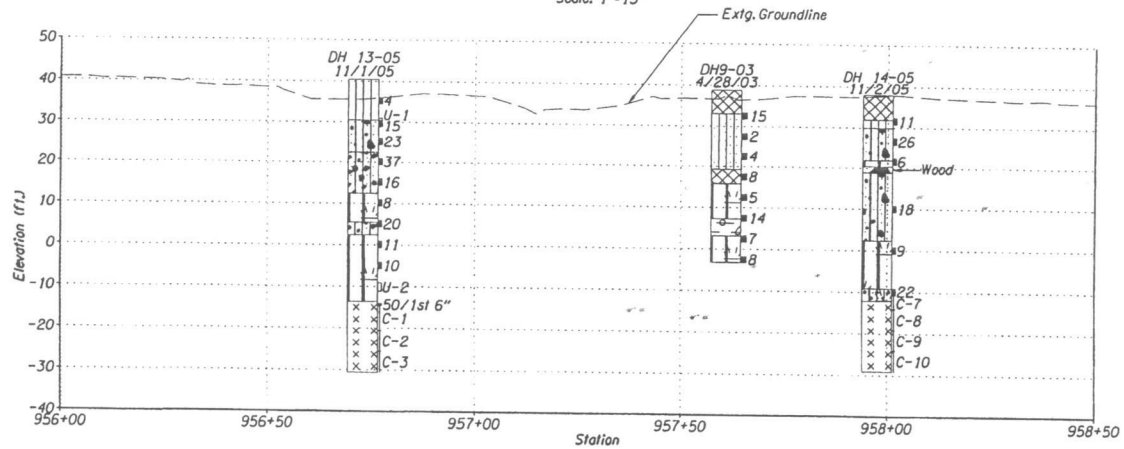
Project Name **Jetty Creek Realignment** Hole No. **DH9-03**

Depth (ft)	Test Type, No.	Percent Recovery	Soil / Rock: Driving Resistance / Discontinuity Data Or RQD%	Percent Natural Moisture	Material Description SOIL: Soil Name, USCS, Color, Plasticity, Moisture, Consistency/Relative Density, Texture, Cementation, Structure, Origin. ROCK: Rock Name, Color, Weathering, Hardness, Discontinuity Spacing, Joint Filling, Core Recovery, Formation Name.	Unit Description	Graphic Log	Drilling Methods, Size and Remarks / Water Level/ Date	Backfill/ Instrumentation
25	N5	100	3-2-3		N- 5 (25.5-27.0) Organic Clayey SILT with some sand and peat; OH; dark Brown; Medium Plasticity; Wet; Medium Stiff; wood pieces up to 4 inch size throughout; (Marsh Deposit)	**plasticity; wet; medium stiff; large wood pieces throughout; (Alluvium)**		up at 7.77m.	
	A6	0			A- 6 (27.0-30.5) No Recovery				
30	N6	33	3-4-10		N- 6 (30.5-32.0) Organic Clayey Silt with some sand grading to Organic Gravelly Silt; OH; dark Brown; Medium Plasticity; Wet; Stiff; wood pieces throughout; (Marsh Deposit)			Slower drilling and wood in bit again.	
	A7	0			A- 7 (32.0-35.5) No Recovery	**31.5 - 35.6 Organic Gravelly SILT; OH; dark brown; medium plasticity; wet; stiff; wood pieces throughout; (Alluvium)**			
35	N7	100	1-3-4	64	N- 7 (35.5-37.0) Gravelly SILT as above in first inch, then organic SILT; OH; dark Brown; Low to Medium Plasticity; Moist; Medium Stiff; very small pieces of organic matter throughout; (Marsh Deposit)	**35.6 - 42.0 Organic SILT with trace fine sand; OH; dark brown; low to medium plasticity; moist; medium stiff; very small pieces of organic matter throughout; (Alluvium)**			
	A8	0			A- 8 (37.0-40.5) No Recovery				
40	N8	100	2-3-5	66	N- 8 (40.5-42.0) Organic SILT with trace fine sand; OH; dark Brown; Low to Medium Plasticity; Moist; Medium Stiff; sandy at bottom of sample; (Marsh Deposit)				
						42.0 End of Hole			
45									
50									
55									
60									
62									

ODOT DRILL LOG JETTY CREEK DH9.GPJ ODOT_MAN.GDT 1/16/07



PLAN
Scale: 1"=15'



PROFILE
Scale: 1"=15'

LEGEND

- Silty GRAVEL with trace Sand to Sandy Gravel, GM/GW, orange brown and black, wet.(Fill)
- Sandy SILT to SILT with trace Sand and Gravel, ML, brown, low to medium plasticity, moist to wet, soft(Fill)
- Sandy SILT to Clayey SILT with some wood fragments, ML, dark brown to mottled brown, low plasticity, moist to wet, medium stiff.(Alluvium)
- Silty SAND with some Gravel to Silty Gravelly SAND, SM, orange brown to mottled brown and grey to grey, nonplastic to low plasticity, wet, medium dense.(Alluvium)
- Silty GRAVEL with some Sand to Silty Sandy GRAVEL, GM, grey, nonplastic, wet, medium dense to dense.(Alluvium)
- Clayey SILT with some Sand to Sandy SILT with some to abundant woody organics, MH to OH, grey to dark grey, nonplastic to medium plasticity, wet, medium stiff to stiff.(Alluvium)
- Solid WOOD(Alluvium)
- Silty SAND with some Gravel and large wood fragemnts, SM, grey, nonplastic, wet, medium dense.(Alluvium)
- Organic Gravelly SILT, OH, dark brown, medium plasticity, wet, stiff, wood pieces throughout(Alluvium)
- SILTSTONE, dark grey, fresh, R2 to R3, close to moderate jointed.(Marine Sedimentary Rocks)

DH 13-05

Core	% Rec.	Hardness	R.Q.D.
C1	100	R2	63
C2	44	R3	-----
C3	100	R3	70

DH 14-05

Core	% Rec.	Hardness	R.Q.D.
C7	69	R3	70
C8	96	R3	34
C9	100	R3	62
C10	100	R3	92

LEGEND

- = ODOT Drill Hole
- 24 = Standard Penetration Test - N Value
- C-1 = Core Sample
- U-1 = Undisturbed Sample
- RQD = Rock Quality Designation

Note: Elevations Shown Are Based On North American Vertical Datum (1988)

Geotechnical Data Shown On This Drawing Are A Consolidation Of Information And/Or Revision In Terminology From The Drill Logs. The Drill Logs Used In Compiling This Drawing Are Available Upon Request. Contractor Shall Refer To Geotechnical Reports And Drill Logs And Information Contained Therein.

△	DATE	REVISION	BY

DRAFTER: Chris Shearer
CHECKER: ----------
REVIEWER: Katie Castelli
DESIGNER
EXPIRES:

OREGON DEPARTMENT OF TRANSPORTATION
REGION 2 TECH CENTER

STRUCTURE NO. 20406
DATE MAY 2006
CALC. BOOK ---

JETTY CREEK, HWY 9
US101: JETTY CREEK CULVERT REPLACEMENT
OREGON COAST HIGHWAY (M.P. 247.52)
TILLAMOOK CO.

FOUNDATION DATA

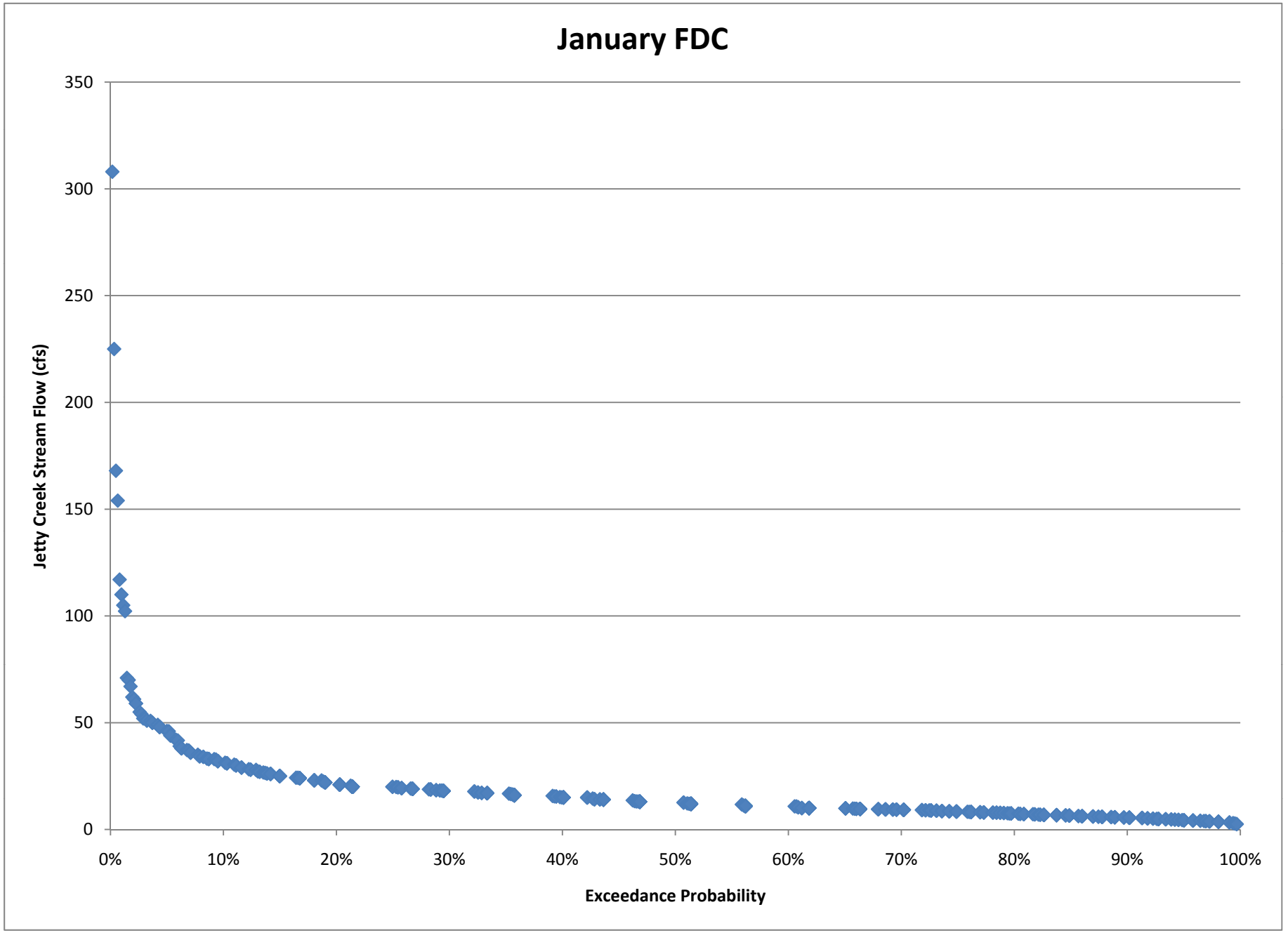
SHEET 5 OF 15
DRAWING NO. JT5

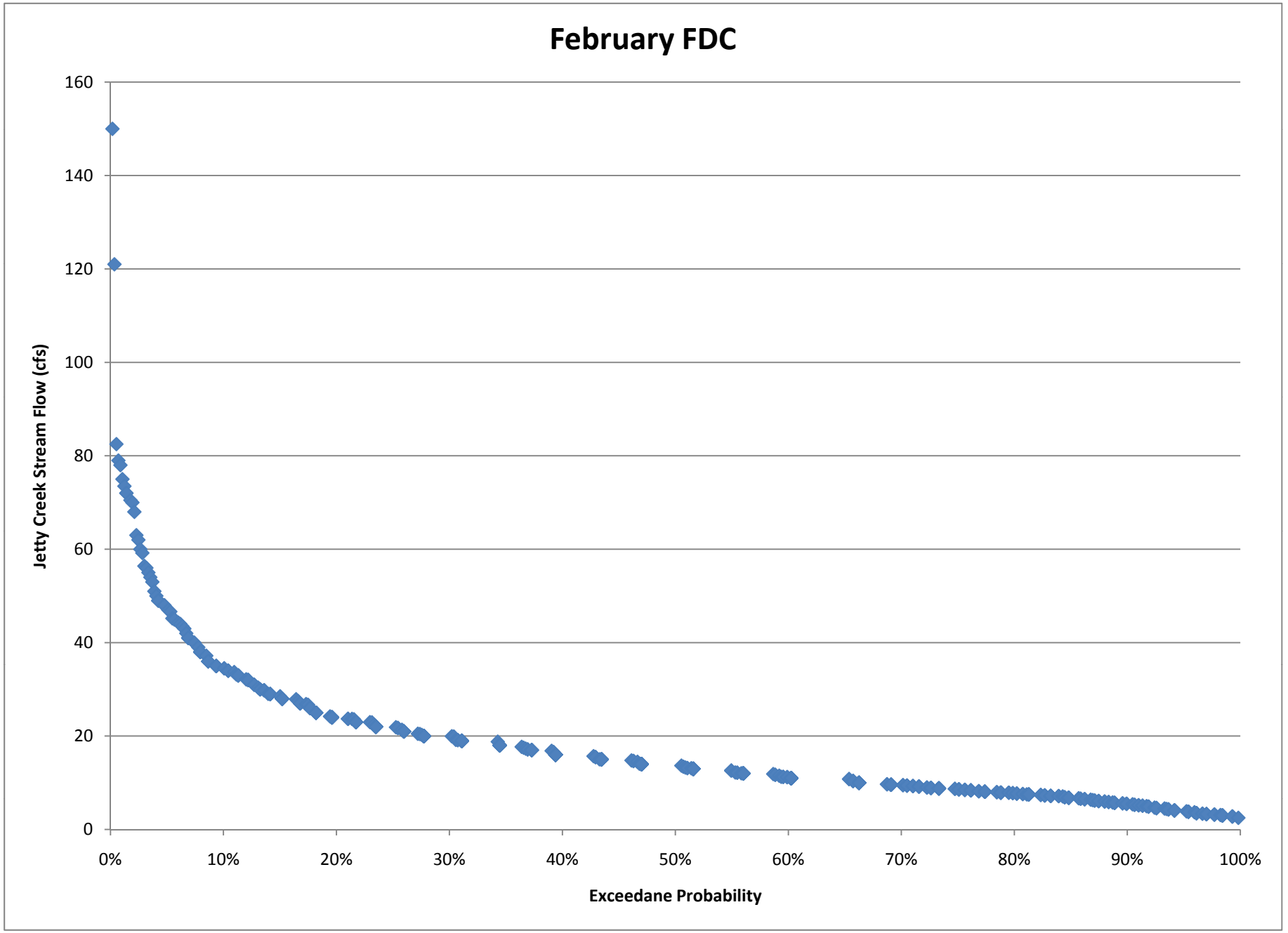
F:\ODOT_DATA\Projects\13807 Jetty Creek\cps20406.dgn 12/27/2006 2:14:35 PM tdb096

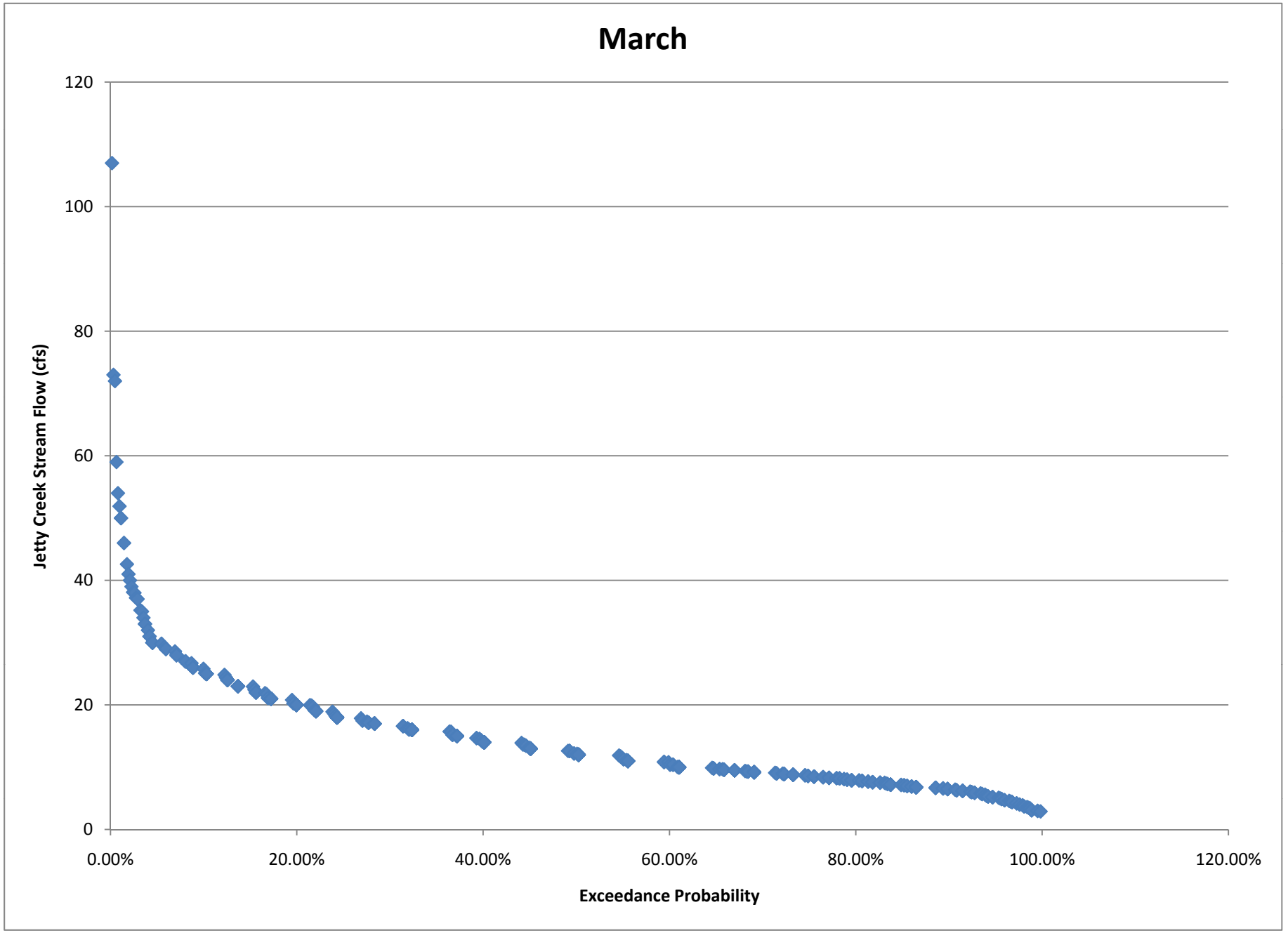
1:180 - FOUNDATION

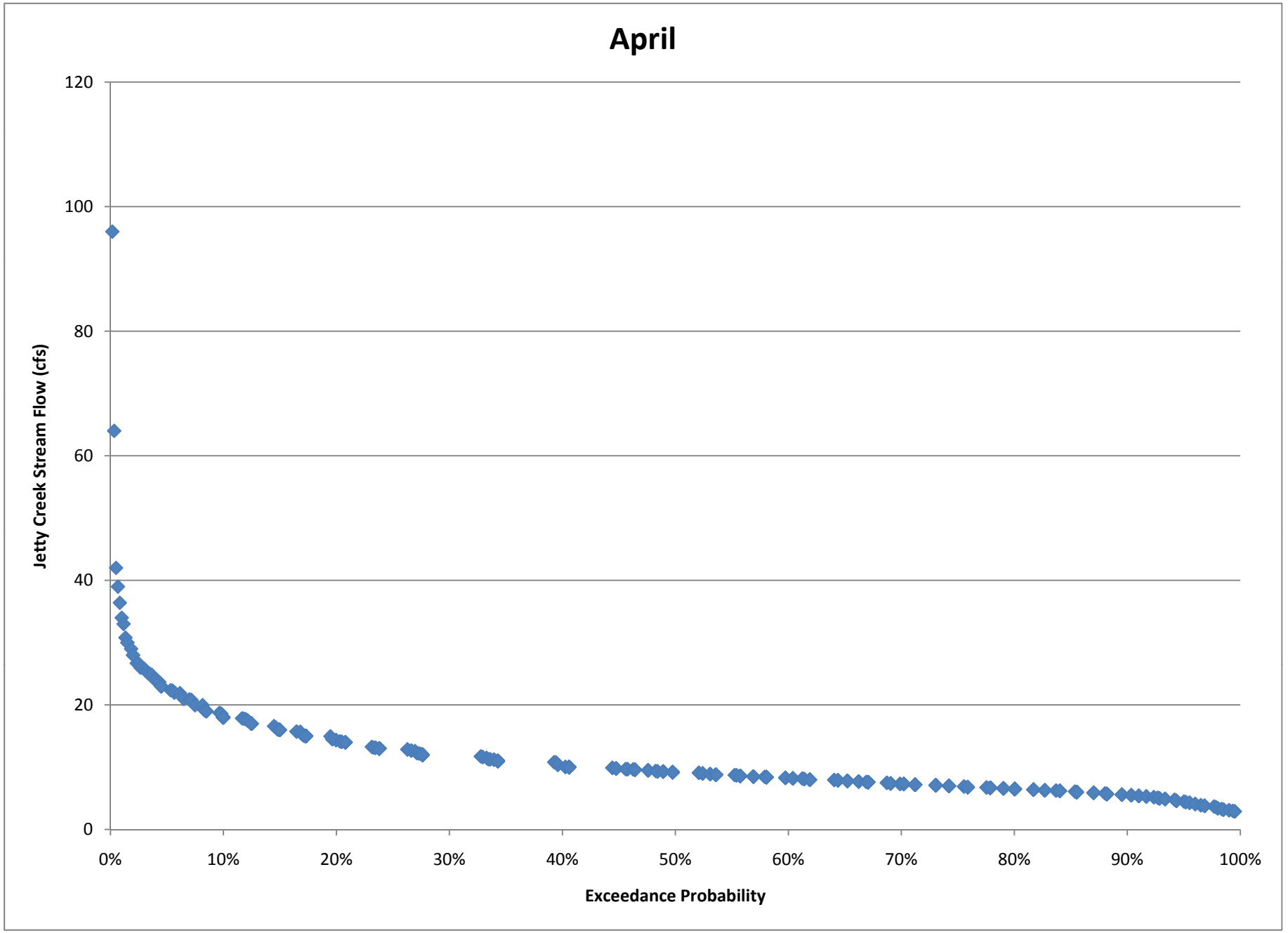
APPENDIX C

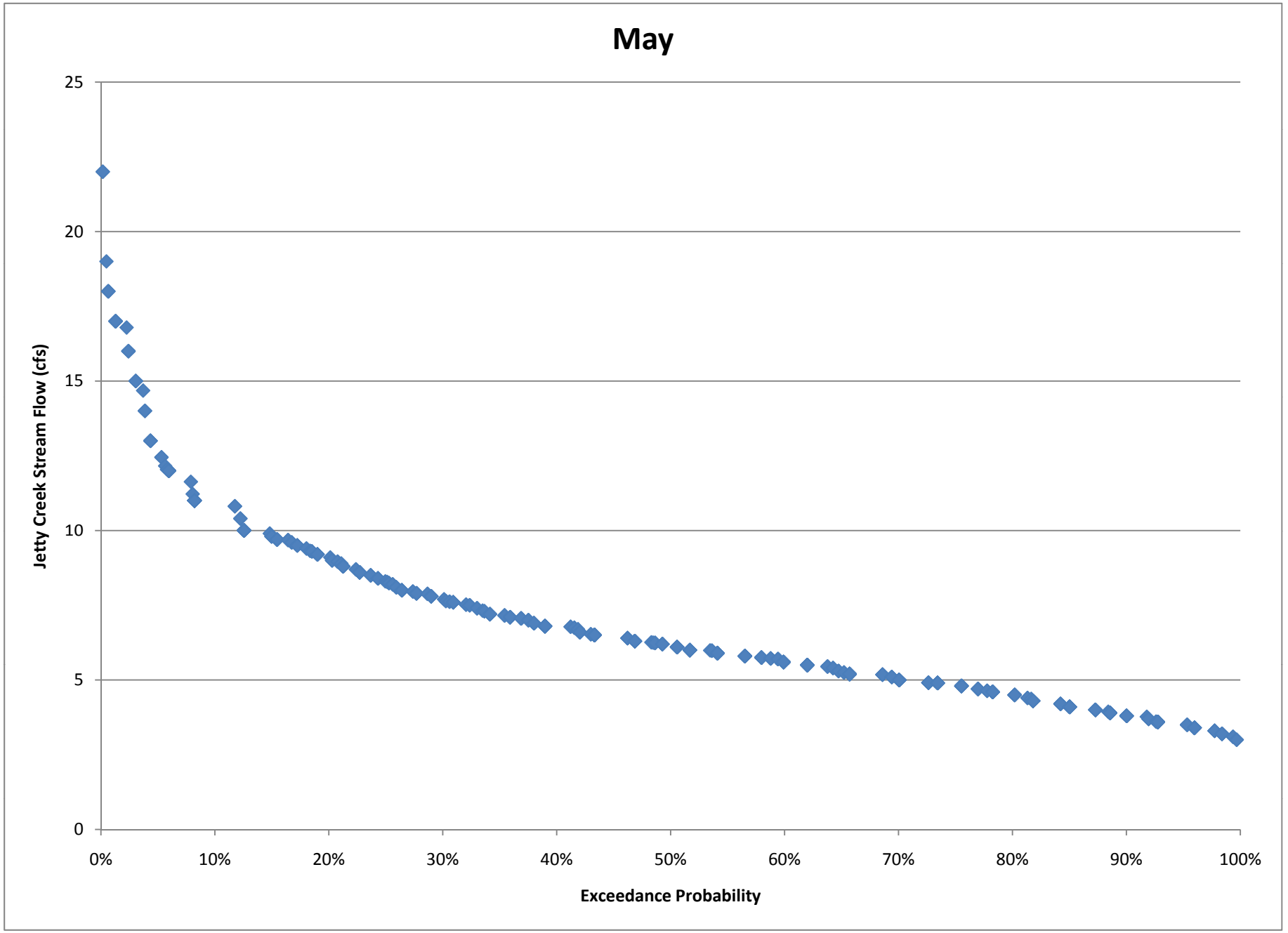
Monthly Flow Duration Curves

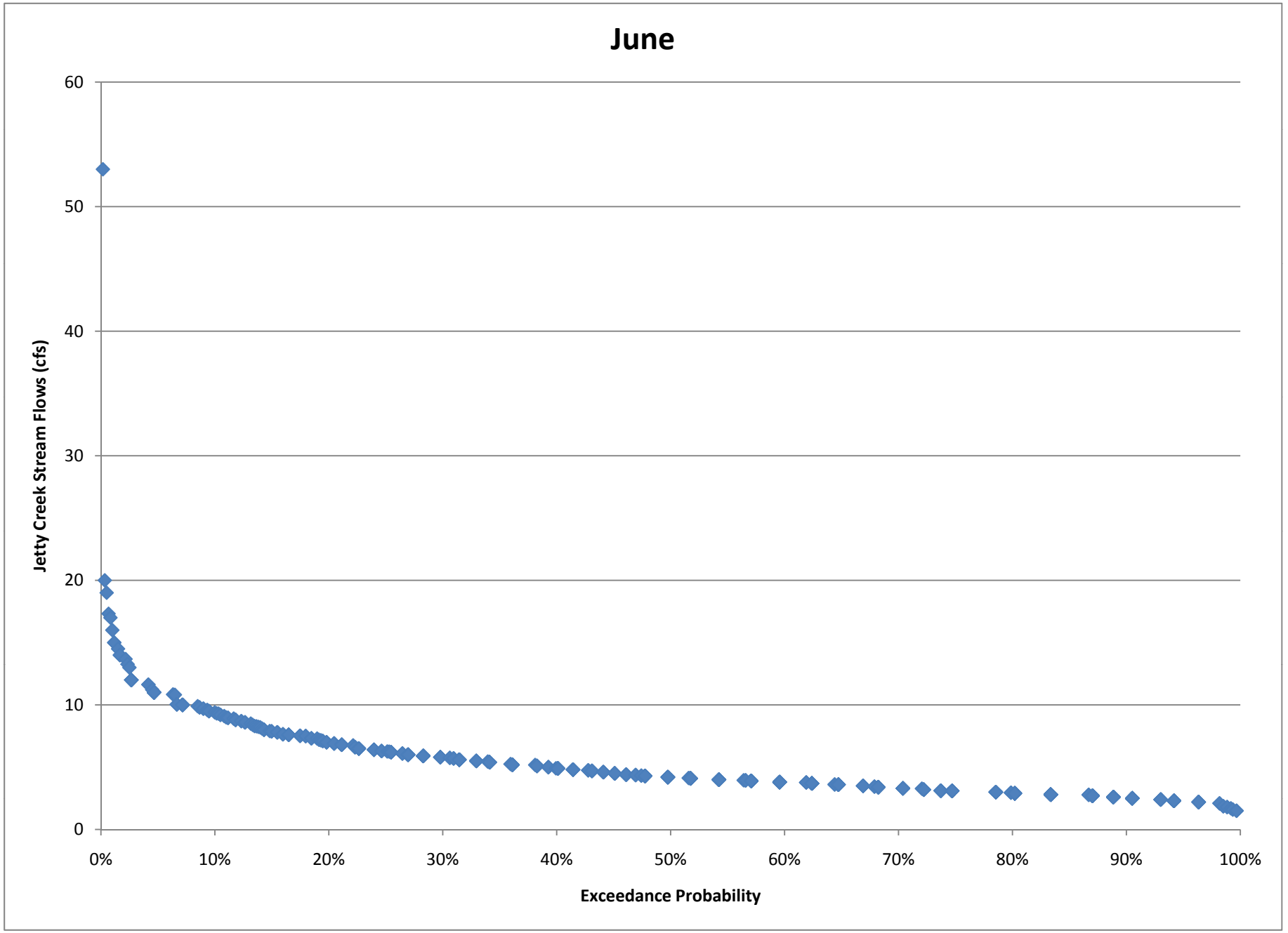

January FDC
Jetty Creek Stream Flow (cfs)
350
300
250
200
150
100
50
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability

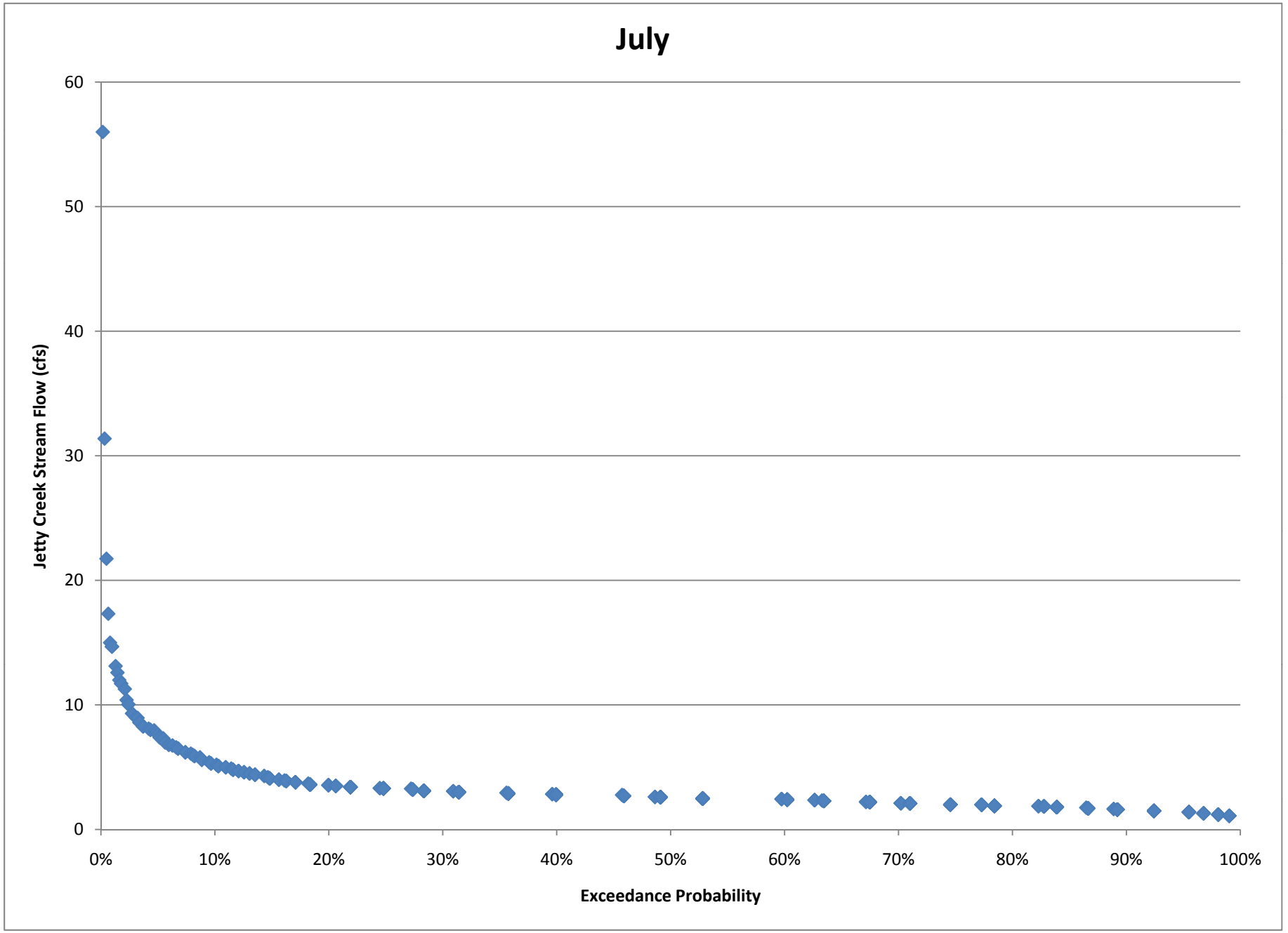

February FDC
160
140
120
100
80
60
40
20
0
Jetty Creek Stream Flow (cfs)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedane Probability

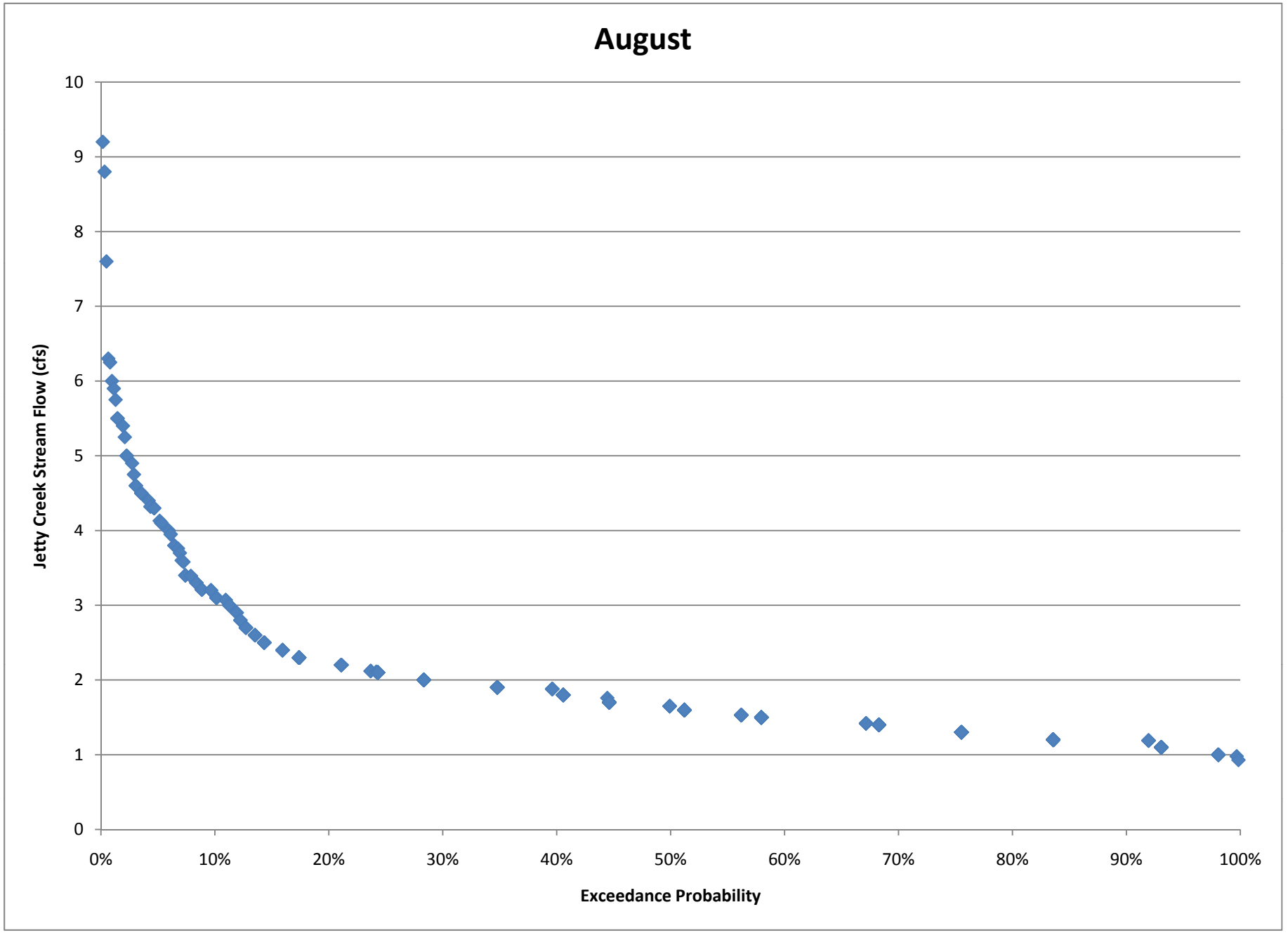

March
120
100
80
60
40
20
0
Jetty Creek Stream Flow (cfs)
0.00%
20.00%
40.00%
60.00%
80.00%
100.00%
120.00%
Exceedance Probability

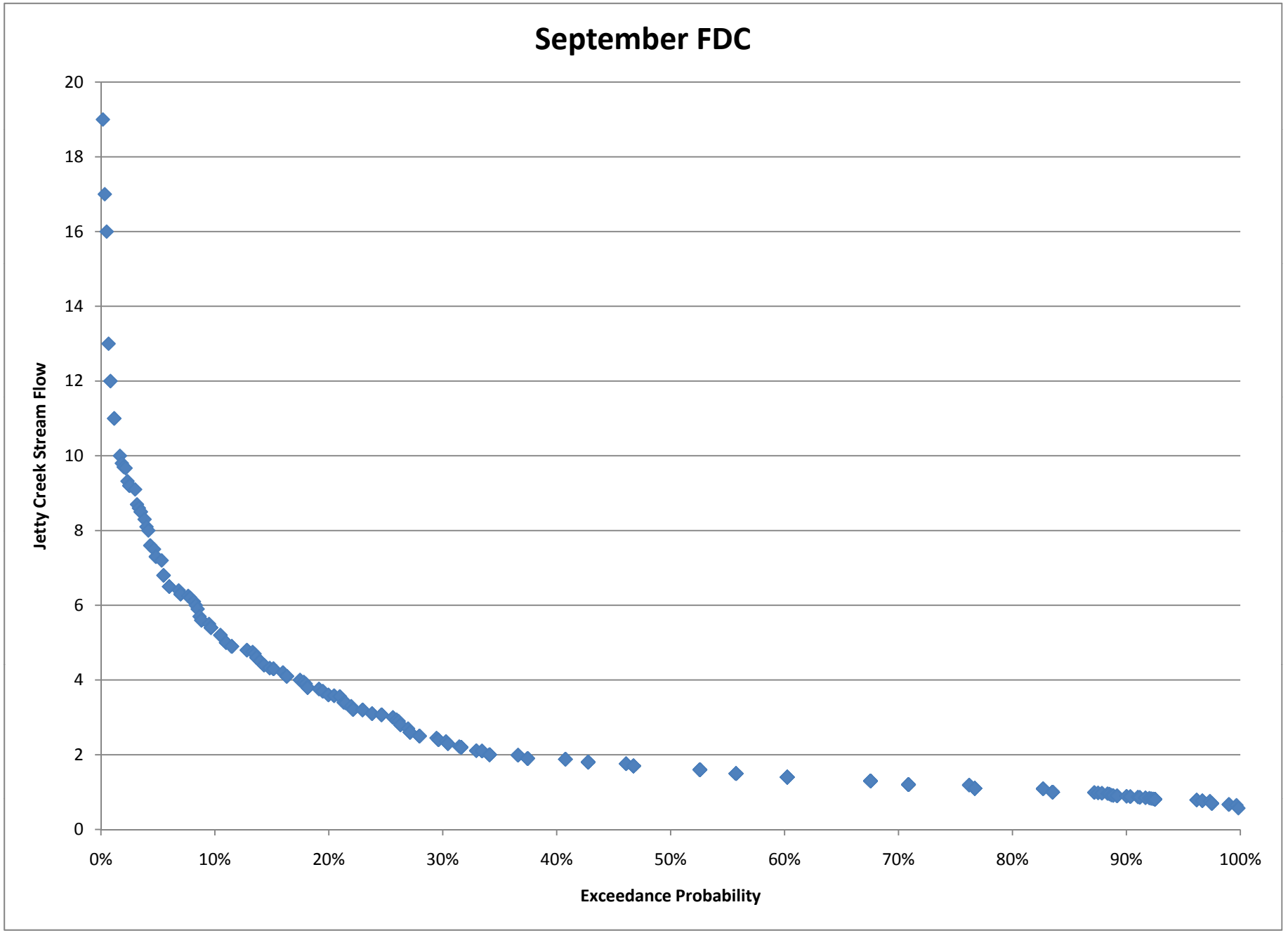

April
120
100
80
60
40
20
0
Jetty Creek Stream Flow (cfs)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability

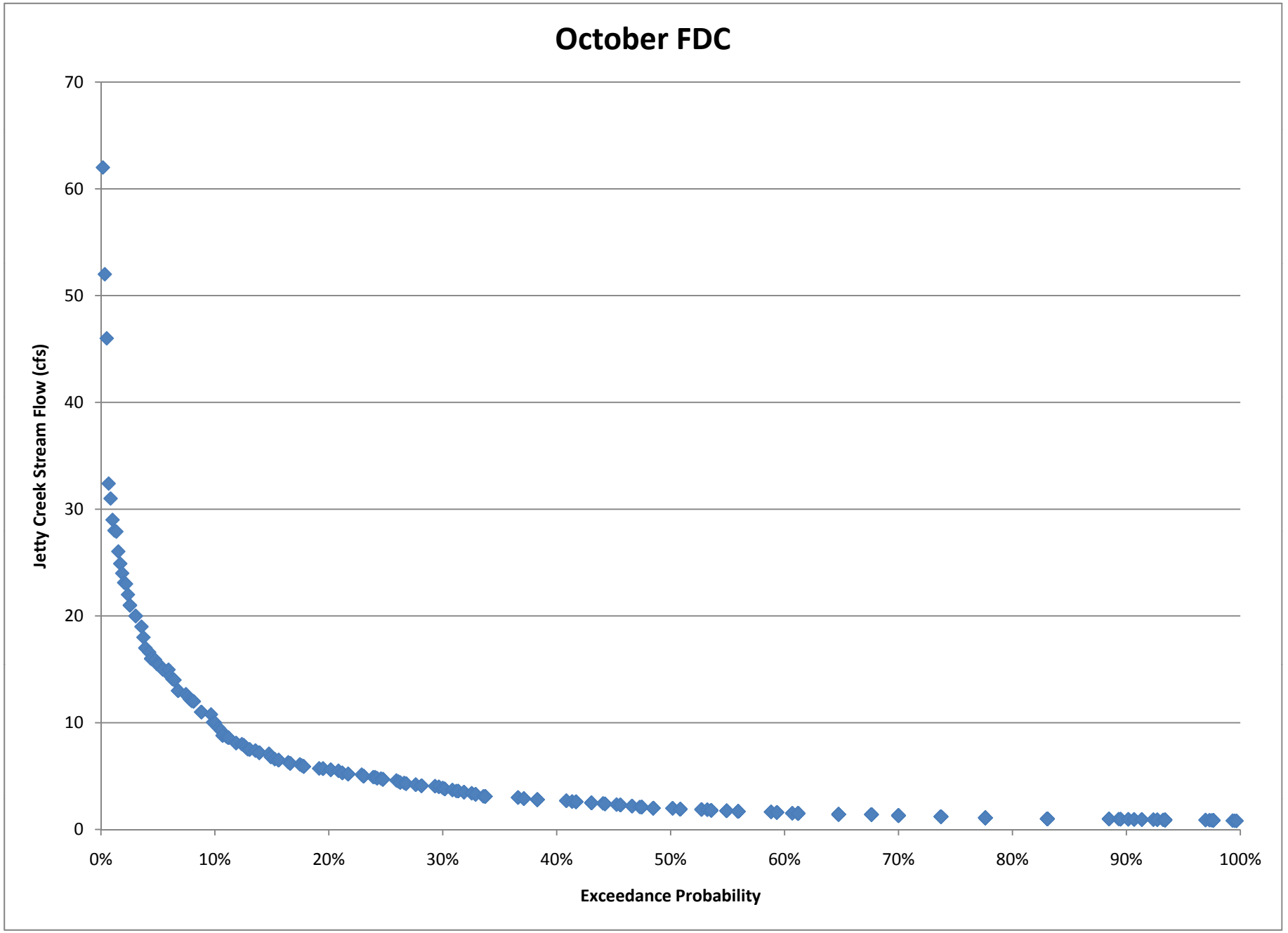

May
25
20
15
10
5
0
Jetty Creek Stream Flow (cfs)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability

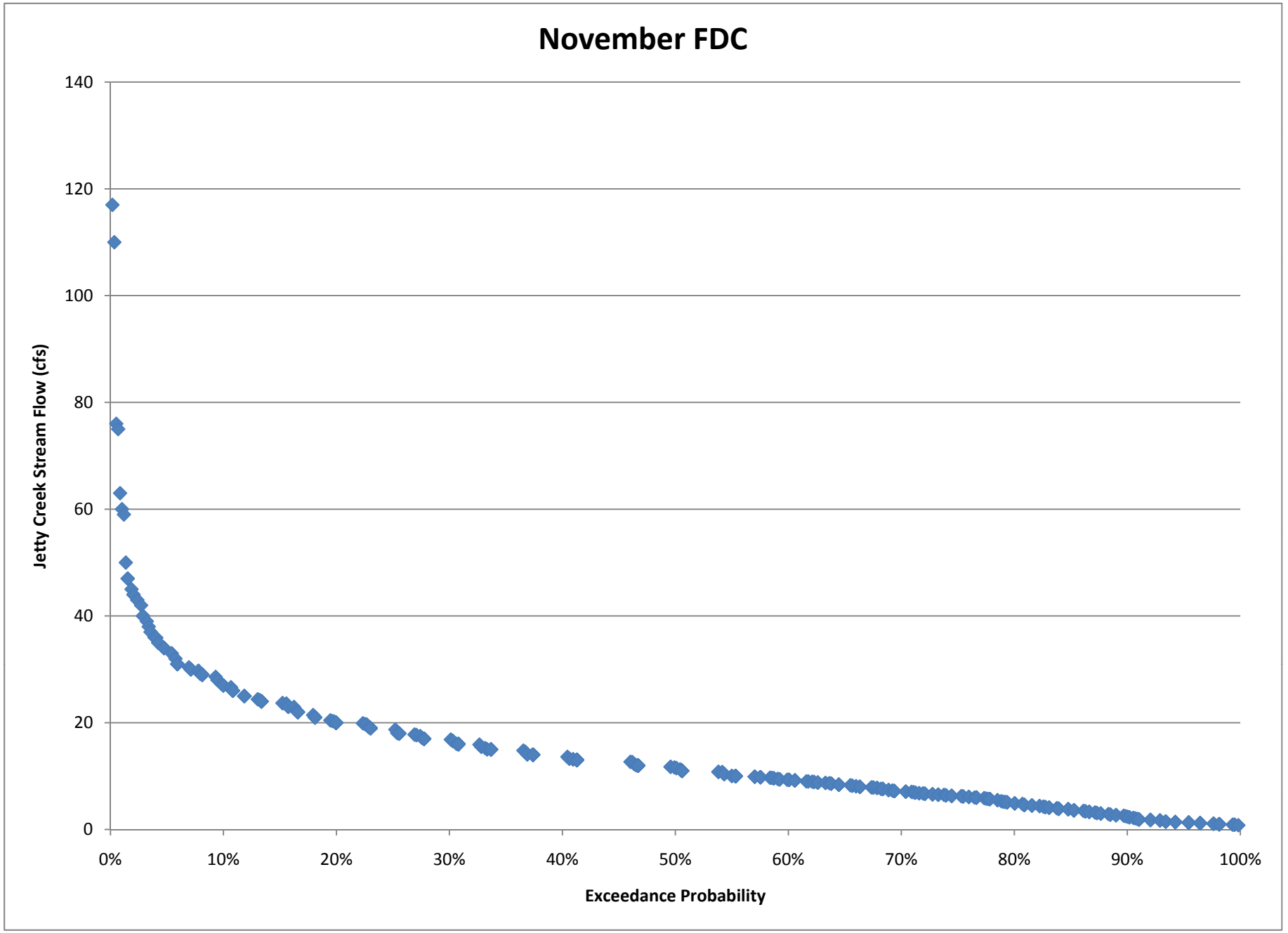

June
60
50
40
30
20
10
0
Jetty Creek Stream Flows (cfs)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability

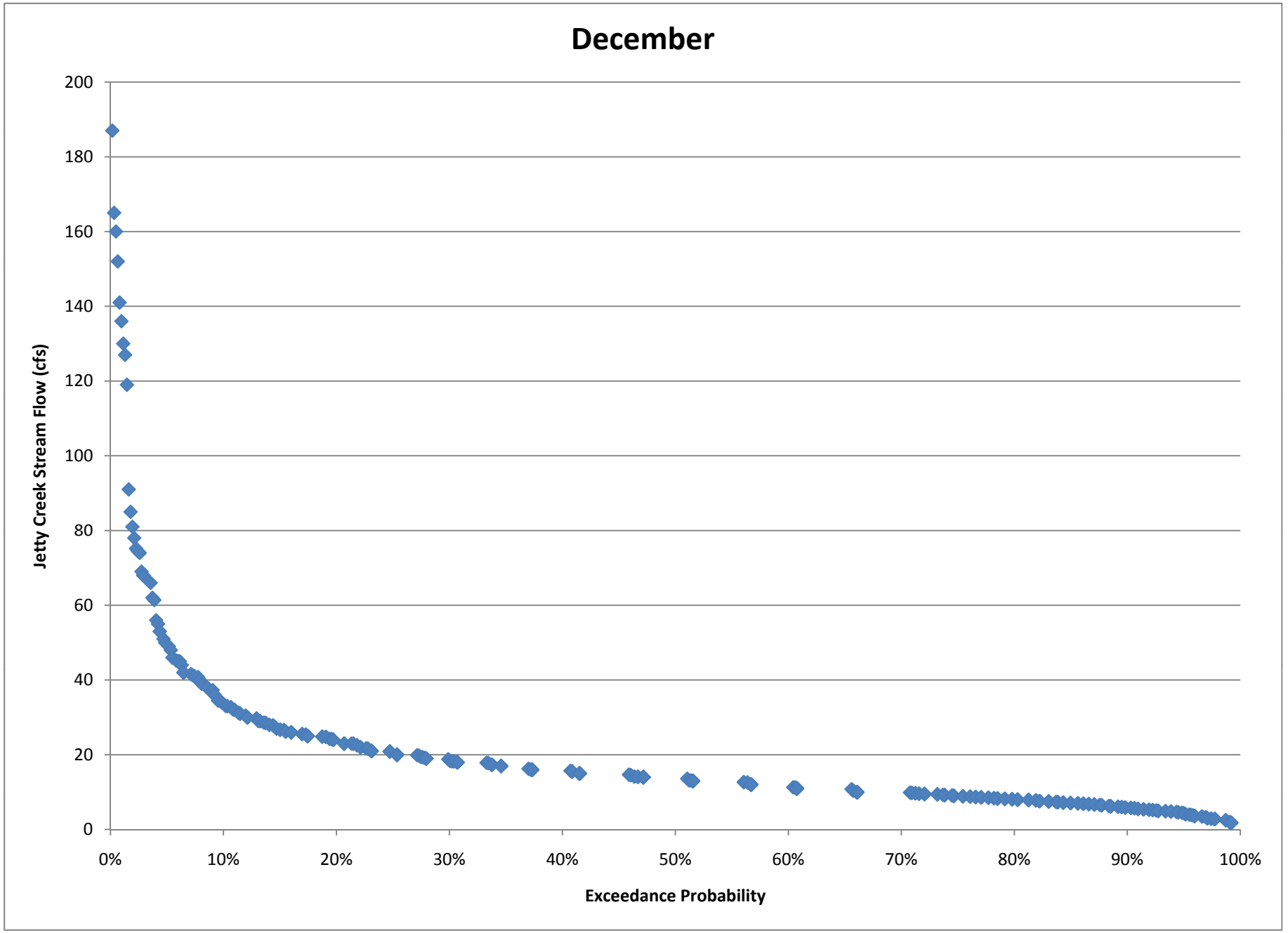

July
60
50
40
30
20
10
0
Jetty Creek Stream Flow (cfs)
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability


August
Jetty Creek Stream Flow (cfs)
10
9
8
7
6
5
4
3
2
1
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability


September FDC
Jetty Creek Stream Flow
20
18
16
14
12
10
8
6
4
2
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability


October FDC
Jetty Creek Stream Flow (cfs)
70
60
50
40
30
20
10
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability


November FDC
Jetty Creek Stream Flow (cfs)
140
120
100
80
60
40
20
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability


December
Jetty Creek Stream Flow (cfs)
200
180
160
140
120
100
80
60
40
20
0
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Exceedance Probability

APPENDIX D

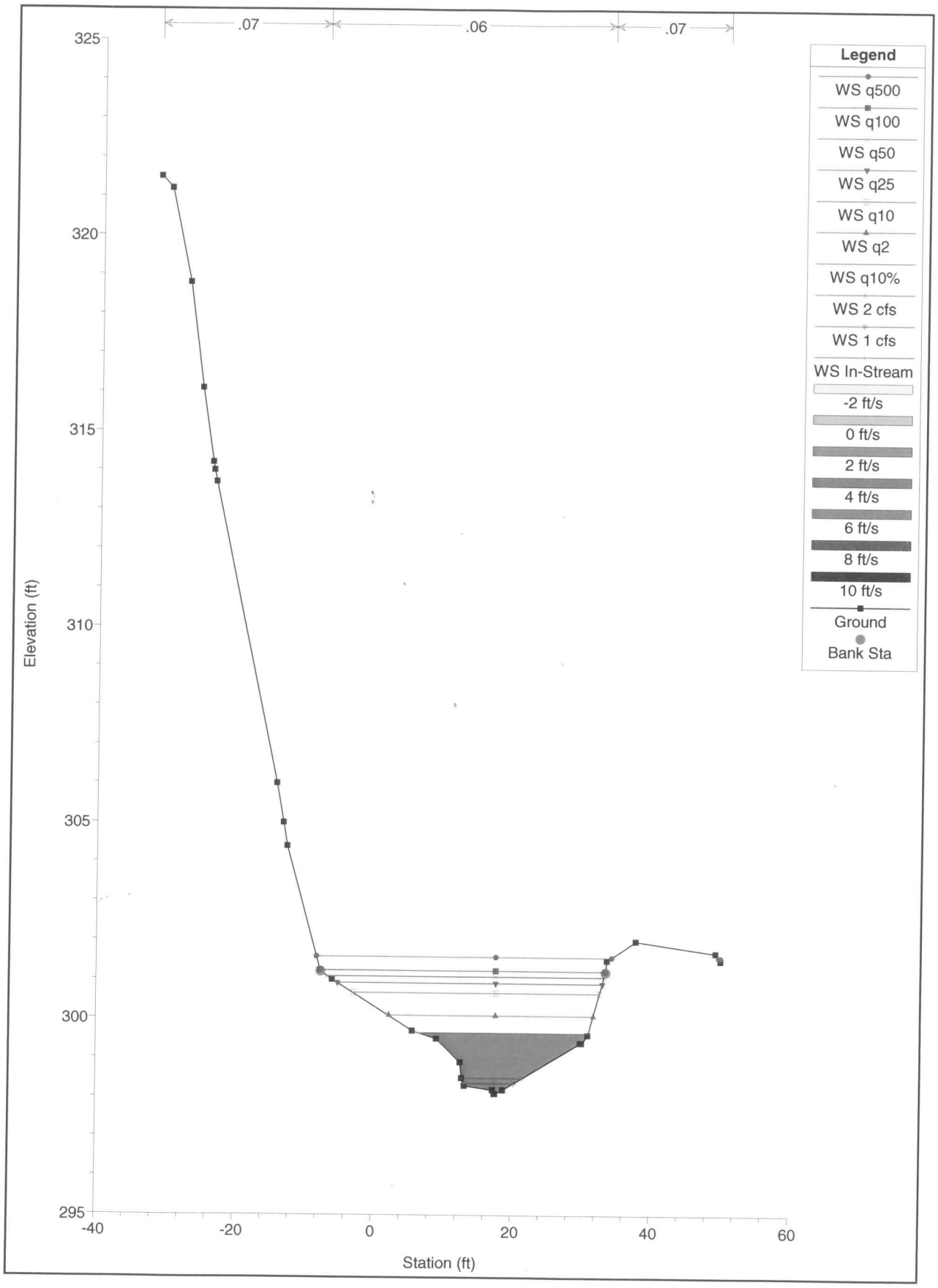
HEC-RAS Model Results

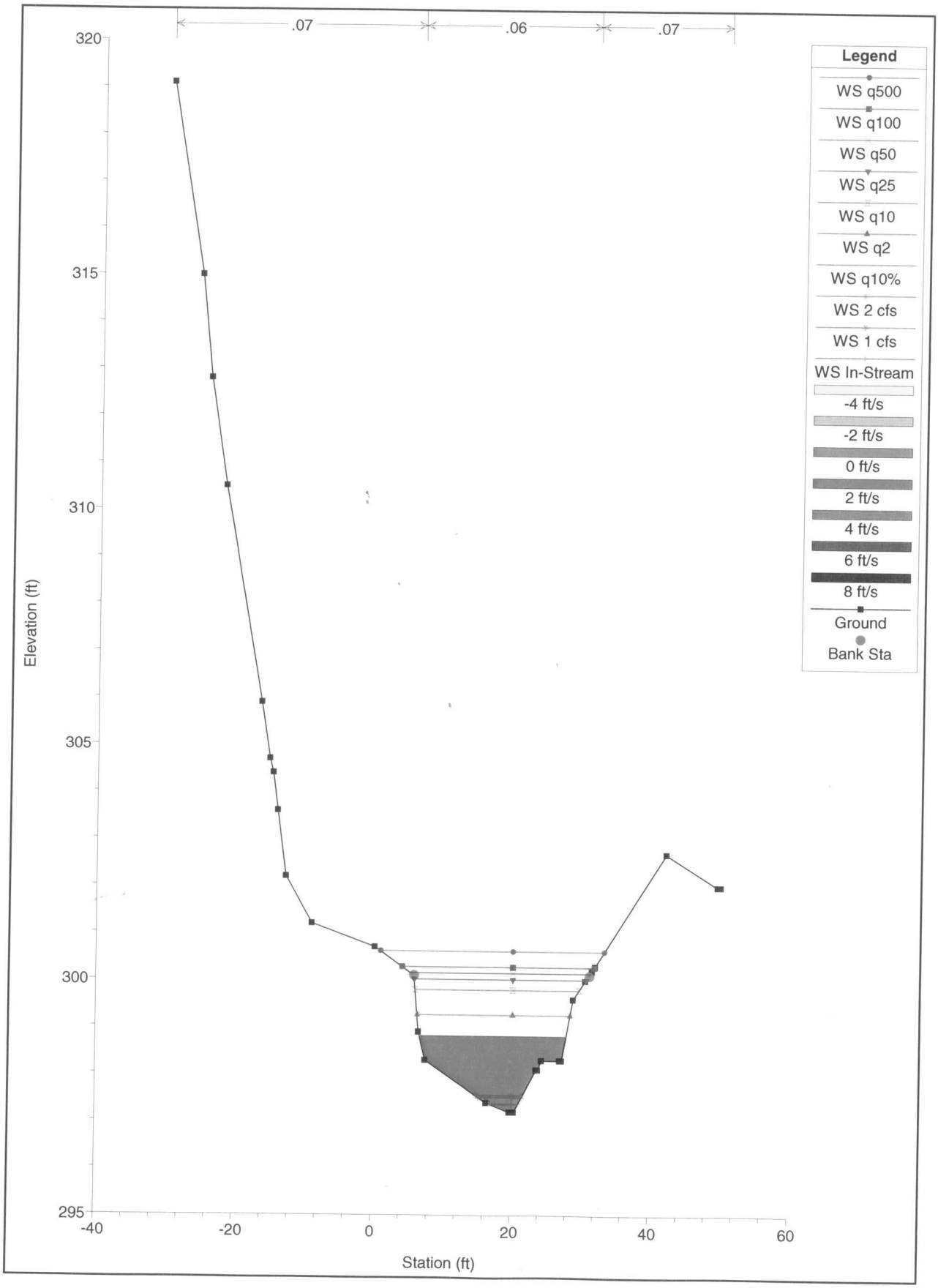
HEC-RAS Plan: Restored Creek River: JettyCreek Reach: JC

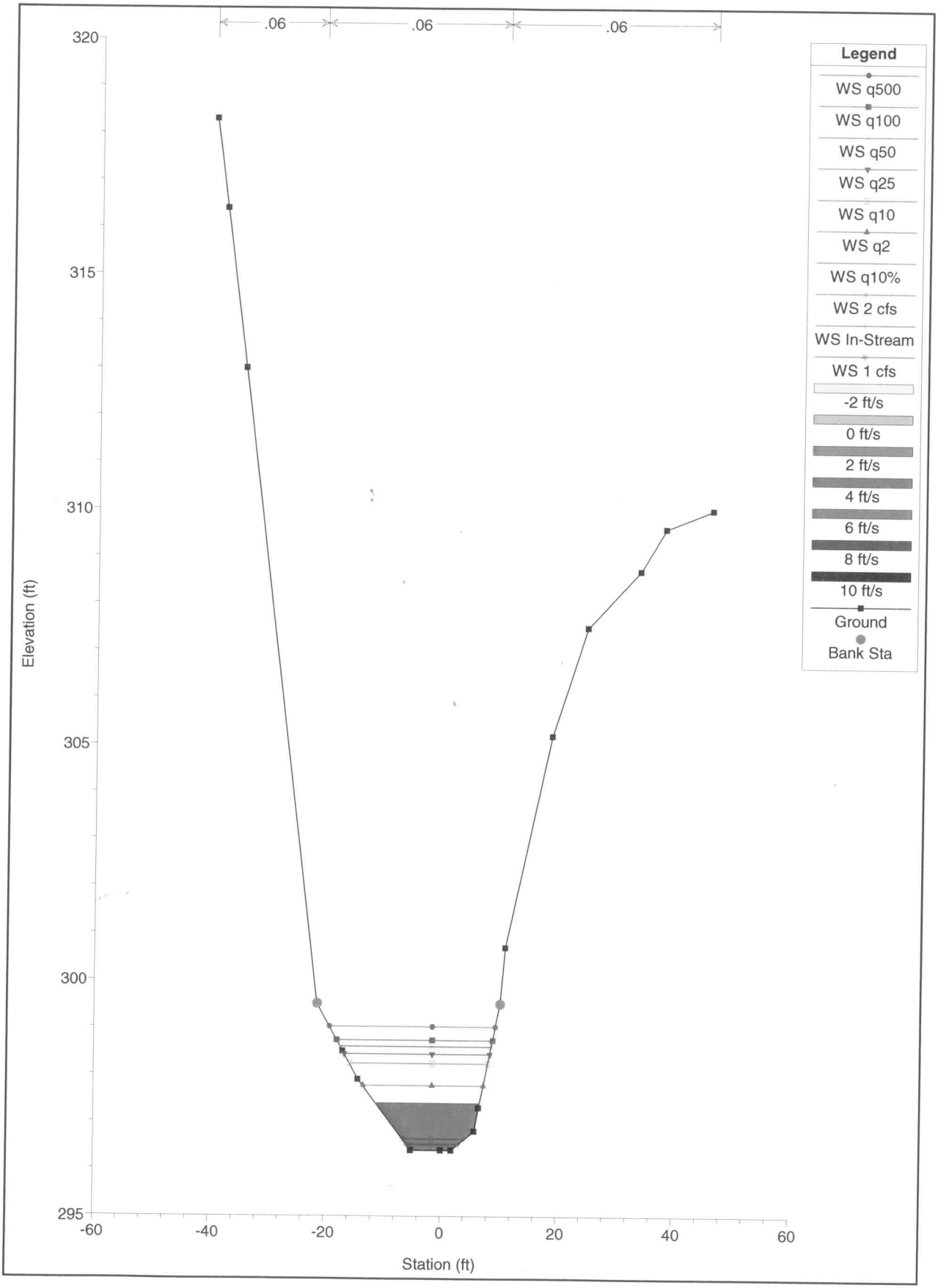
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JC	730	q10%	60.00	298.10	299.65	299.31	299.79	0.019853	3.01	19.93	24.43	0.59
JC	730	q2	110.00	298.10	300.09	299.69	300.27	0.017850	3.44	31.95	29.48	0.58
JC	730	q25	230.00	298.10	300.91	300.26	301.14	0.013614	3.85	59.82	38.07	0.54
JC	730	q50	260.00	298.10	301.08	300.37	301.32	0.013042	3.92	66.39	39.78	0.53
JC	730	q100	290.00	298.10	301.23	300.47	301.48	0.012585	4.00	72.49	41.02	0.53
JC	730	q500	370.00	298.10	301.58	300.73	301.86	0.011245	4.26	86.97	42.73	0.52
JC	730	q10	190.00	298.10	300.66	300.10	300.88	0.014747	3.75	50.60	35.46	0.55
JC	730	In-Stream	0.50	298.10	298.36	298.28	298.36	0.009550	0.59	0.85	7.09	0.30
JC	730	1 cfs	1.00	298.10	298.37	298.32	298.39	0.028448	1.07	0.94	7.22	0.52
JC	730	2 cfs	2.00	298.10	298.49	298.37	298.51	0.013552	1.05	1.91	8.61	0.39
JC	710	q10%	60.00	297.20	298.82	298.44	298.95	0.014354	2.88	20.82	21.21	0.51
JC	710	q2	110.00	297.20	299.26	298.77	299.46	0.014750	3.62	30.39	22.08	0.54
JC	710	q25	230.00	297.20	300.02	299.38	300.38	0.016837	4.79	48.01	24.83	0.61
JC	710	q50	260.00	297.20	300.16	299.51	300.55	0.017549	5.05	51.48	26.07	0.62
JC	710	q100	290.00	297.20	300.28	299.64	300.72	0.017897	5.31	54.82	27.75	0.64
JC	710	q500	370.00	297.20	300.61	299.98	301.14	0.017894	5.84	64.78	32.27	0.65
JC	710	q10	190.00	297.20	299.79	299.19	300.10	0.016107	4.47	42.49	23.66	0.59
JC	710	In-Stream	0.50	297.20	297.37	297.34	297.39	0.058337	1.26	0.40	4.07	0.71
JC	710	1 cfs	1.00	297.20	297.51		297.53	0.011409	0.86	1.17	6.26	0.35
JC	710	2 cfs	2.00	297.20	297.55		297.58	0.026715	1.42	1.41	6.76	0.55
JC	520	q10%	60.00	296.40	297.39	297.34	297.71	0.049998	4.51	13.31	17.85	0.92
JC	520	q2	110.00	296.40	297.76	297.72	298.21	0.049318	5.38	20.44	20.70	0.95
JC	520	q25	230.00	296.40	298.43	298.37	299.07	0.042957	6.41	35.86	25.00	0.94
JC	520	q50	260.00	296.40	298.59	298.50	299.25	0.040623	6.52	39.87	25.96	0.93
JC	520	q100	290.00	296.40	298.73	298.62	299.42	0.039367	6.66	43.55	26.81	0.92
JC	520	q500	370.00	296.40	299.01	298.93	299.82	0.040400	7.21	51.31	28.52	0.95
JC	520	q10	190.00	296.40	298.24	298.17	298.82	0.044456	6.13	31.01	23.79	0.95
JC	520	In-Stream	0.50	296.40	296.52	296.45	296.53	0.008099	0.51	0.98	8.96	0.27
JC	520	1 cfs	1.00	296.40	296.51		296.53	0.042252	1.11	0.90	8.81	0.61
JC	520	2 cfs	2.00	296.40	296.63	296.54	296.65	0.013835	0.97	2.06	10.70	0.39
JC	500	q10%	60.00	295.50	296.84		296.90	0.006867	2.09	28.82	28.83	0.36
JC	500	q2	110.00	295.50	297.30		297.41	0.006525	2.61	43.09	32.30	0.38
JC	500	q25	230.00	295.50	298.07		298.25	0.006608	3.46	70.44	37.97	0.40
JC	500	q50	260.00	295.50	298.23		298.43	0.006759	3.66	76.57	42.95	0.41
JC	500	q100	290.00	295.50	298.38		298.60	0.006803	3.82	84.16	53.19	0.42
JC	500	q500	370.00	295.50	298.76		299.00	0.006326	4.04	105.28	57.68	0.41
JC	500	q10	190.00	295.50	297.85		298.00	0.006590	3.22	61.95	36.74	0.40
JC	500	In-Stream	0.50	295.50	295.54	295.54	295.55	0.091317	0.89	0.56	13.55	0.77
JC	500	1 cfs	1.00	295.50	295.62		295.63	0.010062	0.58	1.73	15.43	0.30
JC	500	2 cfs	2.00	295.50	295.63		295.65	0.030499	1.06	1.89	15.52	0.54
JC	450	q10%	60.00	294.70	296.29	295.88	296.44	0.012415	3.30	20.43	23.33	0.50
JC	450	q2	110.00	294.70	296.72	296.32	296.94	0.013425	4.12	31.44	26.95	0.54
JC	450	q25	230.00	294.70	297.32	296.96	297.73	0.017172	5.66	48.45	29.29	0.64
JC	450	q50	260.00	294.70	297.45	297.07	297.89	0.017552	5.93	52.27	29.57	0.66
JC	450	q100	290.00	294.70	297.58	297.18	298.05	0.017833	6.17	56.02	29.95	0.67
JC	450	q500	370.00	294.70	297.91		298.47	0.017890	6.69	66.35	31.64	0.68
JC	450	q10	190.00	294.70	297.13	296.79	297.49	0.016449	5.25	43.06	28.59	0.62
JC	450	In-Stream	0.50	294.70	294.84	294.75	294.84	0.005472	0.48	1.04	7.67	0.23
JC	450	1 cfs	1.00	294.70	294.83	294.78	294.85	0.027977	1.04	0.97	7.64	0.51
JC	450	2 cfs	2.00	294.70	295.00	294.83	295.01	0.007087	0.87	2.29	8.27	0.29
JC	400	q10%	60.00	294.00	294.89	294.89	295.24	0.061055	4.74	12.65	18.33	1.01
JC	400	q2	110.00	294.00	295.28	295.26	295.73	0.052798	5.38	20.44	21.94	0.98
JC	400	q25	230.00	294.00	296.10		296.60	0.029913	5.69	40.43	25.72	0.80
JC	400	q50	260.00	294.00	296.27		296.79	0.027893	5.80	44.83	26.20	0.78
JC	400	q100	290.00	294.00	296.43		296.97	0.026292	5.90	49.13	26.67	0.77
JC	400	q500	370.00	294.00	296.77		297.40	0.025594	6.35	58.29	27.63	0.77
JC	400	q10	190.00	294.00	295.87		296.34	0.033091	5.50	34.54	25.05	0.83
JC	400	In-Stream	0.50	294.00	294.04	294.04	294.06	0.151962	1.16	0.43	10.40	1.00
JC	400	1 cfs	1.00	294.00	294.15	294.06	294.16	0.008270	0.61	1.63	11.42	0.29
JC	400	2 cfs	2.00	294.00	294.12	294.12	294.16	0.081873	1.63	1.23	11.09	0.86
JC	316	q10%	60.00	293.00	294.47	293.70	294.52	0.004536	1.90	32.00	27.86	0.30
JC	316	q2	110.00	293.00	294.98		295.07	0.004601	2.42	46.59	28.52	0.32
JC	316	q25	230.00	293.00	295.79		295.97	0.005481	3.40	70.01	29.36	0.37
JC	316	q50	260.00	293.00	295.97		296.16	0.005604	3.59	75.09	29.56	0.38
JC	316	q100	290.00	293.00	296.13		296.34	0.005700	3.76	80.02	29.78	0.39
JC	316	q500	370.00	293.00	296.42		296.71	0.006674	4.34	88.82	30.12	0.43
JC	316	q10	190.00	293.00	295.57		295.71	0.005105	3.09	63.49	29.13	0.36
JC	316	In-Stream	0.50	293.00	293.09	293.03	293.09	0.004372	0.33	1.54	17.33	0.19
JC	316	1 cfs	1.00	293.00	293.05	293.05	293.07	0.144357	1.24	0.81	16.94	1.00
JC	316	2 cfs	2.00	293.00	293.21	293.07	293.21	0.004512	0.56	3.56	18.04	0.22
JC	1	q10%	60.00	292.20	293.56	293.56	293.98	0.042602	5.30	12.53	17.41	0.90
JC	1	q2	110.00	292.20	294.01	294.01	294.53	0.036010	6.16	21.74	23.35	0.88

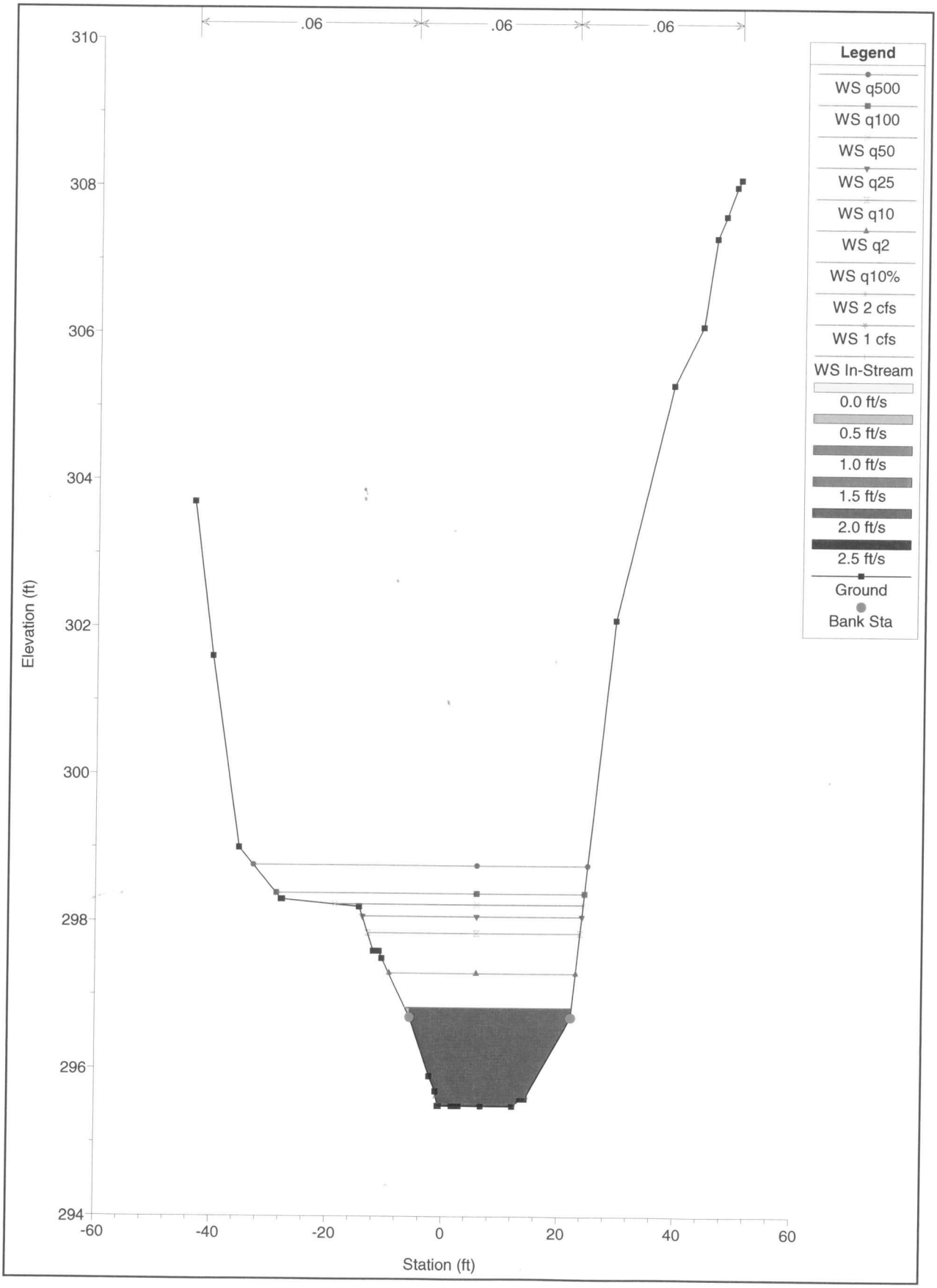
HEC-RAS Plan: Restored Creek River: JettyCreek Reach: JC (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
JC	1	q25	230.00	292.20	294.75	294.75	295.38	0.029486	7.25	42.48	32.33	0.85
JC	1	q50	260.00	292.20	294.83	294.83	295.55	0.032539	7.78	44.95	32.96	0.90
JC	1	q100	290.00	292.20	294.90	294.90	295.71	0.035045	8.26	47.54	33.73	0.94
JC	1	q500	370.00	292.20	295.37	295.37	296.08	0.026320	8.04	65.90	42.08	0.84
JC	1	q10	190.00	292.20	294.52	294.52	295.14	0.032329	7.07	35.26	30.01	0.87
JC	1	In-Stream	0.50	292.20	292.41	292.41	292.46	0.150859	1.67	0.30	4.08	1.09
JC	1	1 cfs	1.00	292.20	292.47	292.47	292.52	0.113294	1.77	0.57	5.72	0.99
JC	1	2 cfs	2.00	292.20	292.53	292.53	292.60	0.101516	2.09	0.95	6.91	0.99


.07
.06
.07
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 2 cfs
WS 1 cfs
WS In-Stream
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
325
320
315
310
305
300
295
-40
-20
0
20
40
60
Station (ft)


.07
.06
.07
320
315
310
305
300
295
Elevation (ft)
-40
-20
0
20
40
60
Station (ft)
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 2 cfs
WS 1 cfs
WS In-Stream
-4 ft/s
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


.06
.06
.06
320
315
310
305
300
295
Elevation (ft)
-60
-40
-20
0
20
40
60
Station (ft)
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 2 cfs
WS In-Stream
WS 1 cfs
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


.06
.06
.06
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 2 cfs
WS 1 cfs
WS In-Stream
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
Ground
Bank Sta
Elevation (ft)
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308
306
304
302
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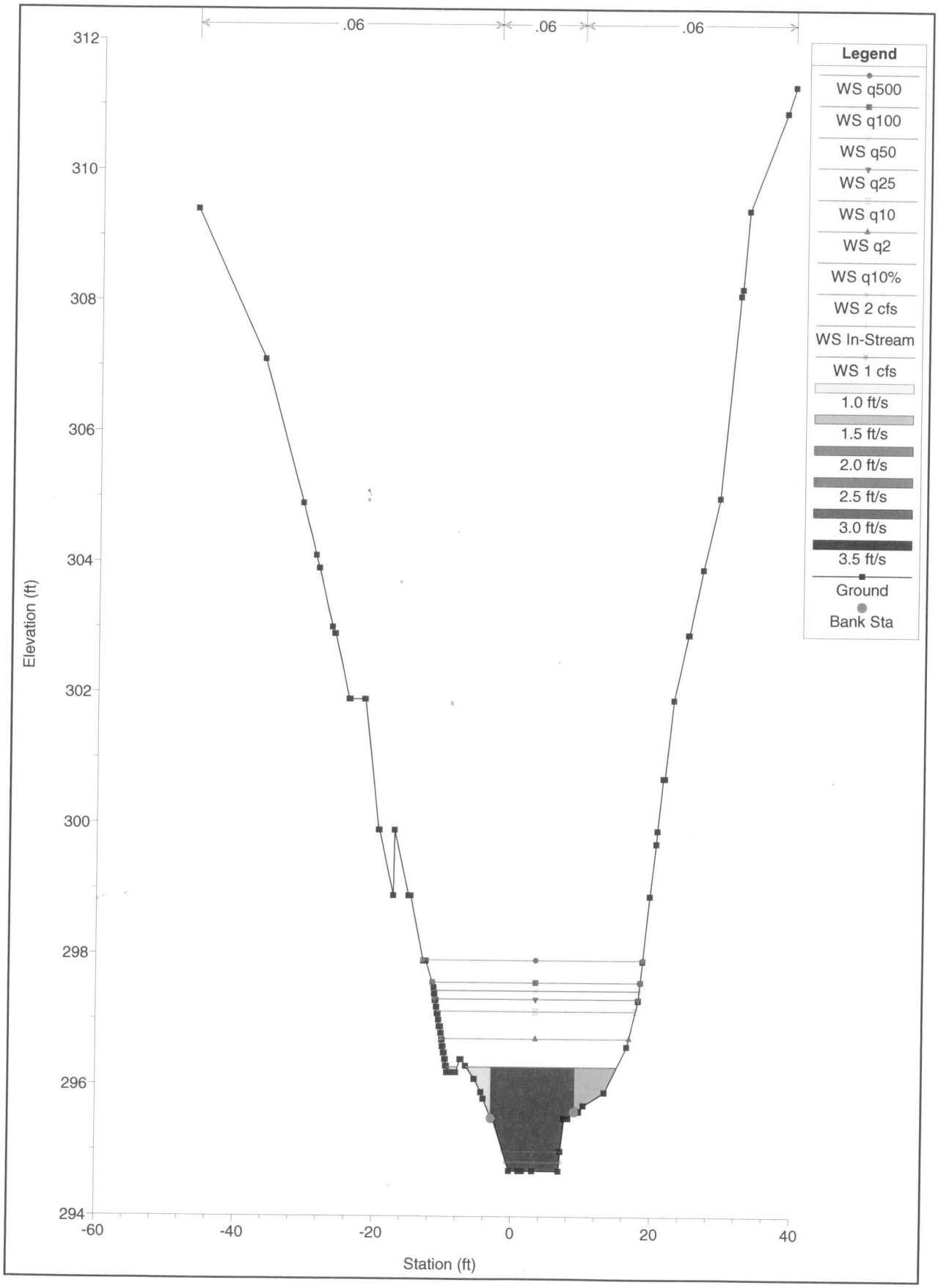
298
296
294
-60
-40
-20
0
20
40
60
Station (ft)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Legend
WS q500
WS q100
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WS q25
WS q10
WS q2
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3.0 ft/s
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Ground
Bank Sta
312
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Elevation (ft)
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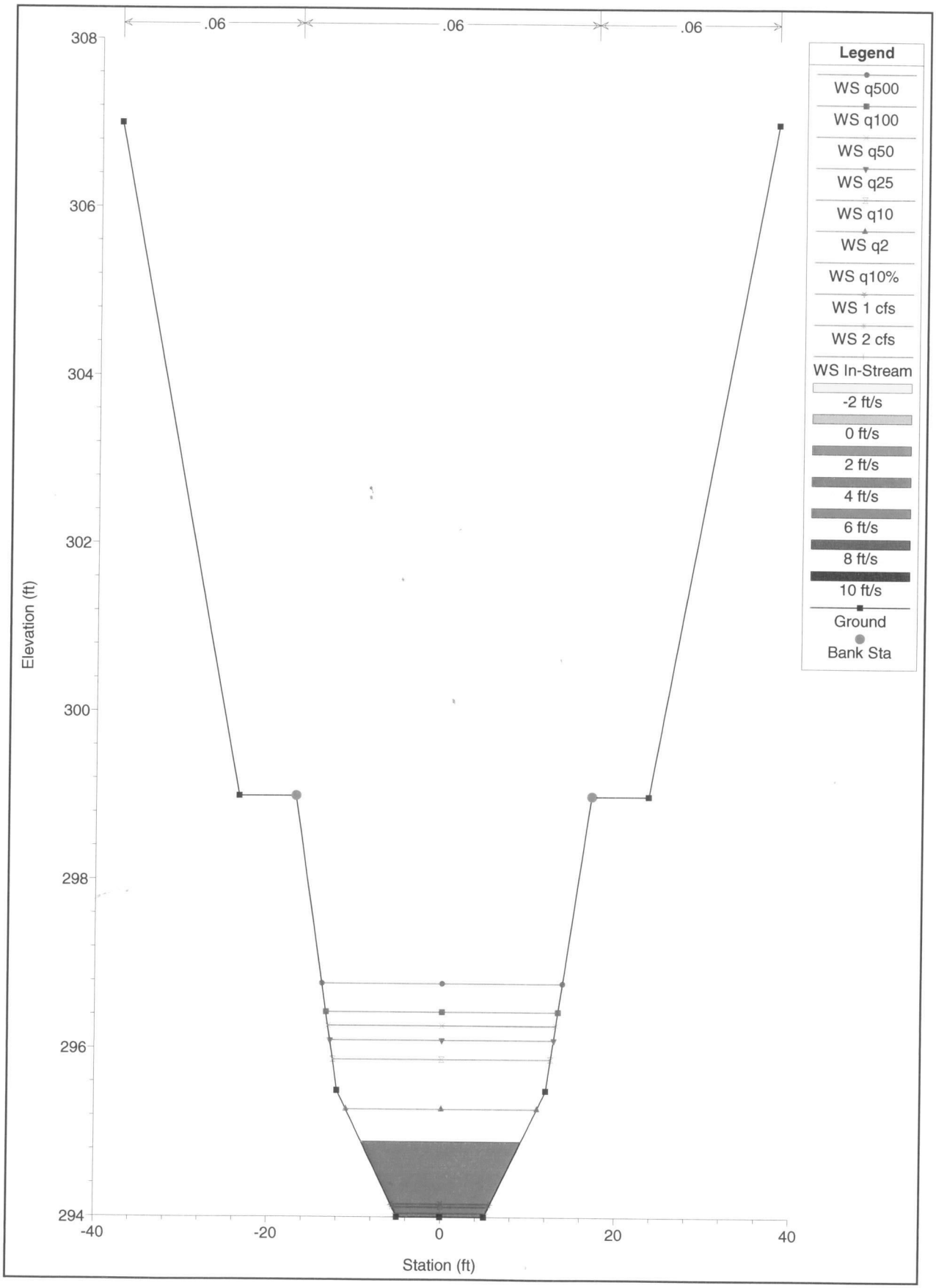
Station (ft)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Elevation (ft)
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-20
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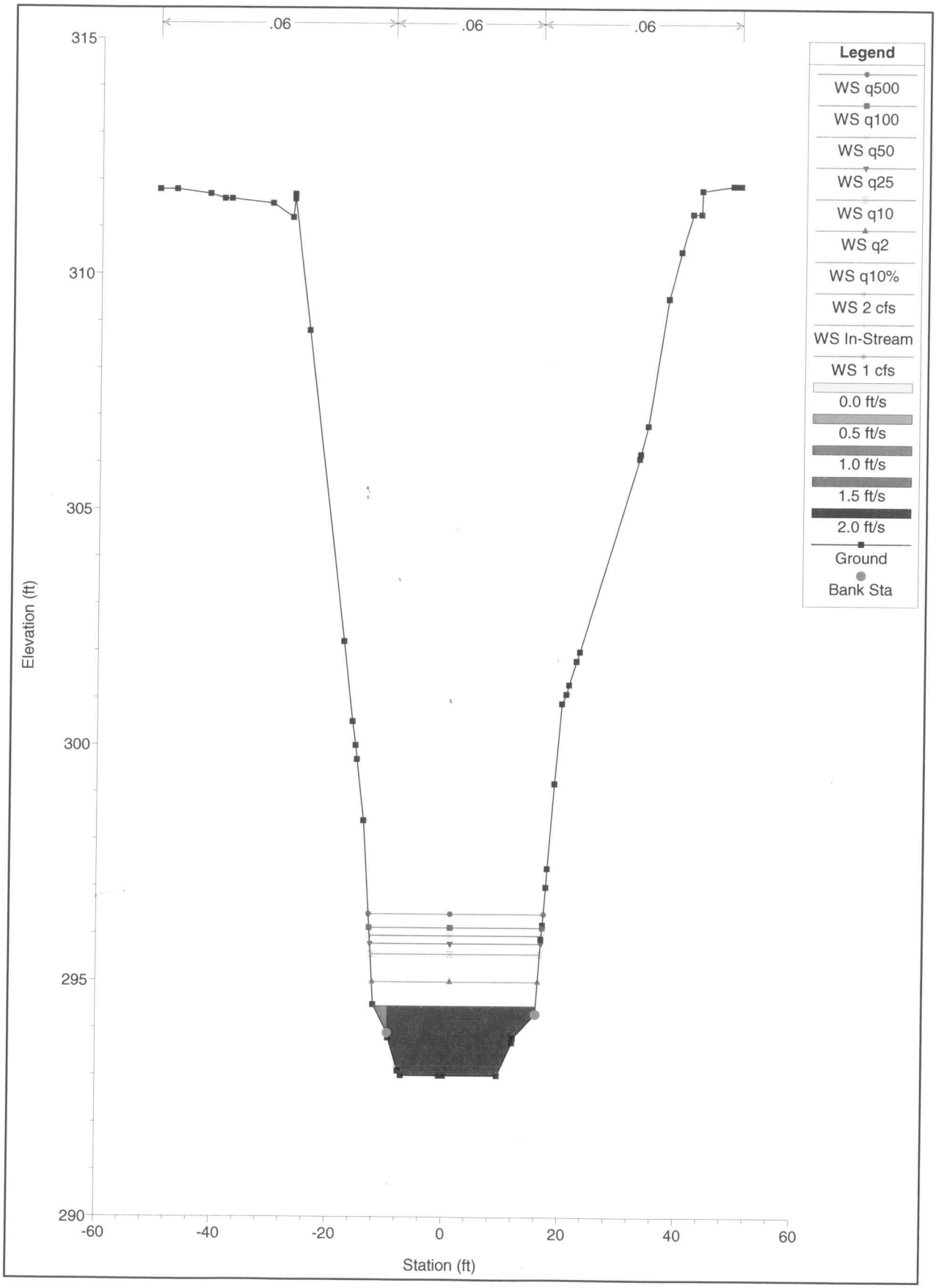
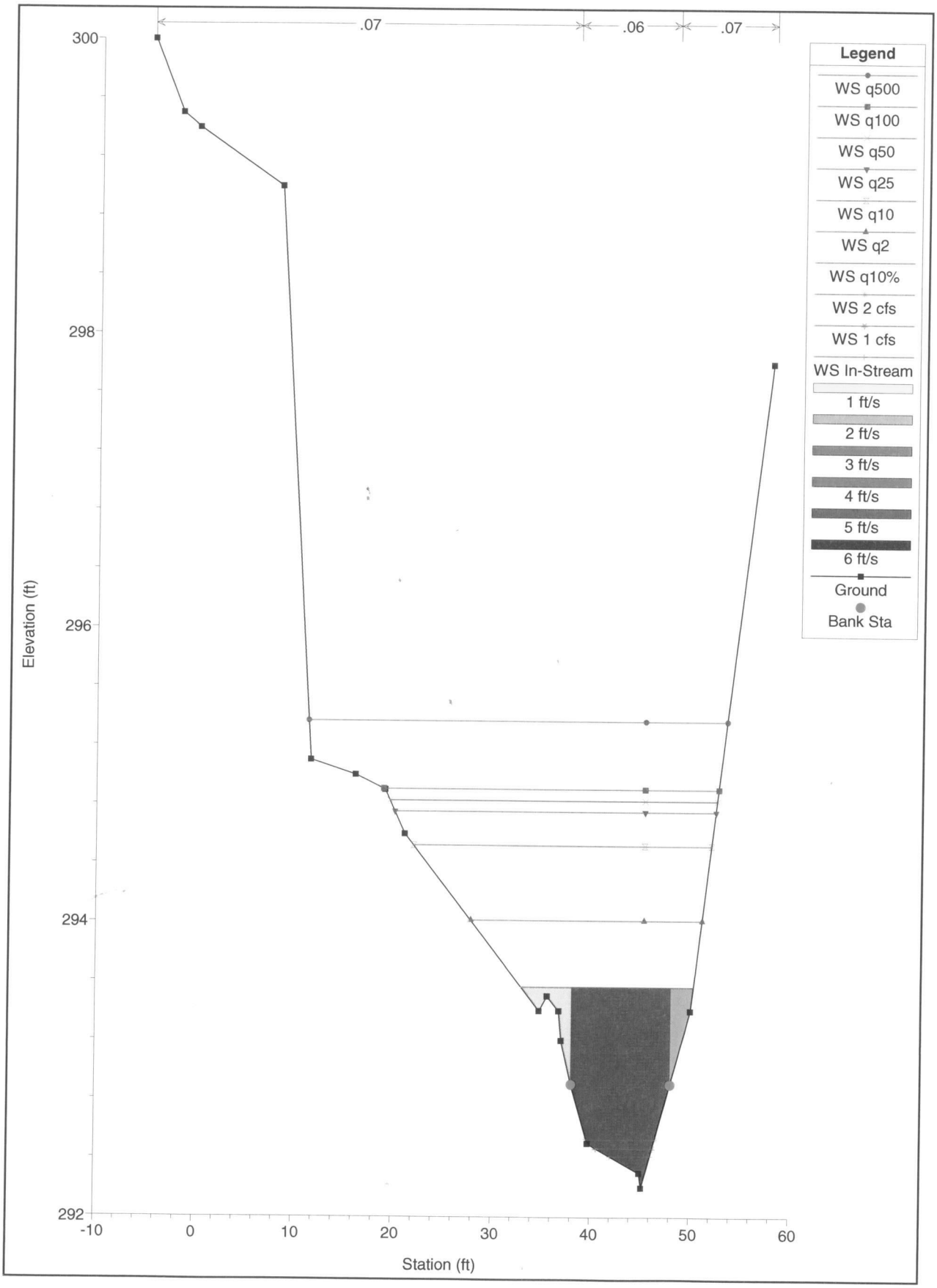
20
40
Station (ft)
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 1 cfs
WS 2 cfs
WS In-Stream
-2 ft/s
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta


.06
.06
.06
315
310
305
300
295
290
Elevation (ft)
-60
-40
-20
0
20
40
60
Station (ft)
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 2 cfs
WS In-Stream
WS 1 cfs
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
Ground
Bank Sta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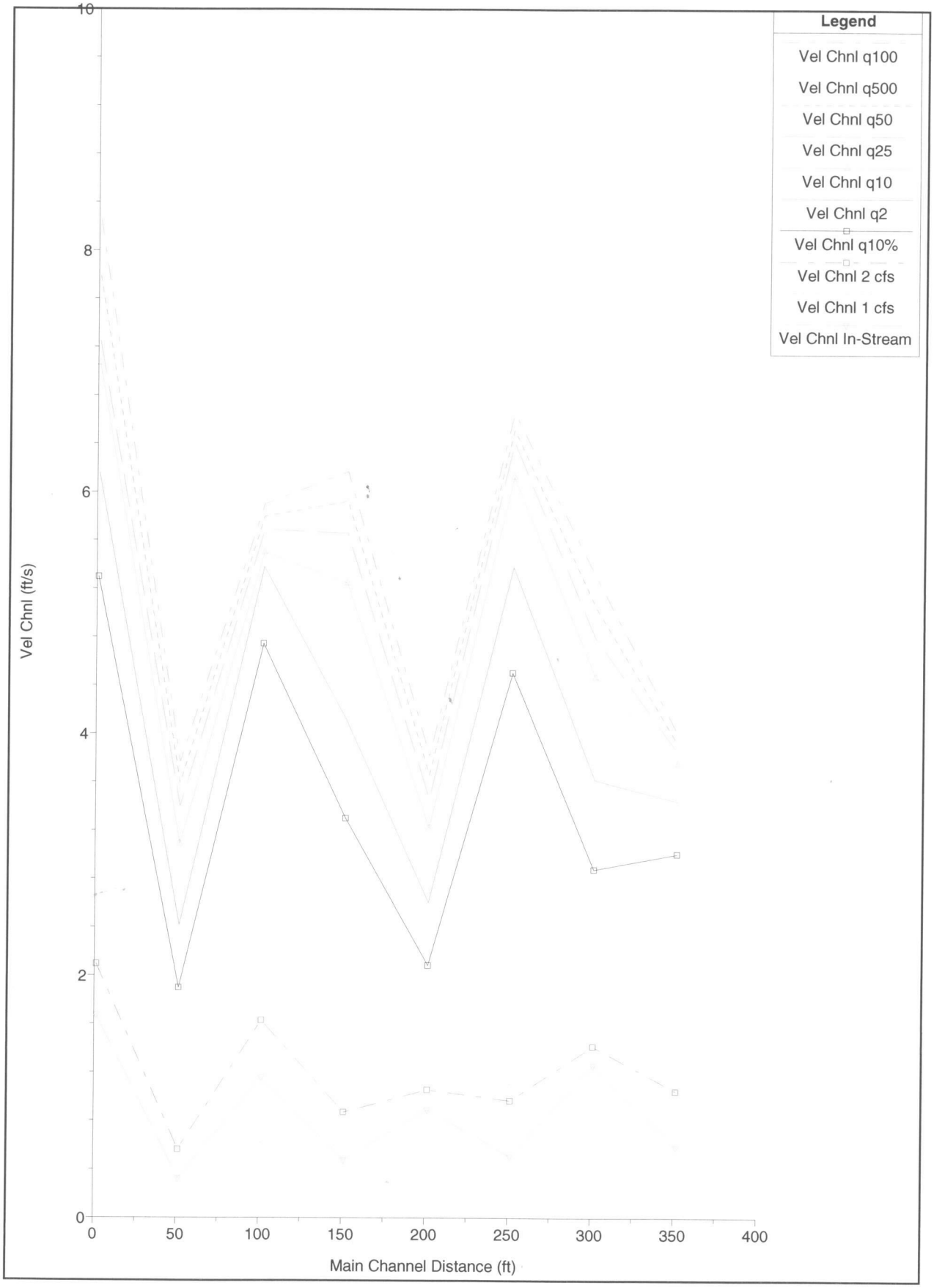
Legend
WS q500
WS q100
WS q50
WS q25
WS q10
WS q2
WS q10%
WS 2 cfs
WS 1 cfs
WS In-Stream
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta
300
298
296
294
292
Elevation (ft)
-10
0
10
20
30
40
50
60
Station (ft)


Legend
Vel Chnl q100
Vel Chnl q500
Vel Chnl q50
Vel Chnl q25
Vel Chnl q10
Vel Chnl q2
Vel Chnl q10%
Vel Chnl 2 cfs
Vel Chnl 1 cfs
Vel Chnl In-Stream
Vel Chnl (ft/s)
0
2
4
6
8
10
0
50
100
150
200
250
300
350
400
Main Channel Distance (ft)

APPENDIX E

Biological Correspondence

Clearing House Contact List:

Agency	Contact	Address	Phone Number	email	Date Sent	Response?
NOAA - NMFS Northwest Region	D. Robert Lohn	7600 Sand Point Way N. E. Bldg 1 Seattle, WA 98115			11/4/2009	N
ODFW - Northwest Region Fish and Wildlife Biologist	Dick Calwell	17330 SE Evelyn Street Clackamas, OR 97015	503-657-2000 ext. 235		11/4/2009	N
DSL Western Regional Resources Coordinated	Joy Vaughan	775 Summer Street NE, Ste 100 Salem, OR 97301	503-986-5200	joy.vaughan@state.or.us	11/4/2009	Y
COE, Portland District		PO Box 2946 Portland, OR 97208	(503) 808-4760		11/4/2009	
SHPO	Roger Roper	725 Summer Street NE, Ste C Salem, OR 97301	503-986-0677		11/4/2009	
ODOT - Northwest Area	Larry McKinley	350 W. Marine Drive Astoria, OR 97103	503-325-7222	Larry.MCKINLEY@odot.state.or.us	11/4/2009	Y
DEQ - Tillamook		2310 First Street, Suite 4 Tillamook, OR 97141	503-842-3038		11/13/2009 (originally sent on 11/4/09)	N
Oregon's Legislative Commission on Indian Services	Karen Quigley	900 Court St. NE, Room 167, Salem OR 97301	(503) 986-1067	Karen.Quigley@state.or.us	11/4/2009	Y
OWRD - Western Region	Bill Ferber	725 Summer Street NE, Ste A Salem, OR 97301	503-986-0893		11/4/2009	Y
Tillamook County Contracts, Facilities, and Fleet Director	Paul Levesque	201 Laurel Ave. Tillamook, OR 97141	503-824-1809	plevesqu@co.tillamook.or.us	11/4/2009	Y
Oregon Department of Forestry Tillamook District	Andy White	5005 Third Street Tillamook, OR 97141	503-842-2545	awhite@odf.state.or.us	11/4/2009	N
USFWS - Pacific Region		911 NE 11th Ave. Portland, OR 97232	503-231-6120		11/4/2009	N
Drinking WaterProgrm	Chris Hughes	PO Box 14450 Portland, OR 97293	971-673-0411	christopher.l.hughes@state.or.us	11/4/2009	N
Tribes of Siletz, Cultural Resources	Robert Kentta		541-444-8244	rkennta@ctsi.nsn.us	11/11/2009 (email)	N
Tribes of Siletz, Natural Resources	Mike Kennedy		541-444-8232	mikek@ctsi.nsn.us	11/11/2009 (email)	N
Tribes of Grande Ronde, Cultural Resources	Eirik Thorsard		503-879-1630	Eirik.thorsgard@grandronde.org	11/11/2009 (email)	Y
Tribes of Grande Ronde, Natural Resources	Mike Wilson		503-879-2380	Mike.Wison@grandronde.org	11/11/2009 (email)	Y

Paul forwarded letter to
Valerie Soilihi at Planning
Department

Date

Agency
Contact Name
Address

Re: Notification of the Jetty Creek Impoundment Dam Improvements at the City of Rockaway Beach

Dear Contact name,

The City of Rockaway Beach seeks to reconstruct a permitted water intake structure and stream channel that have silted in over time. The work shall relocate the Jetty Creek channel back to its original streambed allowing for fish passage while preserving the existing location of the impoundment and point of diversion in compliance with the water rights.

The City is currently performing a study to determine the feasibility of various design alternatives for this project. As part of this study, we would like to identify potential impacts to biological resources in the area and develop design alternatives that would minimize or mitigate these impacts.

Background

The City of Rockaway Beach is located along the Oregon Coast, approximately 80 miles west of Portland and 15 mile north of Tillamook. The City owns and operates a water treatment plant in an easement from Green Diamond Resource Company, on Jetty Creek. The treatment plant is located directly upstream of the new Jetty Creek bridge on Oregon Coast Highway 101, at milepost 47.52 in Township 2N, Range 10W, Section 17 NESE. This plant has a concrete impoundment dam for storage of water for the intake. The City is in the process of upgrading the treatment plant and intake facilities.

The existing impoundment dam includes a fish ladder, however, the ladder was built too steep and does not allow passage. This fish barrier represents the last remaining obstruction in Jetty Creek drainage way to extend fish passage another two miles upstream.

As part of the intake improvement, the City would like to modify the impoundment to provide a bypass channel for fisheries. This project is an important project and is in compliance with the local fisheries program.

The City has applied for and obtained a grant to perform a Biological Inventory in an effort to ensure that the developed project is not likely to jeopardize the continued existence of Oregon Coast Coho salmon, or result in the destruction or adverse modification of the essential fish habitat.

In 2008, the State Highway Division completed the Jetty Creek Bridge Replacement project 700' downstream of the existing impoundment. The State provided a Biological Assessment, which was reviewed by NMFS. NMFS provided a Biological Opinion of incidental take statement describing reasonable and prudent measures necessary to minimize the impact of incidental take associated with the work.

ODOT's biological assessment was combined with several other projects and submitted on May 8, 2008. [Federal Aid # S009(266), (KN13807) Watershed (171002020000564 HUC] A Biological Opinion was given on July 23, 2008 (NMFS No. 2008/03748).

We request any comments or concerns that you may have regarding environmental impacts of this project. Enclosed are maps showing the project vicinity and existing site conditions. We have also included a preliminary drawing to show our intended scope of work at this time. This scope may change through the process of the feasibility study and based on comments received regarding the biological inventory.

Please respond within 30 days with any concerns. If you need any additional information, please contact me at (503) 625-8065 or clombard@hbh-consulting.com.

Sincerely,
HBH Consulting Engineers, Inc.

Cindi Lombard
Project Designer

Enclosure

Oregon
Theodore R. Kulongoski, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St NE, Ste C
Salem, OR 97301-1266
(503) 986-0671
Fax (503) 986-0793
www.oregonheritage.org

August 09, 2010

Ms. Cindi Lombard
HBH Consulting Engs
20015 SW Pacific Hwy STE 101
Sherwood, OR 97140

RE: SHPO Case No. 09-2454
Jetty Creek Impoundment Dam Improve Proj
Construct water intake structure/stream channel
HBH Consulting/City of Rockaway
2N 10W 17, Rockaway, Tillamook County

Dear Ms. Lombard:

Our office recently received a request to review the proposal for the project referenced above. In checking our statewide cultural resource database, I find that there have been no previous cultural resource surveys completed near the proposed project area. However, the project area lies within an area generally perceived to have a high probability for possessing archaeological sites and/or buried human remains.

While not having sufficient knowledge to predict the likelihood of cultural resources being within your project area, extreme caution is recommended during future ground disturbing activities. ORS 358.905 and ORS 97.740 protect archaeological sites and objects and human remains on state public and private lands in Oregon. If any cultural material is discovered during construction activities, all work should cease immediately until a professional archaeologist can assess the discovery. If your project has a federal nexus (i.e., federal funding, permitting, or oversight) please coordinate with your federal agency representative to ensure that you are in compliance with Section 106 of the NHPA.

If you have any questions about my comments or would like additional information, please feel free to contact our office at your convenience. In order to help us track your project accurately, please be sure to reference the SHPO case number above in all correspondence.

Dennis Griffin, Ph.D., RPA
State Archaeologist
(503) 986-0674
dennis.griffin@state.or.us

Oregon
Theodore R. Kulongoski, Governor

Parks and Recreation Department
State Historic Preservation Office
725 Summer St NE, Ste C
Salem, OR 97301-1266
(503) 986-0671
Fax (503) 986-0793
www.oregonheritage.org

August 03, 2010

Ms. Cindi Lombard
HBH Consulting Engineers
20015 SW Pacific Hwy STE 101
Sherwood, OR 97140

RE: SHPO Case No. 09-2454
Jetty Creek Impoundment Dam Improve Project
2N 10W 17, Rockaway, Tillamook

Dear Ms. Lombard:

Thank you for your submission of documentation on the project referenced above. This letter is an inquiry regarding the buildings/structures that comprise the Jetty Creek Impoundment Dam. The case file was misplaced, and just resurfaced. Therefore, we did not respond within the 30-day review period. Please note that this is not our standard procedure and we will make every effort to respond in a timely manner in the future.

If you are still seeking comments or concerns regarding environmental impacts of this project, I am requesting that you supply additional information regarding the existing buildings/structures.

1. Are the buildings/structures 50 years old or older (or will be at the time the project will be constructed)?
   - If not, there is no requirement from our agency regarding the review of the project for effects to above-ground historic resources. In this case, please let us know the dates of original construction and we will note that in our records.
2. If there are buildings/structures that are 50 years old or older, do they retain their historic components (integrity)? If so, they would be considered eligible for listing in the National Register.
3. If eligible for the National Register, a Finding of Effect (no effect, no adverse effect, or adverse effect) would need to be completed.

Therefore, if the buildings/structures meet the 50-year threshold, we would appreciate receiving photographs, and any additional description information, including your evaluation of eligibility. By completing a determination of eligibility during the planning phase, we will know whether or not there will need to be a finding of effect once the project is designed.

This letter refers to above-ground historic resources only. Comments pursuant to a review for archaeological resources will be sent separately. Please let me know if you have any questions or concerns and include the reference SHPO Case No. 09-2454 in any subsequent correspondence.

Sincerely,

Julie Osborne

Julie Osborne
Preservation Specialist
(503) 986-0661 or Julie.Osborne@state.or.us

As of August 2009, a redesigned form is available for Section 106 and ORS 358.653 projects. Find it on our updated and expanded Review and Compliance website: www.oregonheritage.org. Click on the "Review and Compliance" link.

Cindi Lombard

From: Eirik Thorsgard [Eirik.Thorsgard@grandronde.org]
Sent: Thursday, November 12, 2009 12:49 PM
To: Cindi Lombard
Subject: RE: City of Rockaway Beach Jetty Creek Impoundment Project

Hello Cindi,
The Confederated Tribes of the Grand Ronde Community of Oregon Cultural Resources Department has reviewed this proposed project and has no comments or concerns regarding this project at this time.

Eirik Thorsgard MAIS
Cultural Protection Coordinator
Interim Tribal Historic Preservation Officer
Confederated Tribes of the Grand Ronde Community of Oregon
PhD Candidate Flinders University Adelaide, Australia

From: Cindi Lombard [mailto:clombard@hbh-consulting.com]
Sent: Wednesday, November 11, 2009 7:45 AM
To: Eirik Thorsgard
Subject: City of Rockaway Beach Jetty Creek Impoundment Project

Dear Mr. Thorsgard,

Karen Quigley has indicated that the Confederated Tribes of Grand Ronde should be provided information on the City of Rockaway Beach's proposed Jetty Creek Impoundment Project and consulted regarding potential impacts to natural/cultural resources. Attached is a letter providing a brief project description as well as several maps showing the project vicinity, existing conditions, and proposed improvements. If you have any questions, please do not hesitate to contact me. Thank you.

Cindi Lombard
HBH Consulting Engineers, Inc.
20015 SW Pacific Hwy, Sherwood, OR 97140
Phone: (503) 625-8065
Fax: (503) 625-1531

Cindi Lombard

From: CARY Molly A [Molly.A.CARY@odot.state.or.us]
Sent: Friday, November 06, 2009 4:55 PM
To: MCKINLEY Larry * ODOT
Cc: GISLER Steven * ODOT; FRANCIS Ronald L
Subject: FW: City of Rockaway & Jetty Creek Impoundment Dam
Attachments: 3526_001.pdf; 3527_001.pdf

Larry -

I am forwarding your document to Steve Gisler and Ron Francis who were the ODOT Biologist and Wetland specialist on ODOT's Jetty Creek project. They can provide comment to you separately.

ODOT's concerns should be limited to the impacts to our property. Our project at Jetty Creek provided fish passage and wetland mitigation. We have a permitted obligation to maintain both of those functions; the city's project should not affect the water flow to our mitigation sites so that fish can not pass under Highway 101 from the velocity being too high or water being denied in the system. Similarly, hydraulics in the wetland should not be affected to the point that the wetland ceases to function. And of course we don't want the highway to be overtopped by water in a rain event. This would be the best scenario given the use of public funds.

HOWEVER, when permitting the city's project regulatory agencies should take into account down stream affects. For example, if their project dried out the mitigation site it would be up to the regulator to require the city to mitigate our mitigation, and ODOT would need to be taken off the hook for our permit obligations. Similarly if water velocities change so that fish passage is denied it is up to regulators to work with the city to deal with that change.

Water overtopping the highway or impacting the highway is entirely up to ODOT, the district I assume, to regulate.

So, unless Ron and Steve see another angle I don't think we have we need to be actively engaged in this project, but I appreciate the heads up.

Molly

From: MCKINLEY Larry * ODOT
Sent: Friday, November 06, 2009 4:20 PM
To: CARY Molly A
Subject: City of Rockaway & Jetty Creek Impoundment Dam

Molly,

I don't know if we have any role in this effort. If we do it will come from your shop. Please see attached documents.

<<3526_001.pdf>> <<3527_001.pdf>>

Larry McKinley
Northwest Area Manager
Oregon Department of Transportation
350 W. Marine Drive
Astoria, Oregon 97103

Office: 503-325-7222
Fax: 503-325-1314

Cindi Lombard

From: GISLER Steven * ODOT [Steven.GISLER@odot.state.or.us]
Sent: Monday, November 09, 2009 8:49 AM
To: CARY Molly A; MCKINLEY Larry * ODOT
Cc: FRANCIS Ronald L
Subject: RE: City of Rockaway & Jetty Creek Impoundment Dam

Hi Larry, I'm really happy to hear this project is moving forward, as it will remove the last major obstacle to fish passage and greatly improve coho salmon, sea-run cutthroat, and pacific lamprey productivity in the stream. Molly addressed my main concerns with regard to potential impacts to our own project and infrastructure. You might pass on the recommendation to the city/consultants that they might ask NMFS and the Corps about using the Restoration Module of the SLOPES IV Programmatic for ESA coverage on this project…I think it might fit and would save a lot of time and money in permitting.

Let me know if you have any questions,
Steve

From: CARY Molly A
Sent: Friday, November 06, 2009 4:55 PM
To: MCKINLEY Larry * ODOT
Cc: GISLER Steven * ODOT; FRANCIS Ronald L
Subject: FW: City of Rockaway & Jetty Creek Impoundment Dam

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Larry McKinley
Northwest Area Manager
Oregon Department of Transportation
350 W. Marine Drive
Astoria, Oregon 97103
Office: 503-325-7222
Fax: 503-325-1314

Cindi Lombard

From: FRANCIS Ronald L [Ronald.L.FRANCIS@odot.state.or.us]
Sent: Monday, November 09, 2009 9:47 AM
To: MCKINLEY Larry * ODOT
Cc: CARY Molly A
Subject: RE: City of Rockaway & Jetty Creek Impoundment Dam

Larry;

Based on the information in the below email, the proposal would not negatively influence the hydrology in the wetland mitigation site, as it functions independently from Jetty Creek.

Ron Francis
Wetland Specialist
Oregon Department of Transportation
Region 2 Technical Center
455 Airport Rd., Building B
Salem, OR 97301
Office Phone: (503) 986-2817
Cell Phone: (503) 508-2636

From: CARY Molly A
Sent: Friday, November 06, 2009 4:55 PM
To: MCKINLEY Larry * ODOT
Cc: GISLER Steven * ODOT; FRANCIS Ronald L
Subject: FW: City of Rockaway & Jetty Creek Impoundment Dam

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Larry McKinley
Northwest Area Manager
Oregon Department of Transportation
350 W. Marine Drive
Astoria, Oregon 97103
Office: 503-325-7222
Fax: 503-325-1314

APPENDIX F

Special Species Lists

FEDERALLY LISTED, PROPOSED, CANDIDATE SPECIES
AND SPECIES OF CONCERN
UNDER THE JURISDICTION OF THE FISH AND WILDLIFE SERVICE
WHICH MAY OCCUR WITHIN TILLAMOOK COUNTY, OREGON

LISTED SPECIES

Birds

Marbled murrelet	*Brachyramphus marmoratus*	CH T
Western snowy (coastal) plover	*Charadrius alexandrinus nivosus*	CH T
Short-tailed albatross	*Phoebastria albatrus*	E
Northern spotted owl	*Strix occidentalis caurina*	CH T

Reptiles and Amphibians

Marine:

Loggerhead sea turtle	*Caretta caretta*	E
Green sea turtle	*Chelonia mydas*	T
Leatherback sea turtle	*Dermochelys coriacea*	E
Olive (=Pacific) ridley sea turtle	*Lepidochelys olivacea*	T

Invertebrates

Insects:

Oregon silverspot butterfly	*Speyeria zerene hippolyta*	CH T

Plants

Nelson's checker-mallow	*Sidalcea nelsoniana*	T

PROPOSED SPECIES

None

No Proposed Endangered Species	PE
No Proposed Threatened Species	PT

SPECIES OF CONCERN

Mammals

White-footed vole	*Arborimus albipes*
Red tree vole	*Arborimus longicaudus*
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*
California wolverine	*Gulo gulo luteus*
Silver-haired bat	*Lasionycteris noctivagans*
Long-eared myotis bat	*Myotis evotis*
Fringed myotis bat	*Myotis thysanodes*
Long-legged myotis bat	*Myotis volans*
Yuma myotis bat	*Myotis yumanensis*

Birds

Olive-sided flycatcher	*Contopus cooperi*
Black oystercatcher	*Haematopus bachmani*
Harlequin duck	*Histrionicus histrionicus*
Lewis' woodpecker	*Melanerpes lewis*
Mountain quail	*Oreortyx pictus*

Band-tailed pigeon	*Patagioenas fasciata*
Purple martin	*Progne subis*

Reptiles and Amphibians

Northern Pacific pond turtle	*Actinemys marmorata marmorata*
Coastal tailed frog	*Ascaphus truei*
Northern red-legged frog	*Rana aurora aurora*
Southern torrent (seep) salamander	*Rhyacotriton variegatus*

Fish

River lamprey	*Lampetra ayresi*
Pacific lamprey	*Lampetra tridentata*
Coastal cutthroat trout	*Oncorhynchus clarki ssp*

Plants

Pink sand-verbena	*Abronia umbellata ssp. breviflora*
Bog anemone	*Anemone oregana var. felix*
Saddle Mountain bittercress	*Cardamine pattersonii*
Pt. Reyes bird's-beak	*Cordylanthus maritimus ssp. palustris*
Frigid shootingstar	*Dodecatheon austrofrigidum*
Coast Range fawn lily	*Erythronium elegans*
Queen-of-the-forest	*Filipendula occidentalis*
Frye's Limbella	*Limbella fryei*
San Francisco bluegrass	*Poa unilateralis*
Saddle Mountain saxifrage	*Saxifraga hitchcockiana*
Henderson's checker-mallow	*Sidalcea hendersonii*
Bristly-stemmed sidalcea	*Sidalcea hirtipes*
Cascade Head catchfly	*Silene douglasii var. oraria*

DELISTED SPECIES

Birds

Aleutian Canada goose	*Branta canadensis leucopareia*
American Peregrine falcon	*Falco peregrinus anatum*
Bald eagle	*Haliaeetus leucocephalus*
Brown pelican	*Pelecanus occidentalis*

Definitions:

Listed Species: An endangered species is one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future.

Proposed Species: Taxa for which the Fish and Wildlife Service or National Marine Fisheries Service has published a proposal to list as endangered or threatened in the Federal Register.

Candidate Species: Taxa for which the Fish and Wildlife Service has sufficient biological information to support a proposal to list as endangered or threatened.

Species of Concern: Taxa whose conservation status is of concern to the U.S. Fish and Wildlife Service

Scientific Name: ***Charadrius alexandrinus nivosus***
Common Name: **Western snowy plover**

EO NUM: 44
EO ID: 54

Federal Status: PS:LT GRANK: G4T3 NHP List: 2
State Status: LT SRANK: S2 HP Track: Y
Category: Vertebrate Animal
ELCODE: ABNNB03031

Confirmed: First Obs: 1984 Last Obs: 1988 EO Rank:

Directions: NEHALEM SPIT, NEHALEM BAY STATE PARK

County Name	Ecoregion	Owner Name/Type
Tillamook	CR ME	STATE

Watershed
1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName
002N010W	08		45123-F8	Nehalem

Managed Area Name
NEHALEM BAY STATE PARK

Source Feature [Uncertainty Type (Distance)] Use Class
54 Polygon [Areal - Delimited (8 m)]

Annual Observations
- 1993-WINTER - 0 PLOVERS
- 1992-WINTER - 0 PLOVERS
- 1992-SUMMER - 0 PLOVERS
- 1991-WINTER - 0 PLOVERS
- 1991-SUMMER - 0 PLOVERS
- 1988-90-SUMMER/WINTER - NOT SURVEYED
- 1986-87-SUMMER - NOT SURVEYED
- 1985-SUMMER - 0 PLOVERS
- 1985-87-WINTER - 0 PLOVERS
- 1984-WINTER - NOT SURVEYED
- 1984-SUMMER - 1 PLOVER
- 1982-83-WINTER - 2 PLOVERS
- 1978-83-SUMMER - 0 PLOVERS

Feature ID Date Source Observation data

Occurence Data

EO Type:
Minimum Elev.(m): -339
EO Data: 1988-1 SNOWY PLOVER OBSERVED DURING BREEDING SEASON AS REPORTED BY ODFW. SEE ANNOBS
EO Comments: COASTAL SAND DUNE SYSTEM
Protection:
Management:
General:

Scientific Name: ***Oncorhynchus keta pop. 4***
Common Name: **Chum salmon (Pacific Coast ESU)**

EO NUM: 42
EO ID: 10384

Federal Status: GRANK: G5T3Q NHP List: 2
State Status: SC SRANK: S2 HP Track: Y
Category: Vertebrate Animal
ELCODE: AFCHA02024

Confirmed: First Obs: 1999-PRE Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)

Directions: NEHALEM BAY AND TRIBUTARIES

County Name	Ecoregion	Owner Name/Type
Tillamook	CR ME	

Watershed
17100202 - Nehalem

Town-Range	Sec	Note	QuadCode	QuadName
			45123-F7	Foley Peak
			45123-F8	Nehalem
			45123-G7	Soapstone Lake

Managed Area Name

Source Feature [Uncertainty Type (Distance)] Use Class
Data currently not available.

Annual Observations

Feature ID Date Source Observation data

Occurence Data

EO Type: REARING & MIGRATION - fish
Minimum Elev.(m):
EO Data: 2009: Classified as rearing by ODFW. Undocumented fish observation. 1999: ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE

EO Comments:

Protection:

Management:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THEINFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF CHUM IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT. Updated with 2009 ODFW data.

Scientific Name: ***Oncorhynchus kisutch pop. 3***
Common Name: **Coho salmon (Oregon Coast ESU)**

EO NUM: 757
EO ID: 2239

Federal Status: LT GRANK: G4T2Q NHP List: 1 Category: Vertebrate Animal
State Status: SV SRANK: S2 HP Track: Y ELCODE: AFCHA02033
Confirmed: First Obs: 2002 Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)
Directions: NEHALEM RIVER & TRIBUTARIES

County Name	Ecoregion	Owner Name/Type
Clatsop	CR	PRIVATE; STATE
Columbia	ME	
Tillamook		
Washington		

Watershed
1710020201 - UPPER NEHALEM RIVER
1710020202 - MIDDLE NEHALEM RIVER
1710020203 - LOWER NEHALEM RIVER
1710020204 - SALMONBERRY RIVER
1710020205 - NORTH FORK NEHALEM RIVER
1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName
005N004W	23		45123-F4	Cochran
005N007W	28		45123-F5	Rogers Peak
005N007W	26		45123-F6	Cook Creek
005N005W	27		45123-F7	Foley Peak
005N005W	25		45123-F8	Nehalem
005N004W	25		45123-G1	Bacona
005N007W	32		45123-G2	Vernonia
005N005W	33		45123-G3	Clear Creek
005N005W	35		45123-G5	Elsie
005N004W	31		45123-G6	Hamlet
005N004W	33		45123-G7	Soapstone Lake
005N004W	36		45123-H1	Baker Point
005N004W	35		45123-H2	Pittsburg
004N005W	06		45123-H3	Birkenfeld
004N005W	01		45123-H4	Sager Creek
004N004W	04		45123-H5	Vinemaple
004N004W	01		46123-A3	Marshland
004N003W	06		46123-A4	Nicolai Mountain
004N004W	03			
004N004W	05			
004N005W	05			
004N007W	04			
006N005W	08			
005N004W	34			
005N004W	32			
005N005W	36			
005N005W	34			
005N005W	32			
005N007W	33			
005N004W	26			
005N004W	27			
005N005W	26			
005N005W	28			
005N007W	29			
005N004W	24			
005N007W	24			
005N007W	22			
005N004W	14			
005N004W	15			

Managed Area Name
TILLAMOOK STATE FOREST
CLATSOP STATE FOREST

006N005W	19
006N006W	23
006N005W	22
006N005W	24
006N006W	29
006N006W	28
006N005W	30
006N006W	25
006N005W	25
006N004W	29
006N006W	32
006N006W	34
006N004W	33
005N006W	06
005N006W	04
005N007W	01
005N004W	03
005N007W	12
005N004W	11
005N004W	16
005N007W	21
005N007W	23
005N004W	22

Source Feature [Uncertainty Type (Distance)] Use Class

Annual Observations

Data currently not available.

Feature ID Date Source Observation data

Occurence Data

EO Type: REARING & MIGRATION - fish

Minimum Elev.(m):

EO Data: 2009: Classified as rearing by ODFW. Documented fish observations on Bobs Creek and Beneke Creek. ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.

EO Comments:

Protection:

Management:

General: Distribution information used in creating this EOR was derived from draft ODFW maps generated and distributed in 1999. Unless specific data exists in the data field, the information presented in this EOR represents the "best professional judgement" by ODFW's district fisheries biologist; the presence of coho in described areas should be considered undocumented but as having a potential of being present. EOR was updated using ODFW geographic resources data produced and distributed in 2004. Nehalem fish hatchery is located on the North Fork Nehalem River near the confluence of Soapstone Creek.

Scientific Name: ***Oncorhynchus kisutch pop. 3***

Common Name: **Coho salmon (Oregon Coast ESU)**

EO NUM: 758

EO ID: 19079

Federal Status: LT GRANK: G4T2Q NHP List: 1

State Status: SV SRANK: S2 HP Track: Y

Category: Vertebrate Animal

ELCODE: AFCHA02033

Confirmed: First Obs: 1999-PRE Last Obs: 1999-PRE EO Rank:

Directions: JETTY CREEK

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR ME	PRIVATE	1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
			45123-F8	Nehalem	

Source Feature [Uncertainty Type (Distance)] Use Class

Annual Observations

Data currently not available.

Feature ID Date Source Observation data

Occurence Data

EO Type: SPAWNING & REARING - fish

Minimum Elev.(m):

EO Data: ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF COHO IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus kisutch pop. 3*** EO NUM: 760
Common Name: **Coho salmon (Oregon Coast ESU)** EO ID: 1339
Federal Status: LT GRANK: G4T2Q NHP List: 1 Category: Vertebrate Animal
State Status: SV SRANK: S2 HP Track: Y ELCODE: AFCHA02033
Confirmed: First Obs: 2002 Last Obs: 2002 EO Rank:
Directions: FOLEY CREEK & TRIBUTARIES

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR	PRIVATE	1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
002N009W	08		45123-F7	Foley Peak	
002N010W	12		45123-F8	Nehalem	
002N009W	06				
003N010W	36				
002N010W	23				
002N009W	18				
002N010W	13				
002N010W	22				
002N010W	24				
002N010W	01				
002N009W	05				
002N009W	07				

Source Feature [Uncertainty Type (Distance)] Use Class — Annual Observations
Data currently not available.

Feature ID Date Source Observation data

Occurence Data
EO Type: SPAWNING & REARING - fish Minimum Elev.(m):
EO Data: 1992: ODFW SURVEYED 2 SEGMENTS OF FOLEY CREEK (1.1 & 0.6 MILES) AND GENERATED AN ESTIMATED SPAWNING DENSITY OF 4 AND 7 FISH/MILE. ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments: Primarily spawning and rearing use. In 2002 3 small tributaries to Foley Creek, west of Barnesdale, were added as rearing and migration use.
Protection:
Management:
General: Foley Creek is included in ODFW'S stratified random spawning survey program. Distribution information used in creating this EOR was derived from draft ODFW maps generated and distributed in 1999. Unless specific data exists in the data field, the information presented in this EOR represents the "best professional judgement" by ODFW's district fisheries biologist; the presence of coho in described areas should be considered undocumented but as having a potential of being present. EOR was updated using ODFW geographic resources data produced and distributed in 2004.

Scientific Name: ***Oncorhynchus kisutch pop. 3*** EO NUM: 871
Common Name: **Coho salmon (Oregon Coast ESU)** EO ID: 9524
Federal Status: LT GRANK: G4T2Q NHP List: 1 Category: Vertebrate Animal
State Status: SV SRANK: S2 HP Track: Y ELCODE: AFCHA02033
Confirmed: First Obs: 1999-PRE Last Obs: 1999-PRE EO Rank:
Directions: CRESCENT LAKE

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR		17100203 - Wilson-Trusk-Nestuccu

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
			45123-F8	Nehalem	

Source Feature [Uncertainty Type (Distance)] Use Class
Data currently not available.

Annual Observations

Feature ID	Date	Source Observation data

Occurence Data

EO Type: REARING & MIGRATION - fish
Minimum Elev.(m):
EO Data: ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF COHO IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus kisutch pop. 3***
Common Name: **Coho salmon (Oregon Coast ESU)**

EO NUM: 875
EO ID: 23823

Federal Status: LT GRANK: G4T2Q NHP List: 1
State Status: SV SRANK: S2 HP Track: Y
Category: Vertebrate Animal
ELCODE: AFCHA02033

Confirmed: First Obs: 1999-PRE Last Obs: 1999-PRE EO Rank:
Directions: TRIBUTARY TO CRESCENT LAKE.

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR ME		1710020309 - NETARTS / SAND LAKE / NESKOWIN CREEK FRONTAL

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
			45123-F8	Nehalem	

Source Feature [Uncertainty Type (Distance)] Use Class
Data currently not available.

Annual Observations

Feature ID	Date	Source Observation data

Occurence Data

EO Type: SPAWNING & REARING - fish
Minimum Elev.(m):
EO Data: ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.
EO Comments:
Protection:
Management:
General: Distribution information used in this EOR was derived from ODFW geographic resources data produced and distributed in 1999. Unless specific data exists in the data field, the information presented in this EOR represents the "best professional judgement" by ODFW's district fisheries biologist; the presence of coho in described areas should be considered undocumented but as having a potential of being present. EOR was updated using ODFW geographic resources data produced and distributed in 2004.

Scientific Name: ***Oncorhynchus mykiss pop. 31***
Common Name: **Steelhead (Oregon Coast ESU, winter run)**

EO NUM: 488
EO ID: 4113

Federal Status: SOC GRANK: G5T2T3Q NHP List: 1
State Status: SV SRANK: S2S3 HP Track: Y
Category: Vertebrate Animal
ELCODE: AFCHA02136

Confirmed: First Obs: 1999-PRE Last Obs: 2009 EO Rank: E - Verified extant (viability not assessed)
Directions: FOLEY CREEK AND TRIBUTARIES

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR		1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
002N009W	09		45123-F7	Foley Peak	
002N009W	07		45123-F8	Nehalem	

002N009W	06
003N010W	36
002N010W	23
002N009W	18
002N010W	13
002N010W	22
002N010W	24
002N010W	01
002N009W	05
002N009W	08

Source Feature [Uncertainty Type (Distance)] Use Class — Annual Observations

Data currently not available.

Feature ID Date Source Observation data

Occurence Data

EO Type: SPAWNING & REARING - fish — Minimum Elev.(m):

EO Data: 2009: Classified as spawning by ODFW. Undocumented fish observations. WINTER RUN: ODFW DISTRIBUTIION MAPS USED TO CREATE THE 1:24,000 COVERAGE

EO Comments:

Protection:

Management:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 1999. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Oncorhynchus mykiss pop. 31***

Common Name: **Steelhead (Oregon Coast ESU, winter run)**

EO NUM: 538

EO ID: 13043

Federal Status: SOC GRANK: G5T2T3Q NHP List: 1

State Status: SV SRANK: S2S3 HP Track: Y

Category: Vertebrate Animal

ELCODE: AFCHA02136

Confirmed: First Obs: 1999-PRE Last Obs: 1999-PRE EO Rank:

Directions: NEHALEM BAY & RIVER

County Name	Ecoregion	Owner Name/Type	Watershed
Clatsop	CR		17100202 - Nehalem
Tillamook	ME		

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
			45123-F6	Cook Creek	
			45123-F7	Foley Peak	
			45123-F8	Nehalem	
			45123-G5	Elsie	
			45123-G6	Hamlet	

Source Feature [Uncertainty Type (Distance)] Use Class — Annual Observations

Data currently not available.

Feature ID Date Source Observation data

Occurence Data

EO Type: MIGRATION - fish — Minimum Elev.(m):

EO Data: WINTER RUN. ODFW DISTRIBUTION MAPS USED TO CREATE THE 1:24,000 COVERAGE.

EO Comments:

Protection:

Management:

General: DISTRIBUTION INFORMATION USED IN THIS EOR WAS DERIVED FROM ODFW GEOGRAPHIC RESOURCES DATA PRODUCED AND DISTRIBUTED IN 2001. UNLESS SPECIFIC DATA EXISTS IN THE DATA FIELD, THE INFORMATION PRESENTED IN THIS EOR REPRESENTS THE "BEST PROFESSIONAL JUDGMENT" BY ODFW'S DISTRICT FISHERIES BIOLOGIST; THE PRESENCE OF STEELHEAD IN DESCRIBED AREAS SHOULD BE CONSIDERED UNDOCUMENTED BUT AS HAVING A POTENTIAL OF BEING PRESENT.

Scientific Name: ***Progne subis***
Common Name: **Purple martin**

EO NUM: 129
EO ID: 14468

Federal Status: SOC GRANK: G5 NHP List: 2
State Status: SC SRANK: S2B HP Track: Y
Category: Vertebrate Animal
ELCODE: ABPAU01010

Confirmed: First Obs: 1998-06-22 Last Obs: 1998-06-22 EO Rank:

Directions: PARADISE COVE MARINA AND RV PARK ON THE NEHALEM BAY IS ABOUT 1 MI DOWNSREAM OF WHEELER. MARTINS NEST AT THE DOCK.

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR	PRIVATE	1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
002N010W	03		45123-F8	Nehalem	

Source Feature [Uncertainty Type (Distance)] Use Class
14468 Point [Areal - Estimated (50 m)]

Annual Observations

Feature ID Date Source Observation data

Occurence Data

EO Type:
EO Data: 1998: 7 PAIRS.
Minimum Elev.(m): 5
EO Comments: 5 PAIRS IS NESTING UNDER CAP ON PILING AND 2 ON APARTMENTS.
Protection:
Management: THIS SITE COULD HAVE MANY MORE NEST BOXES WITH PERMISSION OF PARADISE COVE MARINA.
General:

Scientific Name: ***Progne subis***
Common Name: **Purple martin**

EO NUM: 130
EO ID: 14469

Federal Status: SOC GRANK: G5 NHP List: 2
State Status: SC SRANK: S2B HP Track: Y
Category: Vertebrate Animal
ELCODE: ABPAU01010

Confirmed: First Obs: 1998-06-22 Last Obs: 1998-07-22 EO Rank:

Directions: BRIGHTON MARINA IS ON HWY 101 APPROXIMATELY 3 MI S OF WHEELER, ON NEHALEM BAY.

County Name	Ecoregion	Owner Name/Type	Watershed
Tillamook	CR	PRIVATE	1710020206 - COOK CREEK / LOWER NEHALEM RIVER

Town-Range	Sec	Note	QuadCode	QuadName	Managed Area Name
002N010W	09		45123-F8	Nehalem	

Source Feature [Uncertainty Type (Distance)] Use Class
14469 Point [Areal - Estimated (50 m)]

Annual Observations

Feature ID Date Source Observation data

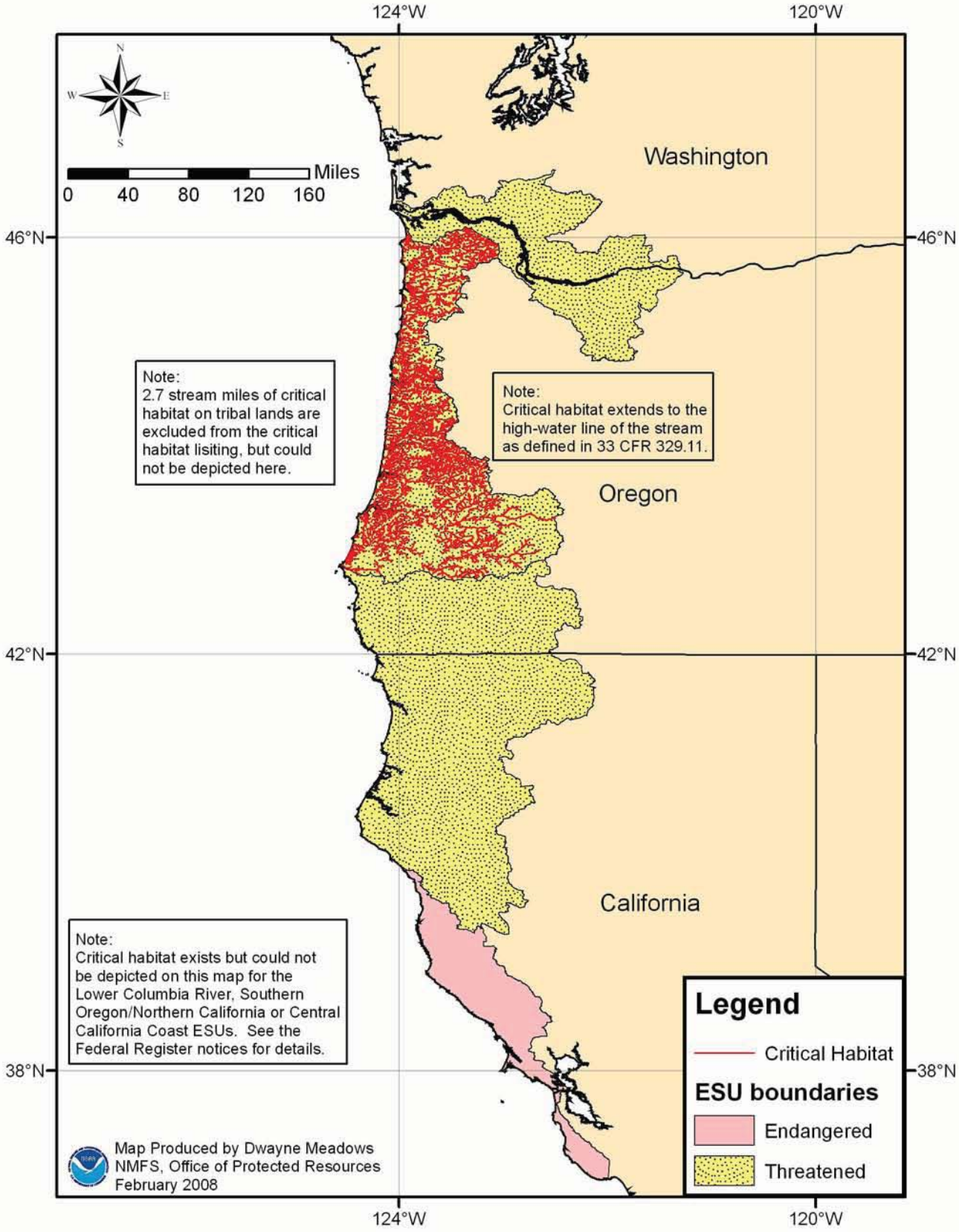
Occurence Data

EO Type:
EO Data: 1998: 2 PAIRS NESTING UNDER METAL CAPS ON THE PILINGS.
Minimum Elev.(m): 5
EO Comments:
Protection:
Management:
General:

---

11 records total

Coho Salmon Critical Habitat



APPENDIX G

Water Rights

STATE OF OREGON

COUNTY OF TILLAMOOK

CERTIFICATE OF WATER RIGHT

This Is to Certify, *That* CITY OF ROCKAWAY

of P.O. Box 35, Rockaway *, State of* Oregon, 97136 *, has made proof to the satisfaction of the Water Resources Director, of a right to the use of the waters of* Jetty Creek

a tributary of Pacific Ocean *for the purpose of* municipal

under Permit No. 34498 *and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from* December 8, 1969 *that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed* 1.0 cubic foot per second

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the Lot 3 (NE¼ SE¼), Section 17, T. 2 N., R. 10 W., W. M., 1700 feet North and 300 feet West from the SE Corner, Section 17

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to ---------- *of one cubic foot per second per acre,*

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

NE¼ SE¼
S½ SE¼
Section 17
N½ NE¼
SW¼ NE¼
E½ NW¼
E½ SW¼
NW¼ SE¼
Section 20
W½
Section 29

NW¼ NW¼
S½ NW¼
SW¼
W½ SE¼
Section 32
T. 2 N., R. 10 W., W. M.

W½ NW¼
SW¼
Section 5
All
Section 6
T. 1 N., R. 10 W., W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described and is subject to the existing minimum flow policies established by the Water Policy Review Board.

WITNESS the signature of the Water Resources Director, affixed this date. April 30, 1979

James E. Sexson
Water Resources Director

Recorded in State Record of Water Right Certificates, Volume 41 *, page* 47952

STATE OF OREGON

COUNTY OF TILLAMOOK

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

STATE OF OREGON
WATER RESOURCES DEPARTMENT
SALEM, OREGON 97310

confirms the right to use the waters of JETTY CREEK, a tributary of NEHALEM BAY, in the NORTH COAST BASIN to maintain an instream flow for the purpose of SUPPORTING AQUATIC LIFE.

The right is for flows to be maintained IN JETTY CREEK FROM WRD GAGE 30125 (NW 1/4, SECTION 16, T 2 N, R 10 W, W.M.) TO THE MOUTH OF JETTY CREEK (SE 1/4, SECTION 17, T 2 N, R 10 W, W.M.).

The right is established under Oregon Revised Statutes 537.346.

The date of priority is MAY 8, 1981.

The right is limited to not more than the amounts during the time periods listed below:

Period	Flows (cubic feet per second)
OCT 1 - OCT 15	2.0
OCT 16- MAR 31	5.0
APR 1 - SEP 30	0.5

This instream water right shall not have priority over the right to use water for human consumption, livestock consumption or the use of waters legally released from storage.

Witness the signature of the Water Resources Director affixed this 9th day of JUNE, 1989.

William H. Young
Water Resources Director

Recorded in State Record of Water Right Certificates number 59625.

MF14

STATE OF OREGON

TILLAMOOK COUNTY

PERMIT TO APPROPRIATE THE PUBLIC WATERS

This is to certify that I have examined APPLICATION 61833 and do hereby grant the same SUBJECT TO EXISTING RIGHTS INCLUDING THE APPROPRIATE MINIMUM FLOW POLICIES ESTABLISHED BY THE WATER POLICY REVIEW BOARD and the following limitations and conditions:

This permit is issued to City of Rockaway, PO Box 35, Rockaway, Oregon 97136, phone 355-2291, for the use of the waters of Jetty Creek, a tributary of Nehalem River, for the PURPOSE of municipal use; that the PRIORITY OF THE RIGHT dates from June 24, 1981, and is limited to the amount of water which can be applied to beneficial use and shall not exceed 1.0 cubic foot per second measured at the point of diversion from the stream, or its equivalent in case of rotation with other water users.

The POINT OF DIVERSION is to be LOCATED: 1,662 feet North and 312 feet West from the Southeast Corner of Section 17, being within the NE 1/4 SE 1/4 of Section 17, Township 2 North, Range 10 West, WM, in the County of Tillamook. 19S12

A description of the PLACE OF USE under the permit, and to which such right is appurtenant, is as follows:

Township 1 North	Range 10 West, WM	Section 5	NW 1/4	NE 1/4	Municipal
			NE 1/4	NW 1/4	
			NW 1/4	NW 1/4	
			SW 1/4	NW 1/4	
			SE 1/4	NW 1/4	
			NW 1/4	SW 1/4	
			NE 1/4	SW 1/4	
			NW 1/4	SE 1/4	
			SW 1/4	SE 1/4	
			SE 1/4	SW 1/4	
			SW 1/4	SW 1/4	
		Section 6	SE 1/4	NE 1/4	
			NE 1/4	SE 1/4	
			SE 1/4	SE 1/4	
Township 2 North	Range 10 West, WM	Section 20	NW 1/4	NE 1/4	
			NE 1/4	NW 1/4	
			SW 1/4	NE 1/4	
			SE 1/4	NW 1/4	
			NW 1/4	SE 1/4	
			NE 1/4	SW 1/4	
			NW 1/4	SW 1/4	
			SW 1/4	SE 1/4	
			SE 1/4	SW 1/4	
			SW 1/4	SW 1/4	
		Section 29	NW 1/4	NE 1/4	
			NE 1/4	NW 1/4	
			NW 1/4	NW 1/4	
			SE 1/4	NE 1/4	
			SW 1/4	NE 1/4	
			SE 1/4	NW 1/4	
			SW 1/4	NW 1/4	
			NE 1/4	SE 1/4	
			NW 1/4	SE 1/4	

Section 29	NE 1/4	SW 1/4
	NW 1/4	SW 1/4
	SE 1/4	SE 1/4
	SW 1/4	SE 1/4
	SE 1/4	SW 1/4
	SW 1/4	SW 1/4
Section 32	NW 1/4	NE 1/4
	NE 1/4	NW 1/4
	NW 1/4	NW 1/4
	SW 1/4	NE 1/4
	SE 1/4	NW 1/4
	SW 1/4	NW 1/4
	NW 1/4	SE 1/4
	NE 1/4	SW 1/4
	NW 1/4	SW 1/4
	SW 1/4	SE 1/4
	SE 1/4	SW 1/4
	SW 1/4	SW 1/4

Actual construction work shall begin on or before March 2, 1983 and shall thereafter be prosecuted with reasonable diligence and be completed on or before October 1, 1983. Extended to October 1, 1988 Extended to October 1, 1993 10-1-98

Complete application of the water to the proposed use shall be made on or before October 1, 1984. Extended to October 1, 1988 Extended to October 1, 1993 10-1-98

WITNESS my hand this 2nd day of March, 1982.

/s/ JAMES E. SEXSON
WATER RESOURCES DIRECTOR

APPLICATION 61833

PERMIT 46245

BEFORE THE WATER RESOURCES DIRECTOR OF OREGON

MARION COUNTY

IN THE MATTER OF APPLICATION FOR)
EXTENSION OF TIME IN WHICH TO BEGIN)
AND COMPLETE CONSTRUCTION WORK AND) ORDER
MAKE COMPLETE APPLICATION OF WATER)
UNDER CERTAIN PERMITS)

The owners of the following water permits issued by the Water Resources Director have submitted applications for extensions of time limits within which to begin and/or complete the construction work and/or make complete application of water to beneficial use under their respective permits.

The Water Resources Director is authorized under the provisions of ORS 537.230 to grant extensions of time for good cause shown, within which to complete work to perfect a water right under a permit;

The statements in the applications for extensions filed regarding completion of the projects indicate that each has shown such reasonable diligence as entitles them to an extension of time; and

No protest or objections to the granting of an extension under any of the following permits have been filed by any subsequent permit holders;

NOW, THEREFORE, it is hereby is ORDERED that extensions of time are granted as follows:

				NEW TIME LIMITS TO:		
PERMITTEE	APPL. NUMBER	PERMIT NUMBER	BASIN NUMBER	START CONST.	COMPLETE CONST.	APPLY WATER
PERMITS TO USE GROUNDWATER:						
City of Arlington	G-1185	G-1201	6		10-1-99	10-1-99
City of Arlington	46891	35058	6	10-1-99	10-1-99	10-1-99
City of Fairview	G-5857	G-5594	3		10-1-98	10-1-98
City of Fairview	G-7563	G-7029	3		10-1-99	10-1-99
City of Dundee	G-6331	G-6017	2		10-1-97	10-1-97
City of Dundee	58951	44462	2	10-1-97	10-1-97	10-1-97
Harbor Rural Water District	G-9502	G-9438	15		10-1-99	10-1-99
City of Wallowa	G-11368	G-10569	8		10-1-98	10-1-98
F.M. Cook	G-11436	G-10733	13		10-1-95	10-1-95
Sunridge Water Systems, Inc.	G-11502	G-10617	7		10-1-99	10-1-99
Timberline Rim Water Company	G-11916	G-11165	3		10-1-98	10-1-98
KMB Enterprise	G-12042	G-11146	5		10-1-97	10-1-97

Deer Park Water Association	G-12096	G-11070	15		10-1-97	10-1-97
Brooks Resources Corporation	G-12156	G-11106	5		10-1-95	10-1-95
Richard Halliburton	G-12162	G-11388	17			10-1-95
Richard Halliburton	R-70462	R-11422	17			10-1-95
Richard Halliburton	70463	51380	17			10-1-95
Roy & Elaine Moore	G-12279	G-11185	2			10-1-95
Highland Subdivision Water District	G-12289	G-11347	5		10-1-98	10-1-98
Dennis Obrist	G-12372	G-11351	2			10-1-95
St. Paul Cemetery Trust	G-12379	G-11395	2			10-1-95
James & Loretta Ellett	G-12452	G-11399	4		10-1-94	
James & Loretta Ellett	G-12452	G-11399	4		10-1-95	10-1-95
Leonard G. Turner	G-12575	G-11561	17		10-1-95	
Rodrick Fraser II	G-12723	G-11595	17		10-1-95	

PERMITS TO CONSTRUCT RESERVOIRS AND USE SURFACE WATER:

Daniel E. Davis	R-69987	R-11237	17		10-1-95	10-1-95
Daniel E. Davis	69988	51033	17		10-1-95	10-1-95
Rudolph M. Bauder	R-69901	R-11164	1		10-1-95	10-1-95
Rudolph M. Bauder	69902	50760	1		10-1-95	10-1-95
Roy Peters	R-72031	R-11471	17		10-1-95	

PERMITS TO USE SURFACE WATER:

City of Brookings	37091	27610	15		10-1-99	10-1-99
City of Brookings	41805	31293	15		10-1-99	10-1-99
City of Rainier	44624	33386	1		10-1-97	10-1-97
Lakeside Water Dist.	46056	34393	17		10-1-99	10-1-99
City of Umatilla	54855	41444	7	10-1-99	10-1-99	10-1-99
Weiss Estates Water System Company, Inc.	60573	46099	17		10-1-98	10-1-98
West Extension Irrigation District	61797	45999	7		10-1-96	10-1-96
City of Rockaway	61833	46245	1		10-1-98	10-1-98
Coos Bay-North Bend Water Board	68795	50155	17		10-1-99	10-1-99

APPENDIX H

Fish Passage & Screening Criteria

DIVISION 412
FISH PASSAGE

635-412-0005
Definitions

(1) For the purposes of OAR 635-412-0010 through OAR 635-412-0040 the following definitions shall apply.
(2) "Active channel width" means the stream width between the ordinary high water lines, or at the channel bankfull elevation if the ordinary high water lines are indeterminate.
(3) "Artificial obstruction" means any dam, diversion, dike, berm, levee, tide or flood gate, road, culvert or other human-made device placed in the waters of this state that precludes or prevents the migration of native migratory fish.
(4) "Attraction flow" means the flow that emanates from or near a fishway entrance in sufficient quantity, velocity, and location to attract upstream migrants into the fishway, which can consist of gravity flow from the fish ladder and auxiliary water system flow added in or near the lower ladder.
(5) "Bankfull elevation" means the point on a stream bank at which overflow into a floodplain begins.
(6) "Bed" or "bed and banks" means the physical container of the waters of this state, bounded on freshwater bodies by the ordinary high water line or bankfull stage, and on bays and estuaries by the limits of the highest measured tide.
(7) "Channel" means a waterway that periodically or continuously contains moving waters of this state and has a definite bed and banks that serve to confine the water.
(8) “Commission” means the Oregon Fish and Wildlife Commission.
(9) "Construction" means:
(a) Original construction;
(b) Major replacement, which includes:
(A) for dams and diversions, excavation or replacement of 30 percent by structure volume of the dam, including periodic or seasonal replacements, unless:
(i) only checkboards are replaced, or
(ii) fish passage approval has already been obtained in writing from the Department for expected replacement;
(B) for tide gates and flood gates:
(i) cumulative replacement of over 50 percent of the gate material, or,
(ii) cumulative removal, fill, replacement, or addition of over 50 percent of the structure supporting the gate, excluding road-stream crossing structures;
(C) for dikes, berms, levees, roads, or other artificial obstructions that segment estuaries, floodplains, or wetlands:
(i) activities defined under OAR 635-412-0005(9)(d) in all locations where current channels cross the artificial obstruction segmenting the estuary, floodplain, or wetland, or
(ii) the cumulative removal, fill, replacement, or addition of over 50 percent by volume of the existing material directly above an historic channel or historically-inundated area; and
(D) for other artificial obstructions, the cumulative removal, fill, replacement, or addition of over 50 percent of the structure comprising the artificial obstruction to native migratory fish migration;
(c) Structural modifications that increase storage or diversion capacity; or
(d) For purposes of culverts, installation or replacement of a roadbed or culvert, further defined as:
(A) roadbed installation or replacement at culverts includes any activity that:
(i) creates a road which crosses a channel,
(ii) widens a roadfill footprint within a channel, or
(iii) fills or removes over 50 percent by volume of the existing roadbed material directly above a culvert, except when this volume is exclusively composed of the top 1 foot of roadbed material;
(B) culvert installation or replacement includes any activity that:
(i) installs or constructs a new culvert, overflow pipe, apron, or wingwall within a channel,
(ii) extends existing culverts, aprons, or wingwalls within a channel, except one-time placements of culvert ends which do not extend greater than 1 foot beyond the adjacent road footprint in place prior to August 2001,
(iii) cumulatively through time makes significant repairs or patches to over 50 percent of the linear length of a culvert,
(iv) replaces any part of a culvert, except ends which become misaligned or eroded and which are replaced to their original configuration,

(v) at any point along the linear length of a culvert, reduces the entire inside perimeter of the culvert, or
(vi) makes replacements, repairs, patches, or modifications to an existing culvert that are different than the original configuration and which reduce any level of fish passage for native migratory fish with current access, as determined by the Department, to the culvert.
(10) "Dam" means a structure, or group of structures with different functions, spanning or partially-spanning a stream in one location in order to pool water, facilitate the diversion of water, or raise the water surface elevation.
(11) "Department" means the Oregon Department of Fish and Wildlife.
(12) “Director” means the Director of the Oregon Department of Fish and Wildlife.
(13) "Design streamflow range" means the range of flows within a stream, bracketed by the Low Fish Passage Design Flow and the High Fish Passage Design Flow, for which a fishway shall provide fish passage.
(14) "Emergency" means unforeseen circumstances materially related to or affected by an artificial obstruction that, because of adverse impacts to a population of native migratory fish, requires immediate action.
(15) "Estuary" means a body of water semi-enclosed by land and connected with the open ocean within which salt water is usually diluted by fresh water derived from the land. "Estuary" includes all estuarine waters, tidelands, tidal marshes and submerged lands extending upstream to the head of tidewater. However, for the purposes of these rules, the Columbia River Estuary extends to the western edge of Puget Island.
(16) "Exclusion barrier" means a structure placed that prevents fish passage for the benefit of native migratory fish.
(17) '"Experimental fish passage structure" means a fish passage structure based on new ideas, new technology, or unique, site-specific conditions determined by the Department to not be covered by existing fish passage criteria but to have a reasonable possibility of providing fish passage.
(18) "Fish passage" means the ability, by the weakest native migratory fish and life history stages determined by the Department to require passage at the site, to move volitionally, with minimal stress, and without physical or physiological injury upstream and downstream of an artificial obstruction.
(19) "Fish passage structure" means any human-built structure that allows fish passage past an artificial obstruction, including, but not limited to, fishways and road-stream crossing structures such as culverts and bridges.
(20) "Fishway" means the set of human-built and/or operated facilities, structures, devices, and measures that together constitute, are critical to the success of, and were created for the sole purpose of providing upstream fish passage at artificial or natural obstructions which create a discontinuity between upstream and downstream water or bed surface elevations.
(21) "Fishway entrance" means the component of a fishway that discharges attraction flow into the tailrace and where upstream migrant fish enter the fishway.
(22) "Fishway pools" means discrete sections within a fishway separated by overflow weirs or non-overflow walls that create incremental water surface elevation gains and dissipate energy.
(23) "Floodplain" means that portion of a river valley, adjacent to the channel, which is built of sediments deposited during the present regimen of the stream and which is covered with water when the waterway overflows its banks at flood stage.
(24) "Forebay" means the water impounded immediately upstream of an artificial obstruction.
(25) "Fundamental change in permit status" means a change in regulatory approval for the operation of an artificial obstruction where the regulatory agency has discretion to impose additional conditions on the applicant, including but not limited to licensing, relicensing, reauthorization or the granting of new water rights, but not including water right transfers or routine maintenance permits unless they involve construction or abandonment of an artificial obstruction.
(26) "High fish passage design flow" means the mean daily average stream discharge that is exceeded 5 percent of the time during the period when the Department determines that native migratory fish require fish passage.
(27) "Historically" means prior to 1859 (statehood).
(28) "Inflow" means surface movement of waters of this state from a lower ground surface elevation to a higher ground surface elevation or away from the ocean.
(29) "In-proximity" means within the same watershed or water basin, as defined by the Oregon Water Resources Department, and having the highest likelihood of benefiting the native migratory fish populations, as defined by the Oregon Department of Fish and Wildlife, directly affected by an artificial obstruction.
(30) "Low fish passage design flow" means the mean daily average stream discharge that is exceeded 95 percent of the time, excluding days with no flow, during the period when the Department determines that native migratory fish require fish passage.

(31) "Mitigation" means alternatives to providing fish passage at an artificial obstruction as per ORS 509.585.
(32) "Native migratory fish" means native fish (as defined under OAR 635-007-0501) that migrate for their life cycle needs. These fish include all sub-species and life history patterns of the following species listed by scientific name in use as of 2005. Common names are provided for reference but are not intended to be a complete listing of common names, sub-species, or life history patterns for each species.
(a) Acipenser medirostris ….. Green Sturgeon
(b) Acipenser transmontanus ….. White Sturgeon
(c) Amphistichus rhodoterus ….. Redtail surfperch
(d) Catostomus columbianus ….. Bridgelip sucker
(e) Catostomus luxatus/Deltistes luxatus ….. Lost River sucker
(f) Catostomus macrocheilus ….. Largescale sucker
(g) Catostomus microps ….. Modoc sucker
(h) Catostomus occidentalis ….. Goose Lake sucker
(i) Catostomus platyrhynchus ….. Mountain sucker
(j) Catostomus rimiculus ….. Klamath smallscale sucker
(k) Catostomus snyderi ….. Klamath largescale sucker
(l) Catostomus tahoensis ….. Tahoe sucker
(m) Catostomus warnerensis ….. Warner sucker
(n) Chasmistes brevirostris ….. Shortnose sucker
(o) Hypomesus pretiosus ….. Surf smelt
(p) Lampetra ayresi ….. River lamprey
(q) Lampetra lethophaga ….. Pit-Klamath lamprey
(r) Lampetra minima ….. Miller Lake lamprey
(s) Lampetra similes ….. Klamath River lamprey
(t) Lampetra tridentate ….. Pacific lamprey
(u) Oncorhynchus clarki ….. Coastal, Lahontan and West Slope cutthroat trout
(v) Oncorhynchus keta ….. Chum salmon
(w) Oncorhynchus kisutch ….. Coho salmon
(x) Oncorhynchus mykiss ….. Steelhead, Rainbow and Redband trout
(y) Oncorhynchus nerka ….. Sockeye/Kokanee salmon
(z) Oncorhynchus tshawytscha ….. Chinook salmon
(aa) Prosopium williamsoni ….. Mountain whitefish
(bb) Ptychocheilus oregonensis ….. Northern pikeminnow
(cc) Ptychocheilus umpquae ….. Umpqua pikeminnow
(dd) Salvelinus confluentus ….. Bull trout
(ee) Spirinchus thaleichthys ….. Longfin smelt
(ff) Thaleichthys pacificus ….. Eulachon
(33) "Net benefit" means an increase in the overall, in-proximity habitat quality or quantity that is biologically likely to lead to an increased number of native migratory fish after a development action and any subsequent mitigation measures have been completed.
(34) "Ordinary high water line" (OHWL) means the line on the bank or shore to which the high water ordinarily rises annually in season (Note: see OAR 141-085-0010 for physical characteristics that can be used to determine the OHWL in the field.).
(35) "Oregon Plan" means the guidance statement and framework described in ORS 541.405.
(36) "Over-crowding" means fish density within a pool's wetted volume is such that there is less than 0.25 cubic feet of water per pound of fish for the maximum number of fish expected to be present within the pool at the same time, as determined by the Department.
(37) "Road" means a cleared or built surface, and associated materials or measures for support and safety, used for the purpose of motorized or non-motorized movement between different locations.
(38) "Roadfill footprint" means the area occupied by soil, aggregate, and/or other materials or structures necessary to support a road, including, but not limited to, appurtenant features such as wing walls, retaining walls, or headwalls.
(39) "Stream" means a body of running waters of this state moving over the surface of the land in a channel or bed including stream types classified as perennial or intermittent and channelized or relocated streams.

(40) "Sub-basin" means a 4th-field hydrologic unit as defined by the U.S. Geological Survey.
(41) "Tailrace" means the water immediately downstream of an instream structure.
(42) "Temporary" means in place less than the in-water work period defined by the Department for a particular location.
(43) "Trap" means the set of human-built and/or operated facilities, structures, devices, and measures that hold fish and prevent them from passing volitionally.
(44) "Unforeseen circumstances" means:
(a) An event that causes an existing human-made structure in the waters of the state which provides fish passage to become an artificial obstruction, or
(b) New fish population information indicating that an existing artificial obstruction is placing a local native migratory fish population in jeopardy.
(45) "Volitionally" means with minimal delay and without being trapped, transferred, or handled by any person, unless specifically allowed under OAR 635-412-0035(6).
(46) "Waters of this state" means natural waterways including all tidal and non-tidal bays, intermittent and perennial streams, constantly flowing streams, lakes, wetlands and other bodies of water in this state, navigable and non-navigable, including that portion of the Pacific Ocean that is within the boundaries of Oregon.
(47) "Wetlands" means those areas that are inundated or saturated by surface 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.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.580, ORS 509.585, ORS 509.610 and ORS 509.625
Hist.: Adopted 1-6-06, f. & certified ef. 1-9-06

635-412-0010
Fish Passage Task Force
(1) The Director shall appoint nine members to constitute the Fish Passage Task Force.
(2) Three members shall represent interests subject to the obligation to install passage at facilities they install, own or operate; three members shall represent fishing, environmental or conservation interests, and three members shall represent the general public.
(3) Members shall serve four-year terms, and shall be eligible for re-appointment to the task force, except that the initial designation of members shall appoint members of each interest group to a three year, four year or five year term to establish a staggered system of new appointments for each interest group's members.
(4) The Task Force shall:
(a) serve as the public advisory committee and advise the Director and Commission regarding rulemaking to implement the fish passage and waiver requirements;
(b) prioritize projects from the statewide inventory of artificial dams and obstructions for purposes of enforcement;
(c) recommend to the Director and Commission appropriate levels of funding and special conditions applicable to projects installing passage or alternatives to passage resulting in a net benefit to native migratory fish;
(d) select one of its members to serve as chair and one as vice chair of the Task Force;
(e) review and recommend to the Commission which projects should be exempt, and changes to the list of projects exempt from passage requirements under Section 8 of Section 2 of HB 3002 (2001);
(f) report semiannually to the joint legislative committee created under ORS 171.551, or to the appropriate interim legislative committee with responsibility for salmon restoration or species recovery, advising the committee on matters related to fish passage;
(g) review applications for waivers of the fish passage requirement, and advise the Commission as to whether alternative measures result in a net benefit to native migratory fish;
(h) perform such other duties relating to fish passages requested by the Director or Commission;
(i) meet at such times and places as may be determined by the chair or by a majority of members of the task force.
(5) The Department's Fish Passage Coordinator shall serve as staff for the task force.

(6) The chair of the Task Force shall conduct the meetings of the task force, serve as the main contact point between the Department and Commission and the Task Force and perform such other duties as the Task Force shall set. The vice chair of the task force shall serve as chair if the chair is unavailable to carry out the duties of chair.
(7) Members of the Task Force may not receive compensation for services as a member of the Task Force; however, in accordance with ORS 292.495, a member of the Task Force may receive reimbursement for actual and necessary travel or other expenses incurred in the performance of official duties.

Stat. Auth.: HB 3002
Stats. Implemented: HB 3002
Hist.: Adopted 1-24-02, ef. upon filing

635-412-0015
Prioritization
(1) The Department shall establish for enforcement purposes a list of priority artificial obstructions at which fish passage would provide the greatest benefit to native migratory fish.
(2) The priority list shall be based on the needs of native migratory fish.
(a) The prioritization shall consider the following factors relative to each artificial obstruction for all native migratory fish currently or historically present at the artificial obstruction:
(A) the quantity of native migratory fish habitat which is inaccessible,
(B) the quality of native migratory fish habitat which is inaccessible,
(C) unique or limited native migratory fish habitat which is inaccessible, or should remain inaccessible for fish management purposes,
(D) the biological status of the native migratory fish,
(E) the level of fish passage currently provided at the artificial obstruction,
(F) the presence of other artificial obstructions upstream and downstream and the timeframe native migratory fish will be able to utilize restored passage, and
(G) existing agreements with the Department regarding fish passage.
(b) The prioritization may utilize existing Department information or professional judgment in the absence of information specific to a given site.
(c) The priority list shall contain one artificial obstruction per Oregon sub-basin, which shall be ranked across the state.
(d) The Department shall field verify the information used for prioritization prior to enforcement actions.
(e) The Department shall re-evaluate the priority list with the most recent information after enforcement occurs at five priority artificial obstructions or as directed by the Commission.
(3) The Commission shall review, approve, or amend the priority list after the initial priority list is developed, when the Department re-prioritizes, and no less frequently than once every five years.
(4) Once the Commission has approved the priority list, the Department may order a person owning or operating an artificial obstruction on the priority list who has been issued a water right, owns a lawfully installed culvert or owns another lawfully installed obstruction to install fish passage or to provide mitigation if:
(a) the Department can arrange for non-owner or non-operator funding of at least 60 percent of the cost for fish passage design, construction, and installation, and
(b) the artificial obstruction is ranked in the top ten for the state or highest within a Department Region on the priority list.
(5) Once the Department has arranged for non-owner or non-operator funding of at least 60 percent of the cost for fish passage design, construction, and installation at an artificial obstruction the owner or operator has two years to:
(a) install a fish passage structure according to a fish passage plan approved by the Department, or
(b) provide mitigation that the Commission determines is a net benefit to native migratory fish.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.585 and ORS 509.625
Hist.: Adopted 1-6-06, f. & certified ef. 1-9-06

635-412-0020
Fish Passage Approval

(1) No person shall construct or maintain any artificial obstruction across any waters of this state that are inhabited, or were historically inhabited, by native migratory fish without providing passage for native migratory fish.

(2) Prior to construction, fundamental change in permit status or abandonment of an artificial obstruction in any waters of this state, a person owning or operating an artificial obstruction shall obtain a determination from the Department as to whether native migratory fish are or were historically present in the waters, unless the owner or operator assumes the presence of native migratory fish.

(3) If the Department determines, or the owner or operator assumes, that native migratory fish are or were historically present in the waters, prior to construction, fundamental change in permit status, or abandonment of the artificial obstruction the person owning or operating the artificial obstruction shall either:

(a) Obtain from the Department an approval determination of a fish passage plan that meets the requirements of OAR 635-412-0035 for the specific artificial obstruction.

(b) obtain from the Department a programmatic approval of a fish passage plan for multiple artificial obstructions of the same type. The Department may also grant programmatic approval to an agent for multiple owners or operators of artificial obstructions of the same type. Programmatic approvals are only valid so long as the owner or operator complies with the conditions of the programmatic approval. The Department shall only provide programmatic approval if:

(A) fish passage structures placed under the programmatic approval meet criteria determined by the Department,

(B) the owner, operator, or agent demonstrates to the Department prior experience providing or approving acceptable fish passage structures,

(C) the owner, operator, or agent reports installation information annually to the Department, including but not limited to the location and installation date of all fish passage structures placed under the programmatic approval,

(D) the owner or operator allows, or the agent requires owners or operators to allow, the Department to inspect fish passage structures placed under the programmatic approval at reasonable times, and

(E) the owner, operator, or agent agrees to expeditiously remedy all fish passage structures placed under the programmatic approval which the Department finds do not meet the criteria or conditions of the programmatic approval,

(c) pursuant to ORS 527.710(6), install and maintain road-stream crossing structures on non-federal forestlands in compliance with State Board of Forestry, through the Oregon Department of Forestry, rules and guidelines. These rules and guidelines require concurrence by the Oregon Department of Fish and Wildlife that they meet the purposes of the Department's fish passage program,

(d)obtain a waiver from fish passage requirements for the artificial obstruction as provided in OAR 635-412-0025, or

(e)obtain an exemption from fish passage requirements for the artificial obstruction as provided in OAR 635-412-0025.

(4) Fish passage plans shall provide for and be implemented such that fish passage is installed at the artificial obstruction prior to completion of or by the end of the same in-water work period as the action which triggered fish passage requirements under subsection (2), unless:

(a) an owner or operator demonstrates to the Department an imminent or immediate threat to human safety which requires construction at a failed artificial obstruction prior to being able to complete the requirements of subsection (3), and the Department approves a fish passage plan in which the requirements of subsection (3) shall be met by the end of the next in-water work period or as soon as practicable. Providing passage at the time of construction is preferred,

(b) the Commission finds that additional time is necessary and appropriate given the size and scope of the project,

(c) installation begins within this period and the Department finds that additional time to complete installation is necessary and appropriate given the size and scope of the project, or

(d) the Department finds that additional time is necessary and appropriate as part of the terms and conditions of a negotiated settlement for a federal proceeding, or in coordination with other federal requirements.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.585 and ORS 509.645
Hist.: Adopted 1-6-06, f. & certified ef. 1-9-06

635-412-0025
Fish Passage Waivers and Exemptions
(1) Waivers from fish passage requirements shall be granted for an artificial obstruction if the Commission (or Department, as applicable) determines that mitigation rather than fish passage proposed by the person owning or operating the artificial obstruction provides a net benefit to native migratory fish.
(2) Net benefit to native migratory fish is determined by comparing the benefit to native migratory fish that would occur if the artificial obstruction had fish passage to the benefit to native migratory fish that would occur using the proposed mitigation. To qualify for a waiver of the requirement to install fish passage, mitigation shall result in a benefit to fish greater than that provided by the artificial obstruction with fish passage. The net benefit to fish determination shall be based upon conditions that exist at the time of comparison.
(3) Waivers shall be valid so long as the owner or operator continues to provide the agreed-upon mitigation measures and until the waived artificial obstruction undergoes further construction, a fundamental change in permit status, or abandonment.
(4) The Commission (or Department as applicable) may grant exemptions from fish passage requirements at an artificial obstruction if it is determined that:
(a) a lack of fish passage has been effectively mitigated;
(b) the owner or operator has received a legal waiver for the artificial obstruction from the Commission or the Department; or
(c) there is no appreciable benefit to providing fish passage.
(5) For exemptions granted under subsection (4)(a) and (4)(b), the exemption continues only so long as the original benefit of the mitigation is maintained.
(6) The Commission shall review, at least once every seven years, exempt artificial obstructions that do not have exemption expiration date to determine whether the exemption should continue. The Commission may revoke or amend an exemption if it finds that circumstances have changed such that the basis for the exemption no longer applies. An exemption granted as a result of an action which triggered fish passage requirements under OAR 635-412-0020(2) tolls the trigger event until the exemption is revoked.
(7) To obtain a waiver or an exemption from fish passage requirements, an owner or operator of an artificial obstruction shall obtain from and submit to the Department an application for the waiver or exemption.
(8) Based on application review, verification and site-specific knowledge, Department staff shall provide a written benefit analysis of whether the waiver request meets the requirements of subsection (1) or the exemption request meets the requirements of subsections (4) and (5). If there is some level of fish passage at the artificial obstruction, but it does not meet the requirements of OAR 635-412-0035, that passage shall be factored into the Department's net benefit analysis, allowing a reduction in required mitigation.
(9) To receive a waiver, or an exemption under subsection (4)(a), an owner or operator of an artificial obstruction shall enter an agreement with the Commission (or Department as applicable) that clearly describes timelines, duties, responsibilities, and options regarding the mitigation. The agreement shall state that the mitigation shall be completed prior to completion of or by the end of the same in-water work period as the action which triggered fish passage requirements under OAR 635-412-0020(2), unless the Commission finds that additional time is necessary and appropriate:
(a) given the size and scope of the project or
(b) to coordinate with requirements of federal proceedings.
(10) Once the application, analysis, and a draft agreement are completed, a decision on whether the waiver or exemption shall be granted shall be made by:
(a) the Department:
(A) if it determines that the total stream distance, including tributaries, affected by the artificial obstruction for which the waiver or exemption is being sought is less than or equal to 1 mile to a natural barrier;
(B) if the request is for an exemption under subsection (4)(a) or (4)(b); or,
(C) for re-authorization of an existing hydroelectric project subject to ORS 543A.030 to ORS 543A.055 and not subject to federal hydroelectric relicensing; and
(b) the Commission:
(A) in all other instances; or
(B) if the Department refers a decision to the Commission; or
(C) if the owner or operator files a protest of the Department’s determination to the Commission.

(11) The decision to grant a waiver or exemption shall include the determination described in subsection (1) or (4) as well as approval of the agreement required in subsection (9).
(12) In addition to the Fish Passage Task Force as prescribed in OAR 635-412-0010(4)(e) and (g), the Department shall notify local watershed council(s), local soil and water conservation district(s), identified stakeholders, and others who have expressed an interest in fish passage issues or the specific waiver or exemption request and provide an opportunity to comment on the request at least three weeks prior to a decision on whether the waiver or exemption should be granted.
(13) The Commission (or Department, as applicable) may require further public comment prior to a decision on whether a waiver or exemption should be granted.
(14) The Department shall maintain a database of the locations of waived and exempted artificial obstructions and mitigation.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.585 and ORS 509.645
Hist.: Adopted 1-6-06, f. & certified ef. 1-9-06

635-412-0030
Fish Passage Protests
(1) A person owning or operating an artificial obstruction may request alternative dispute resolution at any point in the process of determining fish passage requirements.
(2) The owner or operator of the artificial obstruction who objects to a determination made by the Department under these rules may file a protest with the Commission. Protests must be submitted in writing within 30 days of receipt of a written determination from the Department and must include the grounds for protesting the Department's determination.
(3) The Commission may approve, deny, or modify the Department's determination after sufficient opportunity for public review and comment.
(4) If a protest is not filed within 30 days of receipt of a written determination from the Department, the Department's determination shall become a final order.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.585 and 509.645
Hist.: Adopted 11-12-04, filed and ef. 11-17-04

635-412-0035
Fish Passage Criteria
(1) General requirements for fish passage are:
(a) unless the owner or operator of an artificial obstruction chooses to provide year-round fish passage for all native migratory fish and life history stages, the Department shall determine:
(A) native migratory fish currently or historically present at the site which require fish passage,
(B) life history stages which require fish passage, and
(C) dates of the year and/or conditions when passage shall be provided for the life history stages and native migratory fish;
(b) the person submitting the fish passage plan to the Department for approval shall submit all information necessary to efficiently evaluate whether the design will meet fish passage criteria;
(c) if site-specific circumstances indicate that the fish passage criteria are not adequate to provide fish passage, the Department may require in writing that additional fish passage criteria be met;
(d) if native migratory fish- or site-specific circumstances warrant it, the Department may provide an exception to any specific fish passage criterion if the Department determines in writing that fish passage shall still be provided;
(e) all fish passage structures shall be designed to take into consideration their upstream and downstream connection and prevent undesirable impacts to fish passage, including but not limited to scour and headcuts;
(f) if joint state and federal approval is required, the Department shall take into account federal requirements during approval;
(g) primarily at sites with little existing site information or questionable design solutions, the Department may require monitoring and reporting to determine if a fish passage structure meets applicable criteria and/or is providing fish passage; and

(h) the person owning or operating an artificial obstruction shall maintain the fish passage structure in such repair and operation as to provide fish passage of native migratory fish at all times required by the Department.
(2) Requirements for fish passage at dams and other artificial obstructions which create a discontinuity between upstream and downstream water surface or streambed elevations are:
(a) fishways shall provide fish passage at all flows within the design streamflow range;
(b) the fishway entrance shall be located and adequate attraction flow shall be provided at one or more points where fish can easily locate and enter the fishway;
(c) fishway water velocities shall:
(A) range between 1 and 2 feet per second in transport channels,
(B) average no greater than 5 feet per second in baffled-chute fishways, including but not limited to Alaska steeppasses and denils, and
(C) not exceed 8 feet per second in discrete fishway transitions between the fishway entrance, pools, and exit through which fish must swim to move upstream, including but not limited to slots, orifices, or weir crests;
(d) at any point entering, within, or exiting the fishway where fish are required to jump to move upstream, the maximum difference between the upstream and downstream water surface elevations shall be 6 inches, except it shall be 12 inches if only salmon or steelhead adults require fish passage;
(e) in fishway locations through which fish must swim, water depths shall be a minimum of 6 inches where only juveniles require passage and 12 inches where adults require passage, except:
(A) baffled-chute fishways, including but not limited to Alaska steeppasses and denils, shall have a minimum flow depth of 2 feet throughout the length of the fishway, and
(B) water depths shall be a minimum of 2 feet within jump pools which shall be located downstream of any point entering, within, or exiting the fishway where fish are required to jump to move upstream;
(f) all fishway locations through which fish must swim shall be at least 12 inches wide;
(g) fishway pools shall:
(A) be sized according to the native migratory fish and life history stages requiring passage and to avoid over-crowding,
(B) have $V \geq wQH/4$ at all flows within the design streamflow range, where:
(i) "V" is the water volume in cubic feet,
(ii) "*w*" is 62.4, the unit weight of water, in pounds per cubic foot,
(iii) "Q" is the fish ladder flow in cubic feet per second,
(iv) "H" is the energy head of pool-to-pool flow in feet, and
(v) 4 has a unit of foot-pounds per second per cubic foot,
(C) where the fishway bends 90 degrees or more, have turning pools with a flowpath centerline double the length of non-turning pools, and
(D) be placed at least every 25 feet of horizontal distance in baffled-chute fishways, including but not limited to Alaska steeppasses and denils;
(h) the fishway exit should be located to minimize the risk of fish unintentionally falling downstream of the artificial obstruction;
(i) fishway trash racks shall:
(A) allow for easy maintenance and debris removal,
(B) have a minimum clear space between vertical members of 9 inches, except:
(i) 10 inches shall be provided if adult chinook are present, and
(ii) at least 4 inches shall be provided if only juveniles are present, and
(C) have a minimum clear space between horizontal members of 12 inches;
(j) the fishway shall:
(A) have water temperatures which are within 1 degree Fahrenheit of the water entering the fishway,
(B) be designed to assure that fish do not leap out of the fishway,
(C) have all edges and fasteners which fish may contact ground smooth or chamfered,
(D) not have protrusions extend into the flow path of the fishway,
(E) have as much ambient lighting as possible,
(F) have fishway components which are not detailed in OAR 635-412-0035(2), including but not limited to auxiliary water systems, designed considering the most recent National Marine Fisheries Service or U.S. Fish and Wildlife Service fish passage criteria and guidelines, and

(G) meet the species-specific requirements in OAR 635-412-0035(7) if any of those native migratory fish require fish passage;
(k) requirements for specific types of fishways include:
(A) baffled-chute fishways, including but not limited to Alaska steeppasses and denils, shall not be used in areas where downstream passage will occur through the baffled-chute fishway,
(B) all fishways of a specific type with accepted configurations shall comply with those configurations, and
(C) fish passage plans for stream channel-spanning weirs, roughened channels (including but not limited to nature-like, rock, or engineered-stream fishways), and hybrid fishways (including but not limited to pool-and-chute ladders) which may combine criteria elements of natural streams and/or established fishway types (including but not limited to pool-and-weir, vertical slot, and baffled-chute fishways) shall clearly demonstrate how water depths, water velocities, water drops, jump pools, structure sizing, and fish injury precautions shall provide fish passage;
(l) for downstream fish passage: [Note: fish screening and bypass requirements for diverted water are separate from these requirements.]
(A) fish passage structures shall have an open water surface, except a submerged or enclosed conduit or orifice may be utilized if:
(i) acceptable guidance or collection mechanisms are used and kept free from debris,
(ii) water depth is greater than 4 inches during all flows,
(iii) water velocity is greater than 2 feet per second during all flows,
(iv) water is not pumped,
(v) conduits have smooth surfaces and avoid rapid changes in direction to preclude fish impact and injury, and
(vi) conduits are at least 10 inches wide;
(B) plunging flow moving past an artificial obstruction via spillways, outlet pipes, or some other means which may contain fish shall:
(i) at all flows, fall into a receiving pool of sufficient depth, depending on impact velocity and quantity of flow, to ensure that fish and flow shall not impact the stream bottom or other solid features, and
(ii) have a maximum impact velocity into a receiving pool, including vertical and horizontal velocity components, less than 25 feet per second; and
(C) water depth over spillways shall be greater than 4 inches during all flows.
(3) Requirements for fish passage at road-stream crossing structures such as bridges and culverts are:
(a) Stream Simulation Option:
(A) open-bottomed and closed-bottom road-stream crossing structures shall have beds under or within the structure that:
(i) are equal to or greater than the active channel width, as measured at sufficient locations outside the influence of any artificial or unique channel constrictions or tributaries both upstream and downstream of the site,
(ii) are equal to the slope of, and at elevations continuous with, the surrounding long-channel streambed profile, unless the Department approves maintaining a pre-existing road-impounded wetland,
(iii) have, for open-bottomed road-stream crossing structures, a minimum of 3 feet vertical clearance from the active channel width elevation to the inside top of the structure,
(iv) maintain average water depth and velocities that simulate those in the surrounding stream channel, and
(v) are composed of material that:
(I) assures the bed under or within the road-stream crossing structure is maintained through time,
(II) is either natural (similar size and composition as the surrounding stream) or supplemented to address site-specific needs including, but not limited to, bed retention and hydraulic shadow,
(III) contains partially-buried, over-sized rock if the road-stream crossing structure is greater than 40 feet in length,
(IV) is mechanically placed during structure installation rather than allowed to naturally accumulate, unless the surrounding streambed is primarily bedrock, and
(V) excluding partially-buried over-sized rock, is, for closed-bottom road-stream crossing structures, at a minimum depth of 20 percent of the structure height and a maximum depth of 50 percent of the structure height; and
(B) trash racks shall not extend below the active channel width elevation and shall have a minimum of 9 inches clear spacing between vertical members; or

(b) Alternative Option: the Department may approve road-stream crossing structures for which clear justification is provided, based on fish performance and/or fish behavior data and hydraulic conditions, that the alternative design shall provide fish passage.
(4) Requirements for fish passage at artificial obstructions in estuaries, and above which a stream is present, are:
(a) fish passage shall be provided at all current and historic channels;
(b) fish passage structures shall meet the criteria of OAR 635-412-0035(2) or (3), except fish passage structures shall be sized according to the cumulative flows or active channel widths, respectively, of all streams entering the estuary above the artificial obstruction; and
(c) tide gates and associated fish passage structures shall be a minimum of 4 feet wide and shall meet the requirements of OAR 635-412-0035(2) within the design streamflow range and for an average of at least 51% of tidal cycles, excluding periods when the channel is not passable under natural conditions.
(5) Requirements for fish passage at artificial obstructions in estuaries, floodplains, and wetlands, and above which no stream is present, are:
(a) Downstream Fish Passage
(A) downstream fish passage shall be provided after inflow which may contain native migratory fish;
(B) downstream fish passage shall be provided until water has drained from the estuary, floodplain, or wetland, or through the period determined by the Department which shall be based on one, or a combination of, the following:
(i) a specific date,
(ii) water temperature, as measured at a location or locations determined by the Department,
(iii) ground surface elevation,
(iv) water surface elevation, and/or
(v) some other reasonable measure;
(C) egress delays may be approved by the Department based on expected inflow frequency if there is suitable habitat and as long as passage is provided by the time the conditions in OAR 635-412-0035(5)(a)(B) occur;
(D) a minimum egress flow of 0.25 cubic feet per second (cfs) at one point of egress shall be provided;
(E) egress flow of 0.5 cfs per 10 surface acres, for at least the first 100 surface acres of impounded water, shall be provided;
(F) all plunging egress flows shall meet the requirements of OAR 635-412-0035(2)(l)(B);
(G) if egress flow is provided by a pump, it shall be appropriately screened;
(H) the minimum water depth and width through or across the point of egress shall be 4 inches;
(I) the ground surface above the artificial obstruction shall be sloped toward the point(s) of egress to eliminate isolated pools; and
(J) an uninterrupted, open connection with a minimum water depth of 4 inches shall be present from the point of egress to the downstream waters of this state, unless another connection is provided as per OAR 635-412-0035(2)(l)(A).
(b) Upstream Fish Passage: a fishway or road-stream crossing structure with or without a tide gate shall be provided during the period determined by the Department if there is current or historic native migratory fish spawning or rearing habitat within the estuary, floodplain, or wetland area impounded by the artificial obstruction.
(6) Requirements for fish passage at traps are:
(a) a collection permit issued by the Department is required to operate all traps;
(b) traps shall be constructed to prevent physical or physiological injury to native migratory fish;
(c) traps shall meet all requirements of OAR 635-412-0035(2)(g);
(d) traps located within a fishway (i.e., "in-ladder" traps) shall not inhibit native migratory fish from entering the fishway or trap and shall be removed if the Department determines that fish are not entering the trap;
(e) native migratory fish shall be processed through traps with minimal possible delay and as frequently as necessary to avoid over-crowding;
(f) all native migratory fish, excluding those which have approved take authorization from the Department and which do not require fish passage as per OAR 635-412-0035(1)(a), shall be returned to the stream by one of the following methods:
(A) movement from the trap to immediately-adjacent water which has fish passage, or
(B) transport within a watered container, including but not limited to lifts, hoppers, locks, and trucks, from the trap to a location approved by the Commission.

(7) Additional requirements for specific native migratory fish are:
(a) *Acipenser* species (sturgeon)
(A) the fish passage structure shall not require fish to jump when entering, within, or exiting the structure;
(B) the fish passage structure, including trash racks, shall be sized to accommodate the largest individual expected to require fish passage; and
(C) non-volitional transport within a watered container shall be allowed with Department approval.
(b) *Catostomus* and *Chasmistes* species (suckers)
(A) the fish passage structure shall not require fish to jump when entering, within, or exiting the structure;
(B) fishways shall have a maximum water velocity of 4 feet per second;
(C) fishways shall have a minimum water depth of 12 inches;
(D) fishways shall maximize downstream flow between pools to avoid back eddies;
(E) fishways shall have curved walls within turning pools; and
(F) fishways shall have a slope less than 4 percent.
(c) *Lampetra* species (lamprey)
(A) fishways shall not have overhanging surfaces;
(B) fishways shall have rounded or chamfered edge surfaces over which *Lampetra* species may pass;
(C) fishways shall, in locations with water velocities greater than 2 feet per second, have a passage route that:
(i) has a smooth, impermeable, uninterrupted surface or a simulated streambed,
(ii) has water velocities over the structure's surface less than 8 feet per second, and
(iii) is wetted.
(d) *Oncorhynchus* species (trout and salmon): fish passage structures for *Oncorhynchus keta* (chum) shall not require fish to jump when entering, within, or exiting the structure.
(e) *Ptychocheilus* species (pikeminnow): fish passage structures shall meet the requirements of OAR 635-412-0035(7)(a).
(f) if more than one native migratory fish species requires passage at a site and the requirements for the different species are mutually exclusive, the Department shall determine passage criteria.
(8) Requirements for artificial obstruction removal are:
(a) artificial obstruction removals shall follow the requirements of OAR 635-412-0035(10);
(b) if not completely removed, no parts of the remaining artificial obstruction shall:
(A) constrict the stream channel, or
(B) cause low flow depths less than the surrounding stream channel;
(c) after an artificial obstruction is removed the stream channel shall be restored; and
(d) the stream channel restoration shall address impacts to stream habitat caused by the artificial obstruction while in place and by its removal, including but not limited to upstream and downstream channel degradation, and provisions shall be made to address unexpected fish passage issues resulting from removal.
(9) Requirements for exclusion barriers are:
(a) exclusion barriers shall only be placed in the following situations, when fish passage is not required or is provided by other means:
(A) to guide fish to an approved fish passage structure or trap,
(B) to prevent fish from leaving waters of this state and entering human-made water supply conduits,
(C) to prevent fish from entering waters of this state associated with operations of another artificial obstruction that could lead to fish injury, or
(D) to achieve other fish management objectives approved in writing by the Department; and
(b) exclusion barriers shall comply with National Marine Fisheries Service or U.S. Fish and Wildlife Service criteria.
(10) Requirements for fish passage during construction of fish passage structures and periods when temporary artificial obstructions are in place are:
(a) all fish passage structures shall be constructed and temporary artificial obstructions shall be in place only during the site-specific in-water work period defined or approved by the Department;
(b) at times indicated by the Department as per OAR 635-412-0035(1)(a), downstream fish passage shall be provided and:
(A) the outfall of a stream flow bypass system shall be placed to provide safe reentry of fish into the stream channel, and
(B) if downstream fish passage during construction is not required and stream flow is pumped around the site, the site shall meet Department screening and/or bypass requirements;

(c) at times indicated by the Department as per OAR 635-412-0035(1)(a), upstream fish passage shall be provided and shall be based on the wetted-width or flows of the stream during the period of construction or temporary obstruction;
(d) in-stream construction sites shall be isolated from stream flow and fish;
(e) prior to in-stream construction activities, all fish shall be safely collected, removed from the construction site or de-watered reach, and placed in the flowing stream by an authorized person with a collection permit issued by the Department; and
(f) after construction, the construction site shall be re-watered in a manner to prevent loss of downstream surface water as the construction site's streambed absorbs water.
(11) Requirements for experimental fish passage structures are:
(a) experimental fish passage structures shall only be allowed in waters of the state after:
(A) laboratory testing with native migratory fish or similar species indicates that the structure is feasible to provide fish passage,
(B) field testing with a prototype structure, at a location where existing fish passage will not be compromised and where fish passage does not need to be addressed under OAR 635-412-0020(2) and (3), indicates that the structure is likely to provide fish passage, and
(C) in addition to information needed to evaluate the structure's design for the specific location, the following are submitted to the Department and approved:
(i) a written summary of the laboratory and field testing and how the results indicate that fish passage shall be provided,
(ii) a monitoring and reporting plan to determine if the installed experimental fish passage structure meets applicable design objectives and is providing fish passage, and
(iii) a modification plan for the experimental fish passage structure if monitoring indicates that fish passage is not being provided, including standard thresholds that will initiate these modifications;
(b) if at any time an experimental fish passage structure is deemed by the Department in writing to not provide fish passage, the owner or operator, in consultation with the Department, shall make such modifications to the structure or operation as are necessary to provide fish passage, and, after a reasonable period, if modifications are deemed by the Department in writing to not provide fish passage, a fish passage structure that meets the standard criteria of OAR 635-412-0035 shall be installed as soon as practicable but no later than the end of the next complete in-water work period after notification by the Department;
(c) the owner or operator of an experimental fish passage structure shall allow the Department to inspect experimental fish passage structures at reasonable times;
(d) five years after the experimental fish passage structure is installed and fish are present to attempt passage a final monitoring report shall be submitted to the Department and the Department shall determine if the experimental fish passage structure provides fish passage;
(e) if the Department determines that the experimental fish passage structure does not provide fish passage, a fish passage structure that meets the standard criteria of OAR 635-412-0035 shall be installed as soon as practicable but no later than the end of the next complete in-water work period after notification by the Department; and
(f) after three experimental fish passage structures of the same design concept are placed in waters of the state and deemed to provide fish passage by the Department, the experimental fish passage structure shall no longer be considered experimental.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.585 and 509.610
Hist.: Adopted 1-6-06, f. & certified ef. 1-9-06

635-412-0040
Mitigation Criteria
(1) Mitigation shall not be allowed for artificial obstructions located in, or which would prevent access to, "Habitat Category 1" habitat for native migratory fish as described in OAR 635-415-0025(1).
(2) Mitigation options include:
(a) providing fish passage at another pre-existing artificial obstruction which is not required to address fish passage under OAR 635-412-0015 or 635-412-0020;
(b) restoration or enhancement of native migratory fish habitat;

(c) fish management measures to directly increase naturally-producing, wild, native migratory fish populations; and
(d) other actions specifically approved by the Commission.
(3) Mitigation shall not include any activity that is a requirement or condition of any other agreement, law, permit, or authorization except if it is also for fish passage mitigation of the same action at the artificial obstruction for a different level of government.
(4) Unless a fish passage waiver for a site has already been obtained and mitigation has been provided, mitigation activities shall not be completed prior to a decision regarding a fish passage waiver.
(5) The Department shall approve final mitigation designs in writing prior to implementation (Note: mitigation actions or concepts, absent specific designs, can be approved at the time a waiver decision is made).
(6) Mitigation actions that provide fish passage shall meet the fish passage criteria contained in OAR 635-412-0035.
(7) The Commission may require the posting of a bond or other financial instrument acceptable to the Commission to cover the cost of mitigation actions or providing fish passage at the artificial obstruction if the mitigation action does not achieve its goals.
(8) A person owning or operating an artificial obstruction is responsible for maintaining, monitoring, evaluating the effectiveness of, and reporting on mitigation.
(9) Mitigation:
(a) shall be conducted in-proximity to the artificial obstruction, with respect to geographic scope;
(b) shall have habitat type and quality which is more beneficial than that affected by the artificial obstruction, if mitigation is passage into, restoration of, or enhancement of habitat;
(c) shall at least benefit the same native migratory fish species affected at the artificial obstruction;
(d) shall have a clear benefit for those native migratory fish species affected at the artificial obstruction if their status is listed as "threatened" or "endangered" under the state or federal Endangered Species Act;
(e) shall have standards for monitoring, evaluating, and adaptive management which are approved by the Department, which assure that the goal of the mitigation is achieved and maintained, and which are detailed in the waiver agreement required in OAR 635-412-0025(9);
(f) shall be considered if the owner or operator of the artificial obstruction believes the feasibility of fish passage at the artificial obstruction is less than that for mitigation;
(g) may require quantification of baseline conditions before a decision regarding a fish passage waiver is made in situations with no existing information, which require recent information, or which have no clear benefit;
(h) shall attempt to restore or enhance historic conditions;
(i) to the extent possible, shall be consistent with existing native migratory fish or watershed management plans;
(j) may qualify for financial incentives or grants issued by the Department and the owner's or operator's cost for mitigation or passage at the artificial obstruction shall not be a factor in the Department's net benefit determination;
(k) may require data collection and evaluation before a decision regarding a fish passage waiver is made in situations with no existing information, which require recent information, or which have no clear benefit; and
(l) shall be consistent with the purpose and goals of the Oregon Plan.

Stat. Auth.: ORS 496.138
Stats. Implemented: ORS 509.580, 509.585, and 509.610
Hist.: Adopted 1-6-06, f. & certified ef. 1-9-06

11. FISH SCREEN AND BYPASS FACILITIES

11.1 Introduction – Fish Screen and Bypass Facilities

This section provides criteria and guidelines to be used in the development of designs of downstream migrant fish screen facilities for hydroelectric, irrigation, and other water withdrawal projects. The design guidance provided in this section applies to *fishway* designs after a decision to provide a passage facility has been made. Unless directly specified herein, this guidance is not intended for use in evaluation of existing facilities, nor does it provide guidance on the application of the design for any particular site. Sections 1, 2, 3, and the Foreword of this document also apply to the guidelines and criteria listed in this section.

In designing an effective fish screen facility, the swimming ability of the fish is a primary consideration. Research has shown that swimming ability of fish varies and may depend upon a number of factors relating to the physiology of the fish, including species, size, duration of swimming time required, behavioral aspects, migrational stage, physical condition and others, in addition to water quality parameters such as dissolved oxygen concentrations, water temperature, lighting conditions, and others. For this reason, screen criteria must be expressed in general terms.

Several categories of screen designs are in use but are still considered as experimental technology by NMFS. These include Eicher screens, modular inclined screens, coanda screens, and horizontal screens. The process to evaluate experimental technology is described in Section 16. Several of these experimental screen types have completed part or all of the experimental technology process, and may be used in specific instances when site conditions allow. Design of these screens, or new conceptual types of experimental screens, may be developed through discussions with NMFS engineers on a case-by-case basis.

Criteria are specific standards for fishway design, maintenance, or operation that cannot be changed without a written waiver from NMFS. For the purposes of this document, a criterion is preceded by the word “must.” In general, a specific criterion can not be changed unless there is site-specific biological rationale for doing so. An example of biological rationale that could lead to criterion waiver is a determination or confirmation by NMFS biologists that the smallest fry-sized fish will likely not be present at a proposed screen site. Therefore, the juvenile fish screen approach velocity criterion of 0.4 ft/s could be increased to match the smallest life stage expected at the screen site. A guideline is a range of values or a specific value for fishway design, maintenance or operation that may change when site-specific conditions are factored into the conceptual fishway design. For the purposes of this document guidelines are preceded by the word “should.” Guidelines should be followed in the fishway design until site-specific information indicates that a different value would provide better fish passage conditions or solve site-specific issues. An example of site-specific rationale that could lead to a modified guideline is when the maximum river depth at a site is 3 feet, as compared to the design guideline for a fishway entrance depth of 6 feet. In this example, safe and

timely fish passage could be provided by modifying the guideline to match the depth in the river. It is the responsibility of the applicant to provide compelling evidence in support of any proposed waiver of criteria or modification of a guideline for NMFS approval early in the design process, well in advance of a proposed Federal action. After a decision to provide passage at a particular site has been made, the following design criteria and guidelines are applicable, in addition to those described throughout Section 3.

11.2 Functional Screen Design

A *functional screen design* should be developed that defines type, location, size, hydraulic capacity, method of operation, and other pertinent juvenile fish screen facility characteristics. In the case of applications to be submitted to FERC and for consultations under the ESA, a *functional design* for juvenile (and adult) fish passage facilities must be developed and submitted as part of the FERC License Application or as part of the Biological Assessment for the facility. It must reflect NMFS input and design criteria and be acceptable to NMFS. *Functional design* drawings must show all pertinent hydraulic information, including water surface elevations and flows through various areas of the structures. *Functional design* drawings must show general structural sizes, cross-sectional shapes, and elevations. Types of materials must be identified where they may directly affect fish. The final detailed design must be based on the *functional design*, unless changes are agreed to by NMFS.

11.3 Site Conditions

To minimize risks to anadromous fish at some locations, NMFS may require investigation (by the project sponsors) of important and poorly defined site-specific variables that are deemed critical to development of the screen and bypass design. This investigation may include factors such as fish behavioral response to hydraulic conditions, weather conditions (ice, wind, flooding, etc.), river stage/flow relationships, seasonal operational variability, potential for sediment and debris problems, resident fish populations, potential for creating predation opportunity, and other information. The life stage and size of juvenile salmonids present at a potential screen site usually is not known, and may change from year to year based on flow and temperature conditions. Thus, adequate data to describe the size-time relationship requires substantial sampling efforts over a number of years. For the purpose of designing juvenile fish screens, NMFS will assume that *fry*-sized salmonids and low water temperatures are present at all sites and apply the appropriate criteria listed below, unless adequate biological investigation proves otherwise. The burden-of-proof is the responsibility of the owner of the diversion facility.

11.4 Existing Screens

11.4.1 Acceptance Criteria and Guidelines for Existing Screens

If a fish screen was constructed prior the establishment of these criteria, but constructed to NMFS criteria established August 21, 1989, or later, approval of these screens may be considered providing that all six of the following conditions are met:

11.4.1.1 The entire screen facility must function as designed.

11.4.1.2 The entire screen facility has been maintained and is in good working condition.

11.4.1.3 When the *screen material* wears out, it must be replaced with *screen material* meeting the current criterion stated in this document. To comply with this condition, structural modifications may be required to retrofit an existing facility with new *screen material.*

11.4.1.4 No mortality, injury, entrainment, impingement, migrational delay, or other harm to anadromous fish has been noted that is being caused by the facility;

11.4.1.5 No emergent *fry* are likely to be located in the vicinity of the screen, as agreed to by NMFS biologists familiar with the site.

11.4.1.6 When biological uncertainty exists, access to the diversion site by NMFS is permitted by the diverter for verification of the above criteria.

11.5 Structure Placement

11.5.1 Specific Criteria and Guidelines – Structure Placement: Streams and Rivers

11.5.1.1 Instream Installation: Where physically practical and biologically desirable, the screen should be constructed at the point of diversion with the screen face generally parallel to river flow. However, physical factors may preclude screen construction at the diversion entrance. Among these factors are excess river gradient, potential for damage by large debris, access for maintenance, operation and repair, and potential for heavy sedimentation. For screens constructed at the bankline, the screen face must be aligned with the adjacent bankline and the bankline must be shaped to smoothly match the face of the screen structure to minimize turbulence and eddying in front, upstream, and downstream of the screen. Adverse alterations to riverine habitat must be minimized.

11.5.1.2 Canal Installation: Where installation of fish screens at the diversion entrance is not desirable or impractical, the screens may be installed in the canal downstream of the entrance at a suitable location. All screens installed downstream from the diversion entrance must be provided with an effective *bypass system*, as described in Sections 11.9 through 11.12, designed to collect and transport fish safely back to the river with minimum delay. The screen location must be chosen to minimize the effects of the diversion on instream flows by placing the bypass outfall as close as biologically feasible (i.e., considering minimizing length and optimizing the hydraulics of the bypass pipe) and practically feasible to the point of diversion.

11.5.1.3 Functionality: All screen facilities must be designed to function properly through the full range of stream hydraulic conditions as defined in Section 3 and in the diversion conveyance, and must account for debris and sedimentation conditions which may occur.

11.5.2 Specific Criteria and Guidelines – Structure Placement: Lakes, Reservoirs, and Tidal Areas

11.5.2.1 Intake Locations: Intakes must be located offshore where feasible to minimize fish contact with the facility. When possible, intakes must be located in areas with sufficient ambient velocity to minimize sediment accumulation in or around the screen and to facilitate debris removal and fish movement away from the screen face. Intakes in reservoirs should be as deep as practical, to reduce the numbers of juvenile salmonids that encounter the intake.

11.5.2.2 Surface Outlets: If a reservoir outlet is used to pass fish from a reservoir, the intake must be designed to withdraw water from the most appropriate elevation based on providing the best juvenile fish attraction and appropriate water temperature control downstream of the project. The entire range of *forebay* fluctuation must be accommodated in design. Since surface outlet designs must consider a wide spectrum of site-specific hydraulic and fish behavioral conditions, NMFS engineers and biologists must be involved in developing an acceptable conceptual design for any surface outlet fish passage system before the design proceeds.

11.6 Screen Hydraulics – Rotating Drum Screens, Vertical Screens, and Inclined Screens

11.6.1 Specific Criteria and Guidelines – Screen Hydraulics

11.6.1.1 Approach Velocity: The *approach velocity* must not exceed 0.40 ft/s for *active screens*, or 0.20 ft/s for *passive screens*. Using these approach velocities will minimize screen contact and/or impingement of juvenile fish. For screen design, *approach velocity* is calculated by dividing the maximum screened

flow amount by the vertical projection of the *effective screen area*. An exception may be made to this definition of *approach velocity* for screen where a clear egress route minimizes the potential for impingement. If this exception is approved be NMFS, the *approach velocity* is calculated using the entire *effective screen area*, and not a vertical projection. For measurement of approach velocity, see Section 15.2.

11.6.1.2 Effective Screen Area: The minimum *effective screen area* must be calculated by dividing the maximum screened flow by the allowable *approach velocity*.

11.6.1.3 Submergence: For rotating drum screens, the design submergence must not exceed 85%, nor be less than 65% of drum diameter. Submergence over 85% of the screen diameter increases the possibility of entrainment over the top of the screen (if entirely submerged), and increases the chance for impingement with subsequent entrainment if fish are caught in the narrow wedge of water above the 85% submergence mark. Submerging rotating drum screens less than 65% may reduce the self-cleaning capability of the screen. In many cases, stop logs may be installed downstream of the screens to achieve proper submergence. If stop logs are used, they should be located at least two drum diameters downstream of the back of the drum.

11.6.1.4 Flow Distribution: The screen design must provide for nearly uniform flow distribution (see Section 15.2) over the screen surface, thereby minimizing *approach velocity* over the entire screen face. The screen designer must show how uniform flow distribution is to be achieved. Providing adjustable *porosity* control on the downstream side of screens, and/or flow *training wall*s may be required. Large facilities may require hydraulic modeling to identify and correct areas of concern. Uniform flow distribution avoids localized areas of high velocity, which have the potential to impinge fish.

11.6.1.5 Screens Longer Than Six Feet:

- Screens longer than 6 feet must be angled and must have *sweeping velocity* greater than the *approach velocity*. This angle may be dictated by site-specific geometry, hydraulic, and sediment conditions. Optimally, *sweeping velocity* should be at least 0.8 ft/s and less than 3 ft/s.
- For screens longer than 6 feet, *sweeping velocity* must not decrease along the length of the screen.

11.6.1.6 Inclined Screen Face: An inclined screen face must be oriented less than 45° vertically with the screen length (upstream to downstream) oriented parallel to flow, unless the inclined screen is placed in line with riverbank and reasonably matching the slope of the riverbank.

11.6.1.7 Horizontal Screens: Horizontal screens have been evaluated as an experimental technology, and may only be considered if the majority of flow

passes over the end of the screen at a minimum depth of 1 foot, and positive downstream *sweeping velocity* in excess of the approach velocity exists for the entire length of screen. Post construction monitoring of the facility must occur. Since site-specific design conditions are required, NMFS engineers must be consulted throughout the development and evaluation of the design.

11.7 Screen Material

11.7.1 Specific Criteria and Guidelines – Screen Material

11.7.1.1 Circular Screens: Circular screen face openings must not exceed $^{3}/_{32}$ inch in diameter. Perforated plate must be smooth to the touch with openings punched through in the direction of approaching flow.

11.7.1.2 Slotted Screens: Slotted screen face openings must not exceed 1.75 mm (approximately $^{1}/_{16}$ inch) in the narrow direction.

11.7.1.3 Square Screens: Square screen face openings must not exceed $^{3}/_{32}$ inch on a diagonal.

11.7.1.4 Material: The *screen material* must be corrosion resistant and sufficiently durable to maintain a smooth uniform surface with long term use.

11.7.1.5 Other Components: Other components of the screen facility (such as seals) must not include gaps greater than the maximum screen opening defined above.

11.7.1.6 Open Area: The percent open area for any *screen material* must be at least 27%.

11.8 Civil Works and Structural Features

11.8.1 Specific Criteria and Guidelines – Civil Works and Structural Features

11.8.1.1 Placement of Screen Surfaces: The face of all screen surfaces must be placed flush (to the extent possible) with any adjacent screen bay, pier noses, and walls to allow fish unimpeded movement parallel to the screen face and ready access to bypass routes.

11.8.1.2 Structural Features: Structural features must be provided to protect the integrity of the fish screens from large debris, and to protect the facility from damage if overtopped by flood flows. A *trash rack*, log boom, sediment sluice, and other measures may be required.

11.8.1.3 Civil Works: The civil works must be designed in a manner that prevents undesirable hydraulic effects (such as eddies and stagnant flow zones) that may delay or injure fish or provide predator habitat or predator access.

11.9 Bypass Facilities

11.9.1 Specific Criteria and Guidelines – Bypass Layout

11.9.1.1 Bypass Location:

- The screen and bypass must work in tandem to move out-migrating salmonids (including downstream migrant adult salmonids such as steelhead *kelts*, if present) to the bypass outfall with a minimum of injury or delay.
- The bypass entrance must be located so that it may easily be located by out-migrants.
- The bypass entrance and all components of the *bypass system* must be of sufficient size and hydraulic capacity to minimize the potential for debris blockage.
- Screens greater than or equal to 6 feet in length must be constructed with the downstream end of the screen terminating at a bypass entrance. Screens less than or equal to 6 feet in length may be constructed perpendicular to flow with a bypass entrance at either or both ends of the screen, or may be constructed at an angle to flow, with the downstream end terminating at the bypass entrance.
- Some screen systems do not require a bypass system. For example, an end of pipe screen located in a river, lake, or reservoir does not require a bypass system because fish are not removed from their habitat. A second example is a river bank screen with sufficient hydraulic conditions to move fish past the screen face.

11.9.1.2 Multiple Entrances: Multiple bypass entrances should be used if the *sweeping velocity* may not move fish to the bypass within 60 seconds, assuming fish are transported along the length of the screen face at a rate equaling *sweeping velocity*.

11.9.1.3 Training Wall: A *training wall* must be located at an angle to the screen face, with the bypass entrance at the apex and downstream-most point. For many facilities, the wall of the civil works opposite to the screen face may serve as a *training wall*. For single or multiple *vee screen* configurations, *training wall*s are not required, unless an intermediate bypass must be used.

11.9.1.4 Secondary Screen: In cases where there is insufficient flow available to satisfy hydraulic requirements at the bypass entrance for the primary screens, a secondary screen may be required within the primary bypass. The secondary *bypass flow* conveys fish to the bypass outfall location or other destination, and returns secondary screened flow for water use.

11.9.1.5 Bypass Access: Access for inspection and debris removal must be provided at locations in the *bypass system* where debris accumulations may occur.

11.9.1.6 Trash Racks: If *trash racks* are used, sufficient hydraulic gradient must be provided to route juvenile fish from between the *trash rack* and screens to the bypass.

11.9.1.7 Canal Dewatering: The floor of the screen civil works must be designed to allow fish to be routed back to the river safely when the canal is dewatered. This may entail using a small gate and drain pipe, or similar provisions, to drain all flow and fish back to the river. If this cannot be accomplished, an acceptable fish salvage plan must be developed in consultation with NMFS and included in the operation and maintenance plan.

11.9.1.8 Bypass Channel Velocity: To ensure that fish move quickly through the bypass channel (i.e., the conveyance from the terminus of the screen to the bypass pipe), the rate of increase in velocity between any two points in the bypass channel should not decrease and should not exceed 0.2 ft/s per foot of travel.

11.9.1.9 Natural Channels: Natural channels may be used as a bypass upon approval by NMFS engineers. A consideration for utilizing natural channels as a bypass is the provision of off-stream habitat. Requirements for natural channels include adequate depth and velocity, sufficient flow volume, protection from predation, and good water quality.

11.9.2 Specific Criteria and Guidelines – Bypass Entrance

11.9.2.1 Flow Control: Each bypass entrance must be provided with independent flow-control capability.

11.9.2.2. Minimum Velocity: The minimum bypass entrance flow velocity should be greater than 110% of the maximum canal velocity upstream of the bypass entrance. At no point must flow decelerate along the screen face or in the bypass channel. *Bypass flow* amounts should be of sufficient quantity to ensure these hydraulic conditions are achieved for all operations throughout the *smolt* out-migration period.

11.9.2.3 Lighting: Ambient lighting conditions must be included upstream of the bypass entrance and should extend to the *bypass flow* control device. Where lighting transitions cannot be avoided, they should be gradual, or should occur at a point in the *bypass system* where fish cannot escape the bypass and return to the canal (i.e., when bypass velocity exceeds swimming ability).

11.9.2.4 Dimensions: For diversions greater than 3 cfs, the bypass entrance must extend from the floor to the canal water surface, and should be a minimum of 18

inches wide. For diversions of 3 cfs or less, the bypass entrance must be a minimum of 12 inches wide. In any case, the bypass entrance must be sized to accommodate the entire range of *bypass flow*, utilizing the criteria and guidelines listed throughout Section 11.9.

11.9.2.5 Weirs: For diversions greater than 25 cfs, *weir*s used in *bypass system*s should maintain a *weir* depth of at least 1 foot throughout the *smolt* out-migration period.

11.9.3 Specific Criteria and Guidelines – Bypass Conduit and System Design

11.9.3.1 General: Bypass pipes and joints must have smooth surfaces to provide conditions that minimize turbulence, the risk of catching debris, and the potential for fish injury. Pipe joints may be subject to inspection and approval by NMFS prior to implementation of the bypass. Every effort should be made to minimize the length of the bypass pipe, while maintaining hydraulic criteria listed below.

11.9.3.2 Bypass Flow Transitions: Fish should not be pumped within the bypass system. Fish must not be allowed to free-fall within a pipe or other enclosed conduit in a bypass system. Downwells must be designed with a free water surface, and designed for safe and timely fish passage by proper consideration of turbulence, geometry, and alignment.

11.9.3.3 Flows and Pressure: In general, *bypass flow*s in any type of conveyance structure should be open channel. If required by site conditions, pressures in the bypass pipe must be equal to or above atmospheric pressures. Pressurized to non-pressurized (or vice-versa) transitions should be avoided within the pipe. Bypass pipes must be designed to allow trapped air to escape.

11.9.3.4 Bends: Bends should be avoided in the layout of bypass pipes due to the potential for debris clogging and turbulence. The ratio of bypass pipe center-line radius of curvature to pipe diameter (R/D) must be greater than or equal to 5. Greater R/D may be required for super-critical velocities (see Section 11.9.3.8).

11.9.3.5 Access: Bypass pipes or open channels must be designed to minimize debris clogging and sediment deposition and to facilitate inspection and cleaning as necessary. Long bypass designs (eg. greater than 150 feet) may include access ports provided at appropriate spacing to allow for detection and removal of debris. Alternate means of providing for bypass pipe inspection and debris removal may be acceptable as well.

11.9.3.6 Diameter/Geometry: The bypass pipe diameter or open channel bypass geometry should generally be a function of the *bypass flow* and slope, and should be chosen based on achieving the velocity and depth criteria in Sections 11.9.3.8 and 11.9.3.9.

Table 11-1 provides examples for selecting the diameter of a bypass pipe based on diverted flow amount, assuming 1) bypass pipe slope of 1.3%; 2) Manning's roughness of 0.009; and 3) other bypass pipe criteria (Section 11.9) are met. Bypass pipe hydraulics should be calculated for a given design to determine a suitable pipe diameter if the design deviates from the assumptions used to calculate pipe diameters in Table 11-1.

Table 11-1. Bypass Design Examples

Diverted Flow (cfs)	***Bypass flow* (cfs)**	**Bypass Pipe Diameter (in)**	***Bypass flow* Depth (in)**
< 6	5% of diverted flow	10	2 ½
6 - 25	5% of diverted flow	10	4
40	2.00	12	4 ¾
75	3.75	15	6
125	6.25	18	7 ¼
175	8.75	21	8 ½
250	12.5	24	9 ½
500	25.0	30	12
750	37.5	36	14
> 1000	design with direct NMFS engineering involvement		

11.9.3.7 Flow: Design *bypass flow* should be about 5% of the total diverted flow amount, unless otherwise approved by NMFS. Regardless of the *bypass flow* amount, hydraulic guidelines and criteria in Sections 11.9.3.8 and 11.9.3.9 apply.

11.9.3.8 Velocity: The design bypass pipe velocity should be between 6 and 12 ft/s for the entire operational range. If higher velocities are approved, special attention to pipe and joint smoothness must be demonstrated by the design. To reduce silt and sand accumulation in the bypass pipe, pipe velocity must not be less than 2 ft/s.

11.9.3.9 Depth: The design minimum depth of free surface flow in a bypass pipe should be at least 40% of the bypass pipe diameter, unless otherwise approved by NMFS.

11.9.3.10 Closure Valves: Closure valves of any type should not be used within the bypass pipe unless specifically approved based on demonstrated fish safety.

11.9.3.11 Sampling Facilities: Sampling facilities installed in the bypass conduit must not in any way impair operation of the facility during non-sampling operations.

11.9.3.12 Hydraulic Jump: There should not be a hydraulic jump within the pipe.

11.9.3.13 Spillways: Spillways upstream of the screen facility also act as a *bypass system*. These facilities should also be designed to provide a safe passage route back to the stream, adhering to the bypass design principles described throughout Section 11.9

11.9.4 Specific Criteria and Guidelines – Bypass Outfall

11.9.4.1 Location:

- Bypass outfalls must be located to minimize predation by selecting an outfall location free of eddies, reverse flow, or known predator habitat. The point of impact for bypass outfalls should be located where ambient river velocities are greater than 4.0 ft/s during the *smolt* out-migration. Predator control systems may be required in areas with high avian predation potential. Bypass outfalls should be located to provide good egress conditions for downstream migrants.
- Bypass outfalls must be located where the receiving water is of sufficient depth (depending on the impact velocity and quantity of *bypass flow*) to ensure that fish injuries are avoided at all river and *bypass flow*s. The *bypass flow* must not impact the river bottom or other physical features at any stage of river flow.

11.9.4.2 Impact Velocity: Maximum bypass outfall impact velocity (i.e., the velocity of *bypass flow* entering the river) including vertical and horizontal velocity components should be less than 25.0 ft/s.

11.9.4.3 Discharge and Attraction of Adult Fish: The bypass outfall discharge into the receiving water must be designed to avoid attraction of adult fish thereby reducing the potential for jumping injuries and false attraction. The bypass outfall design must allow for the potential attraction of adult fish, by provision of a safe landing zone if attraction to the outfall flow can potentially occur.

11.10 Debris Management

11.10.1 Specific Criteria and Guidelines – Debris Management

11.10.1.1 Inspection and Maintenance: A reliable, ongoing inspection, preventative maintenance, and repair program is necessary to ensure facilities are kept free of debris and that screen media, seals, drive units, and other components are functioning correctly during the outmigration period. A written plan should be completed and submitted for approval with the screen design.

11.10.1.2 Screen Cleaning (Active Screens): *Active screens* must be automatically cleaned to prevent accumulation of debris. The screen cleaner design should allow for complete debris removal at least every 5 minutes, and operated as required to prevent accumulation of debris. The head differential to trigger screen cleaning for intermittent type cleaning systems must be a maximum

of 0.1 feet over clean screen conditions or as agreed to by NMFS. A variable timing interval trigger must also be used for intermittent type cleaning systems as the primary trigger for a cleaning cycle. The cleaning system and protocol must be effective, reliable, and satisfactory to NMFS.

11.10.1.3 Passive Screens: A *passive screen* should only be used when all of the following criteria are met:

- The site is not suitable for an *active screen*, due to adverse site conditions.
- Uniform approach velocity conditions must exist at the screen face, as demonstrated by laboratory analysis or field verification.
- The debris load must be low.
- The combined rate of flow at the diversion site must be less than 3 cfs.
- Sufficient ambient river velocity must exist to carry debris away from the screen face.
- A maintenance program must be approved by NMFS and implemented by the water user.
- The screen must be frequently inspected with debris accumulations removed, as site conditions dictate.
- Sufficient stream depth must exist at the screen site to provide for a water column of at least one screen radius around the screen face.
- The screen must be designed to allow easy removal for maintenance, and to protect from flooding.

11.10.1.4 Intakes: Intakes must include a *trash rack* in the screen facility design which must be kept free of debris. In certain cases, a satisfactory profile bar screen design may substitute for a *trash rack*. Based on biological requirements at the screen site, *trash rack* spacing may be specified that reduces the probability of entraining adult fish.

11.10.1.5 Inspection: The completed screen and bypass facility must be made available for inspection by NMFS, to verify that the screen is being operated consistent with the design criteria.

11.10.1.6 Evaluation: At some sites, screen and bypass facilities may be evaluated for biological effectiveness and to verify that hydraulic design objectives are achieved. At the discretion of NMFS, this may entail a complete biological evaluation especially if waivers to screen and bypass criteria are granted, or merely a visual inspection of the operation if screen and bypass criteria is met in total.

11.10.1.7 Sediment: Provision must be made to limit the build-up of sediment, where it may impact screen operations.

11.11 End of Pipe Screens (including pump intake screens)

11.11.1 Specific Criteria and Guidelines – End of Pipe Screens

11.11.1.1 Location: *End of pipe screens* must be placed in locations with sufficient ambient velocity to sweep away debris removed from the screen face, or designed in a manner to prevent debris re-impingement and provide for debris removal.

11.11.1.2 Submergence: *End of pipe screens* must be submerged to a depth of at least one screen radius below the minimum water surface, with a minimum of one screen radius clearance between screen surfaces and natural or constructed features. For *approach velocity* calculations, the entire submerged *effective screen area* may be used.

11.11.1.3 Escape Route: A clear escape route should exist for fish that approach the intake volitionally or otherwise. For example, if a pump intake is located off of the river (such as in an intake lagoon), a conventional open channel screen should be placed in the intake channel or at the edge of the river to prevent fish from entering a lagoon.