Spring 2014

Restoring generating capacity of Diablo Hydroelectric Project by dredging the confluence of Stetattle Creek and Gorge Reservoir, Diablo, WA

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Prepared for Environmental Science 493, Spring 2014

Under the Supervision of Dr. Leo Bodensteiner

Huxley College of the Environment

Western Washington University

DIGITAL RELEASE

Environmental Impact Assessment
Huxley College of the Environment

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Hailey Beres Jordan Johnson

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Date June 4, 2014

Gorge Reservoir Dredging EIA Project Team
Environmental Impact Assessment ESCI 493
Huxley College of the Environment
Western Washington University
Bellingham, Washington
May 2014

Dear Concerned Citizen,

In accordance with the Washington State Environmental Policy Act (State Environmental Policy Act- Washington Administrative Code 197-11), this Environmental Impact Assessment was developed to determine and evaluate the impacts from the proposed dredging project within Gorge Reservoir under Seattle City Light's authority. Gorge Reservoir and Diablo Dam are part of a series of three on the Skagit River in the North Cascades. Seattle City Light owns and operates these dams, which generate a combined 690 megawatts of electricity for Seattle and the greater Puget Sound region (*Low Impact Hydro Institute, 2008).*

The importance of hydropower in the state of Washington is significant; it supplies over seventy percent of electricity statewide. Washington also produces twenty-nine percent of the nation's hydroelectric generation *(EIA.gov, Washington Profile Overview).*

Engineers with Seattle City Light have identified a substantial decrease in capacity from the turbines at the base of Diablo Dam in recent years. Seattle City Light has proposed dredging a portion of the Gorge Reservoir in order to decrease the tail water level. An increased gradient from Diablo Reservoir to Gorge Reservoir will allow more flow through the Diablo Dam hydroelectric plant.

The area to be dredged is a shallow cobble bar that provides critical habitat for bull trout and other fish. The cobble bar is located near the mouth of the Stetattle Creek, which is a tributary to the Skagit River and the subsequent Gorge Reservoir.

Currently, water behind the Diablo Dam is periodically released to allow scaled and controlled flushing of downstream sediment accumulation in order to establish increased flow. The goal of the dredging is to increase the flow of water through the

Diablo Dam turbines, thus optimizing the hydroelectric plant to provide electricity to Seattle City Light customers.

This report analyzes the environmental impacts of such action to both the natural and built environments. The goal of our analysis was to survey the positive and negative impacts associated with the proposed dredging.

This Environmental Impact Assessment (further referred to as "EIA") addresses the Proposed Action, an Alternative Action, and a No Action Alternative. The Proposed Action is the dredging of the cobble bar as planned by Seattle City Light. The Alternative Action is to relocate eight historical sites in the town of Diablo and reestablish a portion of the original stream path and alluvial fan of the Stetattle Creek tributary into the Gorge Reservoir. This would redistribute the sediments from the Creek in a less concentrated manner, which currently backs up the water level against the dam. The goal of the Alternative Action is to lessen the environmental impacts while still producing the same desired project result. The No Action Alternative would be a continuation of the decreased power output and the maintaining of the cobble bar, as is.

This document was prepared for a capstone Environmental Science course at Western Washington University. The course is dedicated to familiarizing upper-division students in Huxley College of the Environment with the Environmental Impact Statement process as outlined in SEPA (WAC 197-11).

Sincerely,

Hailey Beres

Kandyce Napoleon

Jordan Johnson

Bjorn Ostenson

Restoring Generating Capacity of Diablo Hydroelectric Project by Dredging the Confluence of the Stetattle Creek and Gorge Reservoir
Diablo, WA

Prepared for:

Environmental Science 493
Professor Leo Bodensteiner
Western Washington University
Huxley College of the Environment

Prepared by:

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This report represents a class project that was carried out by students of Huxley College of the Environment at Western Washington University. It has not been undertaken at the request of any persons representing local government or private individuals. Nor does it necessarily represent the opinion or positions of individuals from government or the private sector.

FACT SHEET

Title

Restoring Generating Capacity of Diablo Hydroelectric Project by Dredging the Confluence of Stetattle Creek and Gorge Reservoir

Description

This Environmental Impact Assessment (EIA) is based on the Washington State Environmental Policy Act (SEPA) requirements for any action that may have a significant or adverse impact on the environment. These requirements are stipulated in Chapter 197-11 of the Washington Administrative Code (WAC).

The Proposed Action is to dredge 19,500 cubic yards of substrate from the alluvial fan of Stetattle Creek as it enters Gorge Reservoir. The Alternative Action is to widen the alluvial fan of Stetattle Creek. This action would require the removal of a portion of the town of Diablo. The No Action Alternative maintains the conditions currently observed, in both the natural and built environment.

Location of the Study Site

The study site is located at Gorge Reservoir, Washington

Proposer

Students in ESCI 493- Environmental Impact Assessments Spring 2014

Contact Person

Dr. Leo Bodensteiner, Professor
Department of Environmental Sciences

Huxley College of the Environment
Western Washington University
Bellingham, WA 98225

Permits and Approvals

Permit	Source of Permit	Activity	Contact Agency
Hydraulic Project Approval	Construction Projects in State Waters- RCW 77.55 and WAC 220-110	Work that uses, diverts, obstructs or changes the natural flow or bed of state waters	Washington Department of Ecology, Washington Department of Fish and Wildlife
Section 401 Permit	Section 401 of the Clean Water Act	Any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into navigable waters	Washington Department of Ecology
Section 10 Permit	Section 10 of the Rivers and Harbors Act of 1899, Section 7 of the Endangered Species Act, Coastal Zone Management Act	Activity within, or outside, a state's coastal zone that will affect land or water uses or natural resources of that state's coastal zone	United States Army Corps of Engineers

EIA Contributors & Sections Contributed

Hailey Beres – Air, Natural Resources and Energy, Chapter One, Chapter Two, Concerned Citizen Letter, Fact Sheets, Executive Summary

Jordan Johnson – Water, Plants & Animals, Executive Summary, Photography

Kandyce Napoleon – Environmental Health, Land and Shoreline Use, Transportation, Public Services and Utilities, Digital Release, Fact Sheets, Executive Summary

Bjorn Ostenson – Earth, Executive Summary, GIS Mapping, Photography

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May 4th, 2014

Public Hearing

5:00 PM; Thursday, June 5, 2014
REI Community Room
400 36th St.
Bellingham, WA 98225

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LIST OF DEFINITIONS, ACRONYMS AND ABBREVIATIONS

Ambient noise	Noise naturally occurring in an area.
Berm	A raised embankment built to prevent overflow of a river.
BMI	Benthic macroinvertebrates, an assemblage of organisms that are large enough to be seen without use of a microscope and resides on the bottom substrate (benthos) of aquatic environments
Cobble bar	A large, elevated area within a body of water of rock deposits, typically larger in size than pebbles but smaller than boulders.
dBA	A-weighted decibel. A-Weighted sum of sound energy across the range of human hearing. Human hearing is poor at very low or very high frequencies. Weighting adjusts for this.
EIA	Environmental Impact Assessment, an unofficial simulation of the Environmental Impact Statement, as defined by the Washington State Environmental Policy Act in the Washington Administrative Code 197-11.
FHWA	Federal Highway Administration.
Flushing	Controlled releases of water from a dam to use the water force to alter the flow path.
Head cutting	Erosion of a stream bed upstream of an abrupt drop. Erosion will continue to travel upstream until a natural or synthesized barrier is encountered.
Levee	See *berm* definition.
Megawatts	A unit of power equal to one million watts or 1000 kilowatts. It is an instantaneous amount of energy. Used over a time period, the energy is referred as megawatt hours.
NHPA	National Historic Preservation Act.
Native Char	Term used to describe native Bull Trout and Dolly Varden species. Recognition between the two is difficult to impossible without the use of genetic identification.

SEPA	State Environmental Policy Act for Washington State.
SHPO	State Historic Preservation Officer.
Soundscape	Natural sounds from the environment that create the acoustic environment.
Spoils	The dirt and rock from excavation.
Substrate	A substance or layer that underlies something.
TMDL	Total Maximum Daily Load.
Viewscape	Combination of natural and built environments that create visual features of the landscape.
WAC	Washington Administrative Code.
WSDOT	Washington State Department of Transportation.

EXECUTIVE SUMMARY

Three options were explored within this EIA. The Proposed Action is to dredge the cobble bar area to decrease sediment build-up. The Alternative Action is to relocate portions of the town Diablo, which was built on infill over the original Stetattle Creek delta. Removing this infill and allowing the creek to return to its natural flow will result in sediment deposition in a much less concentrated domain. The No Action Alternative is to maintain the cobble bar and the decreased turbine capacity.

EARTH

Major changes in the topography of the area will result from both the Proposed Action and the Alternative Action. This will result from the dredging of Stetattle Creek cobble bar for the Proposed Action and the removal of the Stetattle Creek levee on the border of the town of Diablo for the Alternative Action. The Proposed Action and Alternative Action increase the likelihood of erosion, as an estimated 19,000 cubic yards of cobble and earth will be removed for both actions. This will in turn potentially compromise the structural integrity of the soil and sediments at the confluence of Gorge Reservoir and Stetattle Creek, posing a risk to the Stetattle Creek Bridge.

AIR

Due to the extraction and transport of spoils, increased motor traffic on the west side of Highway 20 will result in increased amounts of the criteria pollutants, particulate matter, hydrocarbons, nitrogen oxides, carbon monoxide, sulfur dioxide and carbon dioxide. An estimated 4,797 gallons of diesel will be used to transport spoils in the Proposed Action or the Alternative Action, resulting in approximately 107,356 pounds of carbon dioxide released into the local atmosphere.

WATER

The Proposed Action and Alternative Action have potential to significantly affect water quality by increasing turbidity of downstream waters from poor water management. Turbidity impacts can be greatly reduced by proper water management practices such as

silt screens and coffer dams. Careful evaluation of these management techniques will need to be done prior to and during the construction process. No Action will not have an effect on water quality.

The goal of both the Proposed Action and Alternative Action is to increase head flow in the Skagit River adjacent to Stetattle Creek confluence. Hydrology of the river will not be affected by either of these action proposals. During the construction of the Proposed and Alternative Actions drawdown of Gorge Reservoir will be done to limit water management difficulties.

PLANTS & ANIMALS

For the Proposed Action, the major wildlife concern is habitat loss of the native char. Dredging of the cobble bar at Stetattle Creek confluence would eliminate vital native char spawning and rearing habitat, and head cutting into Stetattle Creek could also eliminate habitat. Rainbow trout and eastern brook trout would also be affected from the same habitat loss but these species are not federally threatened like native char. The Alternative Action would affect fish habitat in Stetattle Creek adjacent to the replaced levee. Habitat in the alluvial fan would not be affected as long as flushing from Diablo Dam removed the fine silts that will likely deposit during construction. The No Action alternative would not adversely affect fish populations in Stetattle Creek or the alluvial fan as these areas have been confirmed fish spawning and rearing habitats.

Decreases in fish populations as a result of the Proposed Action will have an effect on osprey that migrate into the area to feed during the summer. Impacts will likely include osprey moving upstream or downstream of Stetattle Creek confluence to feed as a result of fish habitat loss in the Stetattle Creek area.

Marbled murrelet and northern spotted owl populations will likely not be adversely affected by any of the proposed actions unless physically nesting in the construction area. Assessment will be done for each of these species to ensure they are not present in the area surrounding the Stetattle Creek confluence.

NATURAL RESOURCES & ENERGY

Only the Proposed Action and the Alternative Action will provide the desired result of increased hydroelectric generation capacity. Energy expended and emissions released during the dredging or the berm removal and structure relocation will be much less damaging to the environment than the replacement of lost hydroelectric generation with coal generation imported from Montana.

The carbon dioxide emissions of the Proposed Action and the Alternative Action are predicted to be approximately 107,356 pounds. The energy consumed to replace the lost generation within the No Action Alternative will be 24,333 tons of coal each year to continually generate 5 megawatts of electricity. The emissions associated with this amount of coal is 13,918,666 tons of carbon dioxide over the course of a year.

ENVIRONMENTAL HEALTH

Dredging of Gorge Reservoir would not create any changes to the existing infrastructure of the local area. Both the Proposed Action and the Alternative Action would create noise in excess of ambient noise levels in the area. Ambient noise in the project area is recorded at 46 dBA. The Proposed Action would create levels of point-source noise pollution ranging from 68-88 dBA. The increase of noise from the project construction will disrupt the natural soundscape of the area within the time period of the excavation.

LAND USE

Dredging of Gorge Reservoir would not create changes to the existing infrastructure of the local area but would negatively affect recreational use of the area. The removal of the cobble bar detracts recreational value, as well as, aesthetic value of the reservoir by eliminating the small rapids used by kayakers and reducing this geologic feature of the viewscape. The Alternative Action would have the greatest impact on Diablo residents and historic preservation due to the removal and relocation of housing. The Alternative Action would have moderate impacts on the historical integrity of the town because of the required relocation of homes and extension of the Stetattle Creek Bridge, all of which are identified as contributing to the historic background of the town.

TRANSPORTATION

The Proposed and Alternative Actions would affect transportation systems in the Diablo area and connecting roadways. Both actions would have an approximate equal impact on access to the town of Diablo due to increased traffic from the project. Spoils from the Proposed Action and Alternative Actions will be the same amount, resulting in an equal amount of trucks to dispose of the spoils. Hauling of cobble bar material would increase the amount of trips taken on State Route 20 and extend for 15.5 miles from the excavation site. A total of 31 miles would be travelled for every round-trip taken to haul sediment from the site to the "Dirt Pit". The Alternative Action would affect Diablo town residents the most by restricting access to streets during the period of structure removal and replacement.

PUBLIC SERVICES & UTILITIES

Diablo is a "company town," owned and operated by Seattle City Light, which is responsible for the proper function of the town. The town has been in a state of decline denoted by the decrease in population, closure of the school, and reduction of other services. Neither the Proposed Action nor the No Action alternative will have impacts to public services or utilities. The Alternative Action proposal requires the removal of a sewage pump station that would disrupt the provision of sewage services to town residents. Alternate sewage services would have to be provided until the relocation and construction of new sewage facilities.

SCOPE OF THE EIA

The scope of this EIA has been determined following the instruction of the Washington State Environmental Policy Act (SEPA). Though all elements of the environment were considered during the scoping process, only elements determined to be affected by the Proposed Action are included in this Environmental Impact Assessment.
Elements of the Environment Affected by Proposal:

1. Natural Environment

    a. Earth
        i. Topography
        ii. Geology
        iii. Soils
        iv. Seismicity

    b. Air
        i. Climate
        ii. Air Quality

    c. Water
        i. Water Quality
        ii. Hydrology

    d. Plants and Animals
        i. Habitat Diversity
        ii. Native & Non-Native Fish Species

    e. Energy and Natural Resources
        i. Existing Environment

ii. Provision of Electricity

iii. Nonrenewable Resources

iv. Renewable Resources

2. Built Environment

a. Environmental Health

i. Noise

b. Land & Shoreline Use

i. Housing & Existing Land Use Plans

ii. Aesthetics

iii. Recreation

iv. Historical & Cultural Preservation

c. Transportation

i. Transportation Systems

d. Public Services & Utilities

i. Sewer/Solid waste

DECISION MATRIX

ELEMENTS OF THE NATURAL ENVIRONMENT

	PROPOSED ACTION	ALTERNATIVE ACTION	NO ACTION
EARTH			
Topography	-	+	0
Geology	0	0	0
Soils	-	-	0
Seismicity	0	0	0
Erosion	--	-	0
AIR			
Climate	0	0	0
Air Quality	-	-	--
WATER			
Water Quality	-	-	0
Hydrology	0	0	0
PLANTS & ANIMALS			
Habitat Diversity	-	0	0
Native & Non-Native Fish Species	--	-	0
ENERGY & NATURAL RESOURCES			
Existing Environment	0	0	0
Provision of Electricity	++	++	--
Non-Renewable Resources	-	-	--

Renewable Resources	++	++	-

ELEMENTS OF THE BUILT ENVIRONMENT

	PROPOSED ACTION	ALTERNATIVE ACTION	NO ACTION
ENVIRONMENTAL HEALTH			
Noise	-	-	0
LAND & SHORELINE USE			
Housing & Existing Land Use Plans	-	--	0
Aesthetics	-	0	0
Recreation	-	0	0
Historical & Cultural Preservation	0	-	0
TRANSPORTATION			
Transportation Systems	-	-	0
PUBLIC SERVICES &UTILITIES			
Sewer/Solid Waste	0	-	0

TOTALS	-11	-7	-7

KEY

Strong Positive Impact	++, valued at +2
Moderate Positive Impact	+, valued at +1
No Impact or Neutral	0, valued at 0
Moderate Negative Impact	-, valued at -1

Strong Negative Impact	--, valued at -2

CHAPTER ONE
THE PROPOSED ACTION & ALTERNATIVES

1.1 INTRODUCTION

This chapter compares the three actions proposed in this Environmental Impact Assessment. This includes the Proposed Action of dredging as advocated by Seattle City Light, and the Alternative Action and No Action Alternative as developed by our team acting as consulting agents.

This chapter presents the impacts of each action in a comparative form. It evaluates each section of the environment in terms of probable impacts from each developed action. Some of the information presented is based upon the environmental impact of an action, and some is presented as a negative impact of the No Action Alternative. These adverse impacts are summed and are represented in the previous decision matrix.

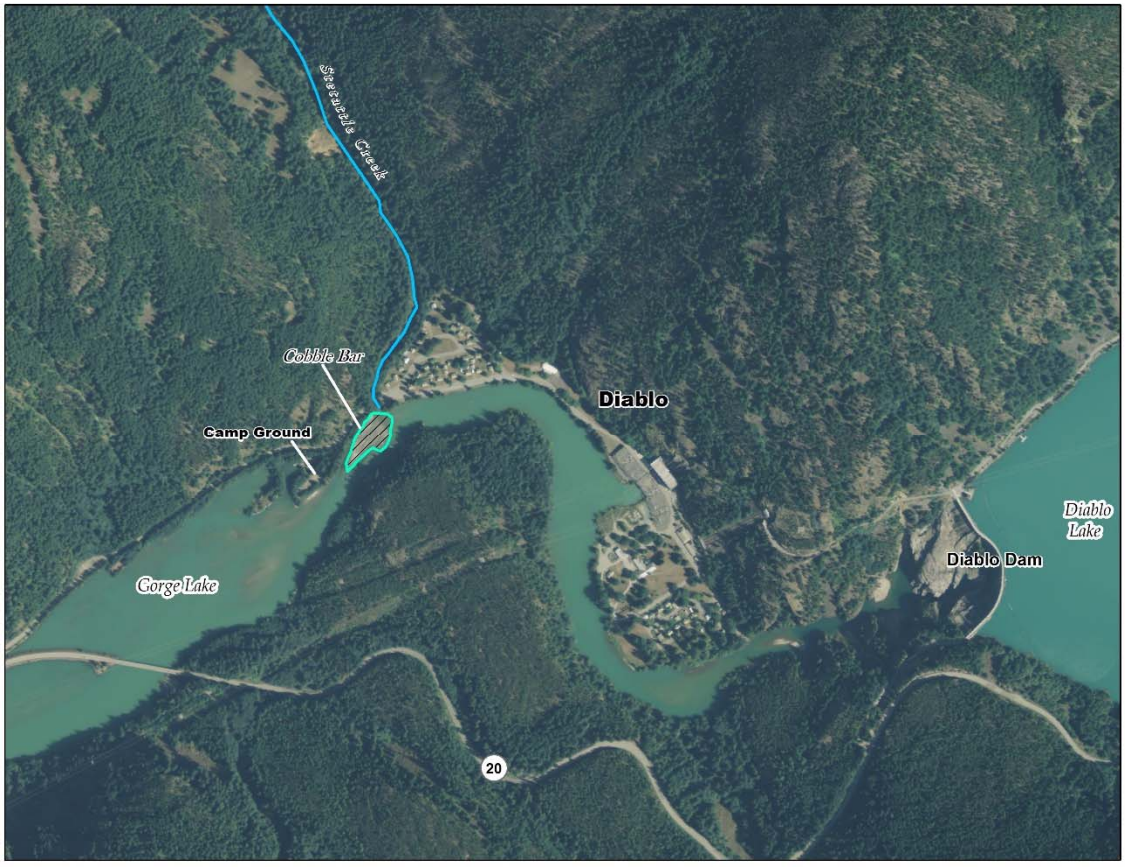

Figure 1. Image showing the Stettatle Creek path and the Cobble Bar.

1.2 PROPOSED ACTION - *Dredging the cobble bar*

Seattle City Light has seen a decrease in generating capacity at the Diablo Dam on the upper Skagit River that has been attributed to the enlargement of a cobble bar at the confluence of the Skagit River (Gorge Reservoir) and the Stetattle Creek. The cobble bar, coupled with sediment transported downstream from a landslide in 2003, has increased the tail water elevation in comparison with the Diablo Reservoir. This has lessened water pressure passing through the turbines and subsequently decreased electricity generating capacity.

It has been estimated that the water level in the Gorge Reservoir has been raised approximately three feet due to the cobble bar and sediments associated with the mouth of the Stetattle Creek. Seattle City Light has determined that dredging the cobble bar area will restore the generating capacity of the Diablo Dam *(R2 Resource Consultants, 2013).*

Seattle City Light partnered with Seattle University to examine removal effects and other alternatives, along with economic benefits over a five-year period to determine the most beneficial action. According to the report by Seattle University, direct excavation of a fifty-foot wide section, six feet deep would lower the tail water height by 3.2 feet and would increase yearly revenue (in terms of current electricity prices) by 1.3 million dollars each year. The estimated cost of excavation would be 440,000 dollars in the first year *(R2 Resource Consultants, 2013).* The dredging will be a more permanent way to increase capacity than frequent "flushing." Flushing is the action of controlled releases from the Diablo Dam to wash sediment downstream and remove some of the bar.

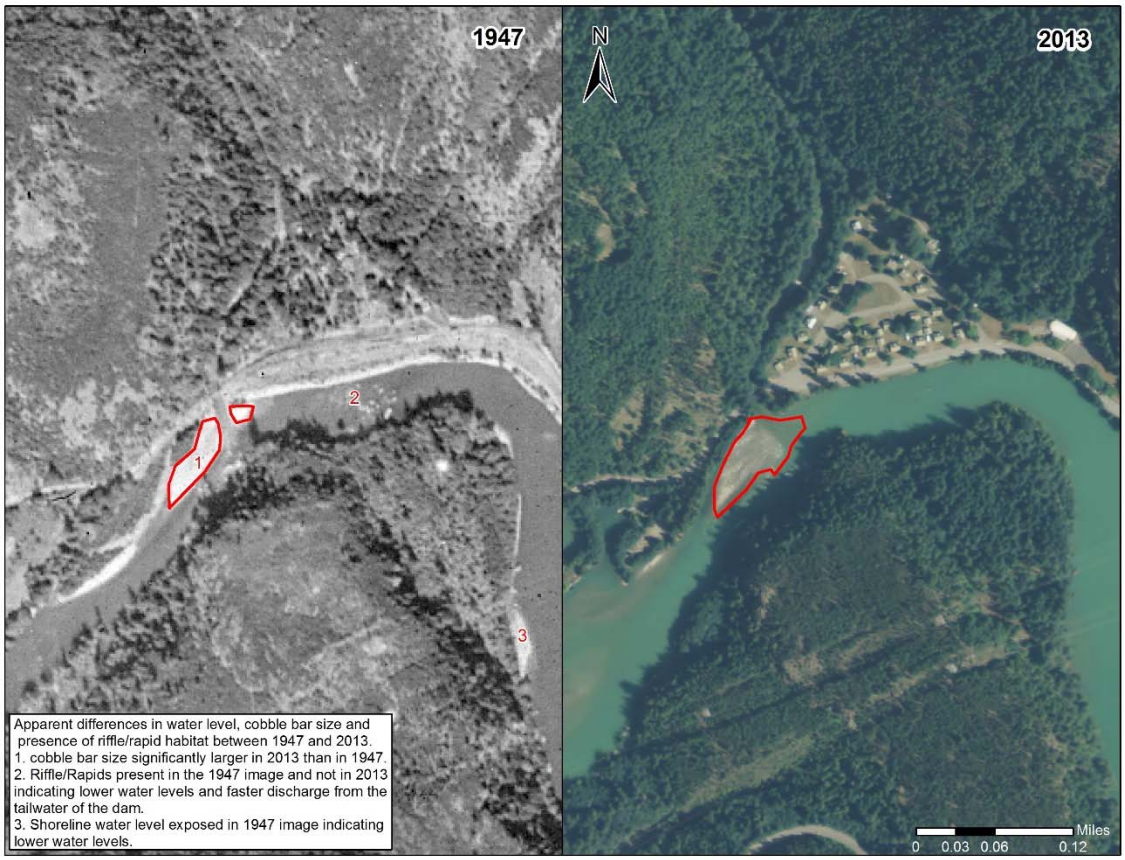

Figure 2. Figure comparing the aerial imagery from 1947 and 2013 in order to illustrate the changes in cobble bar size and Stetattle Creek, Gorge Reservoir confluence zone.

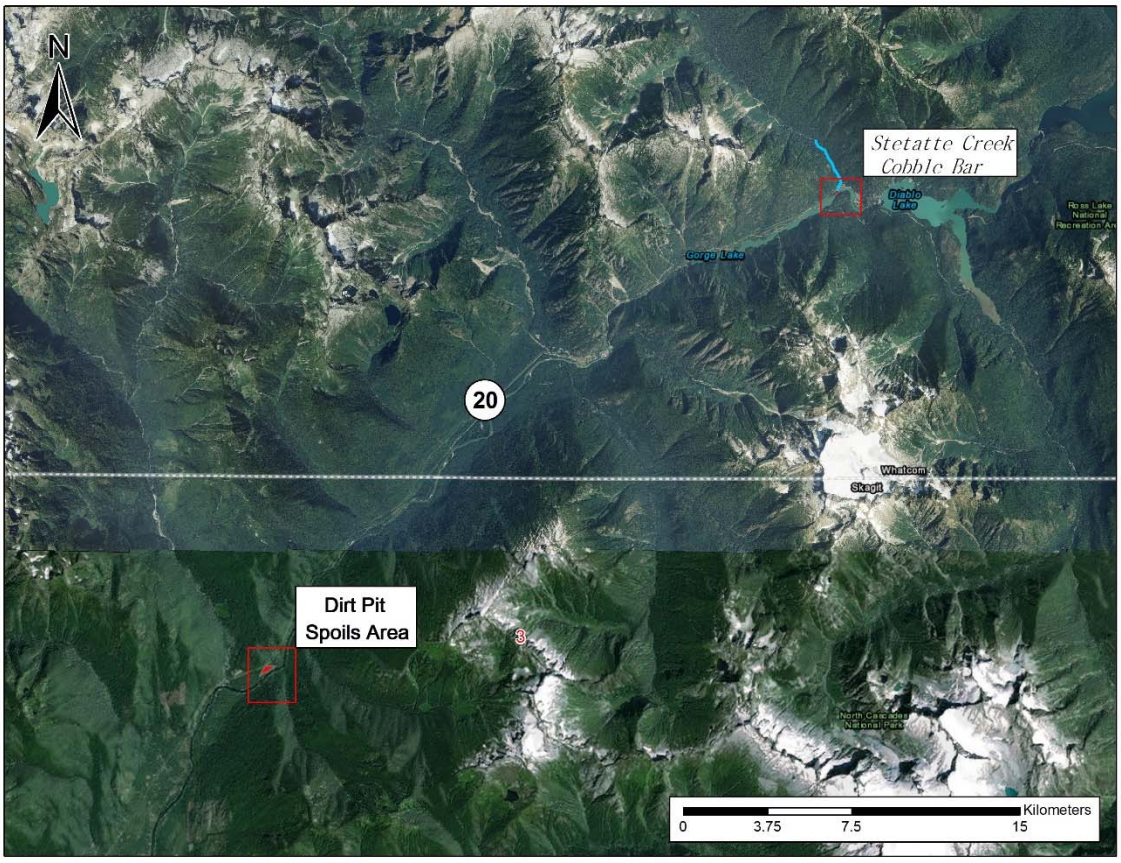

Figure 3. Figure showing the Stetattle Creek/Gorge Reservoir cobble bar, surrounding area and the dirt pit spoils site.

1.3 ALTERNATIVE ACTION

The Alternative Action as proposed by our project team is to remove and relocate eight structures along the town of Diablo's embankment barrier located between the town and Stetattle Creek, as well as the barrier itself. This will allow Stetattle Creek to deposit sediments into the traditional delta, which the flood protection embankment had prevented. Throughout the assessment, the embankment will be referred to also as a "levee" or a "berm."

Reestablishing the natural river delta will reduce concentrated deposits into the cobble bar area, which has backed up the reservoir, increased the tail water height, and decreased water pressure on the turbines. After construction, sequenced flushing will be

discharged from Diablo Dam to remove the fine sediments that accumulated during construction.

Several of the housing structures identified for removal and relocation are listed on the national historic preservation list, which requires a separate approval process for removal. As seen on the map below, we propose the relocation of the eight structures along the embankment, which reaches approximately ⅙-mile back from the confluence of Stetattle Creek and Gorge Reservoir. The relocation will move all eight dwelling units to the east side of the town. A new levee will be established on new west edge to protect the town. The bridge to enter the town of Diablo will need to be reinforced and extended.

The Alternative Action will take place during mid-July to mid-September to avoid negative impacts to water quality and fish spawning. We find that the impacts on the natural environment, including the fish habitat are lessened in this alternative, comparatively with the Proposed Action.

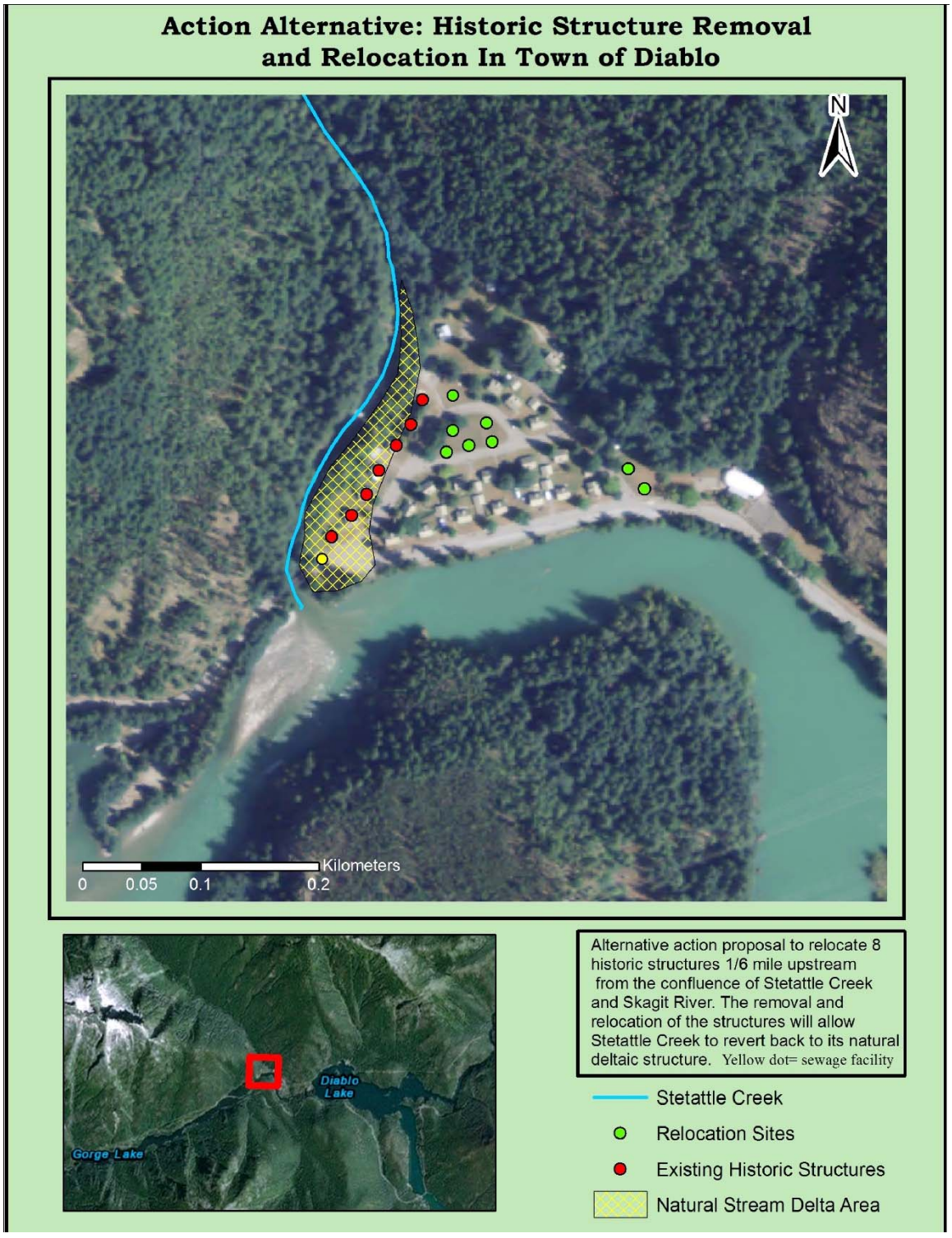

Figure 4. Alternative Action

1.4 NO ACTION ALTERNATIVE

The No Action Alternative maintains current conditions and has no effect on the natural environment. The cobble bar will remain as rearing habitat for the threatened bull trout and other fish species. This alternative will mean that the tail water level will be decreased, which will not increase the flow of water through the turbines at the Diablo Dam hydroelectric project.

There will be no investment of time or resources from Seattle City Light to achieve this alternative, but the yearly decrease in capacity will continue to lower revenue and create higher electricity rates for consumers and place demands on other sources of electricity, which may result in negative effects to the environment.

With the No Action Alternative, there will be no risk of increased rate of bank erosion. All natural environment elements are expected to remain stable; the only effects will be to the Energy and Natural Resources element, with continued decreased capacity of the turbines.

CHAPTER TWO
BACKGROUND INFORMATION

The three dams constructed on the Skagit River were in large due to the efforts of James Delmage Ross, the Seattle City Light Superintendent for a significant portion of his working years. J.D. Ross, a self-taught engineer, had been politically active and persuaded the Department of Agriculture to issue him the permit to construct a dam at Diablo Canyon as well as a powerhouse to generate electricity for the greater Seattle Region. He foresaw a large growth in electricity demand, and correctly so *(Upper Skagit River Hydroelectric Project, 2014).* In December 1917, Seattle City Light received the permit and construction began on the Gorge Dam in Diablo Canyon, and within seven years it was producing electricity.

Three years after the completion of Gorge Dam, Seattle City Light began constructing a second dam on the Skagit River. This dam, named Diablo, was completed in 1930- half the time as the first dam. At the time of completion, Diablo Dam stood at 389 feet, making it the tallest in the world. Six years later, the Diablo powerhouse began producing electricity for Seattle *(Seattle City Light, 2014).*

In the 1920's, Seattle City Light had made plans for a third dam, originally named Ruby Dam, but waited until 1937 to begin construction. It was not completed before J.D. Ross's death in 1939. Ruby Dam was renamed Ross Dam in honor of J.D Ross's dedication to the public utility. It was completed in 1953.

The three dams are still as vital to the Seattle Region as they were in the first half of the 1900's; today they provide approximately 1/4th of the electricity generated by Seattle City Light *(Upper Skagit River Hydroelectric Project, 2014).*

In 1968, North Cascades National Park was created, fully surrounding the Skagit River Hydroelectric Project and meeting with the Canadian border in the north. The area around the reservoirs was established as the Ross Lake National Recreation Area. In 1973, the North Cascades Highway was opened to the public to allow travel over the Cascades to Eastern Washington *(Upper Skagit River Hydroelectric Project, 2014).*

CHAPTER THREE
THE NATURAL ENVIRONMENT

3.1 EARTH

3.1.1 Topography

The general topography of the site area is mountainous with slope gradients up to 85% (Figure 6). The project site on which the dredging and removal will be occurring is located on a slope of less than 6% grade (Figure 6). The cobble bar itself is approximately a 0% grade, but the access to the cobble bar from Diablo road may be limited due to the small steep slope from the road to the river. Diablo road and State Highway 20 experience a negative elevation change of approximately 193 feet from Stetattle Creek to the dirt pit site, a distance of approximately 30 km.

The town of Diablo is located on a slope of approximately 0% grade. The river levee that separates Diablo from Stetattle Creek has is approximately 15 feet wide with an approximate slope to the river of 15% (Figure 6).

3.1.2 Impacts to Topography

Proposed Action Impacts

The Proposed Action will have impacts on the topography of the access site between Diablo Road and Gorge Reservoir, as access to the dredging site will be difficult without alteration. The Proposed Action includes the creation of an access ramp which will result in the clearing and grubbing of the stream bank (*R2 Resource Consultants, 2013*). Alteration of the short slope from the road to the river will be likely. The Proposed Action will alter the topography of the cobble bar, due to the mass removal of the material from the site. The dirt pit site topography will likely not experience impacts from the project action other than introduction of cobble spoils from the Gorge Reservoir to the dirt pit.

Creating an alternate access point to the cobble bar by the dredging equipment may help to mitigate any alterations in the topography of the site. The use of heavy equipment is necessary in order to dredge and remove the material from the cobble bar site. Heavy equipment requires level ground for proper equipment operation.

Alternative Action Impacts

The Alternative Action will likely impact the topography of the Stetattle Creek delta and the levee that is currently in place between Stetattle Creek and the town of Diablo. The removal of the levee will re-establish the stream delta and level out the topography of the 1/6 stretch upstream from the confluence.

No Action Impacts

The No Action Alternative will likely result in the addition of sediment from Stetattle Creek to the cobble bar, changing the volume of the cobble bar and topography of the site.

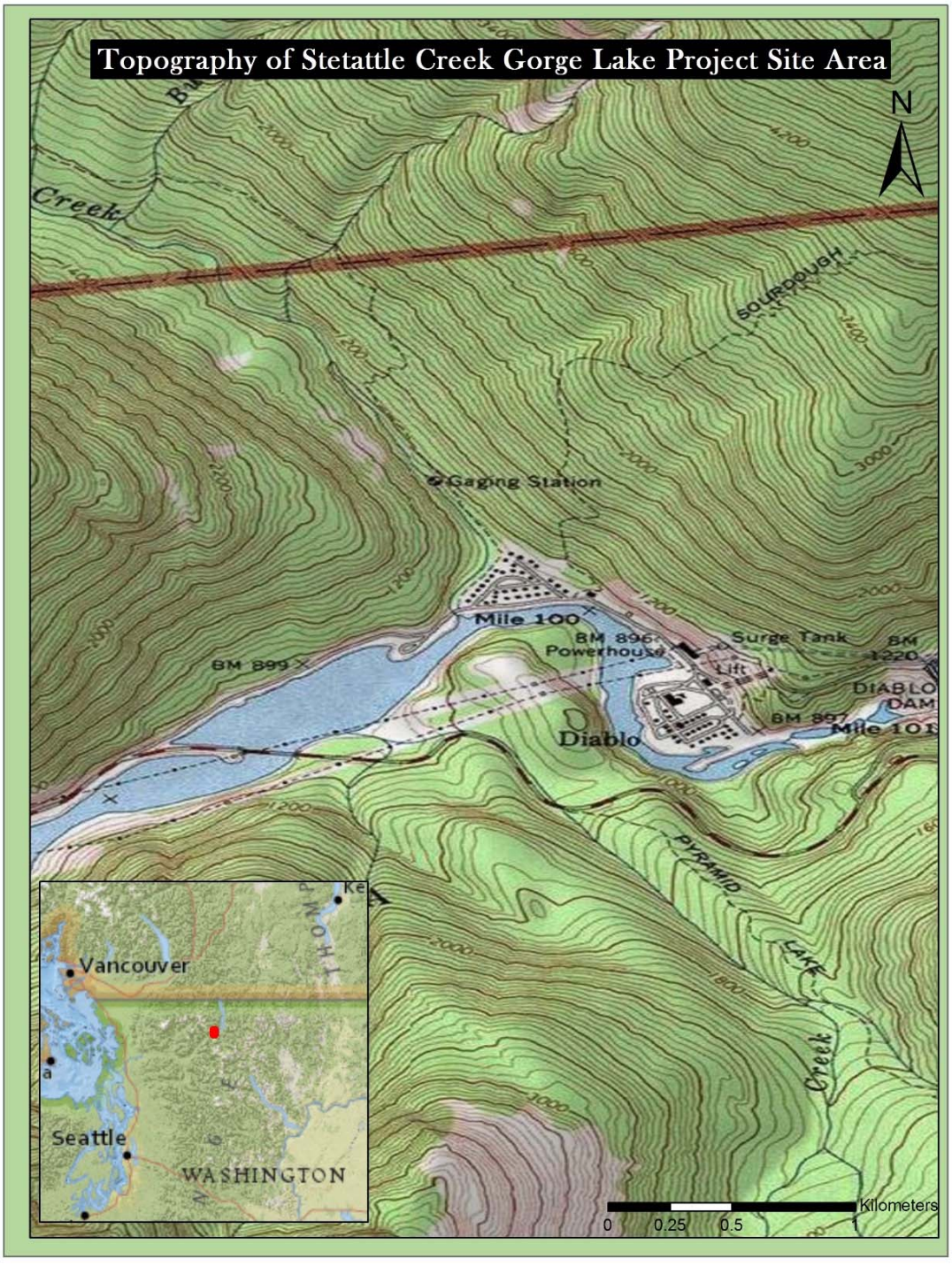

Figure 5. Figure depicting the topography of the project site. Includes topographic elevation and slope lines for the area.

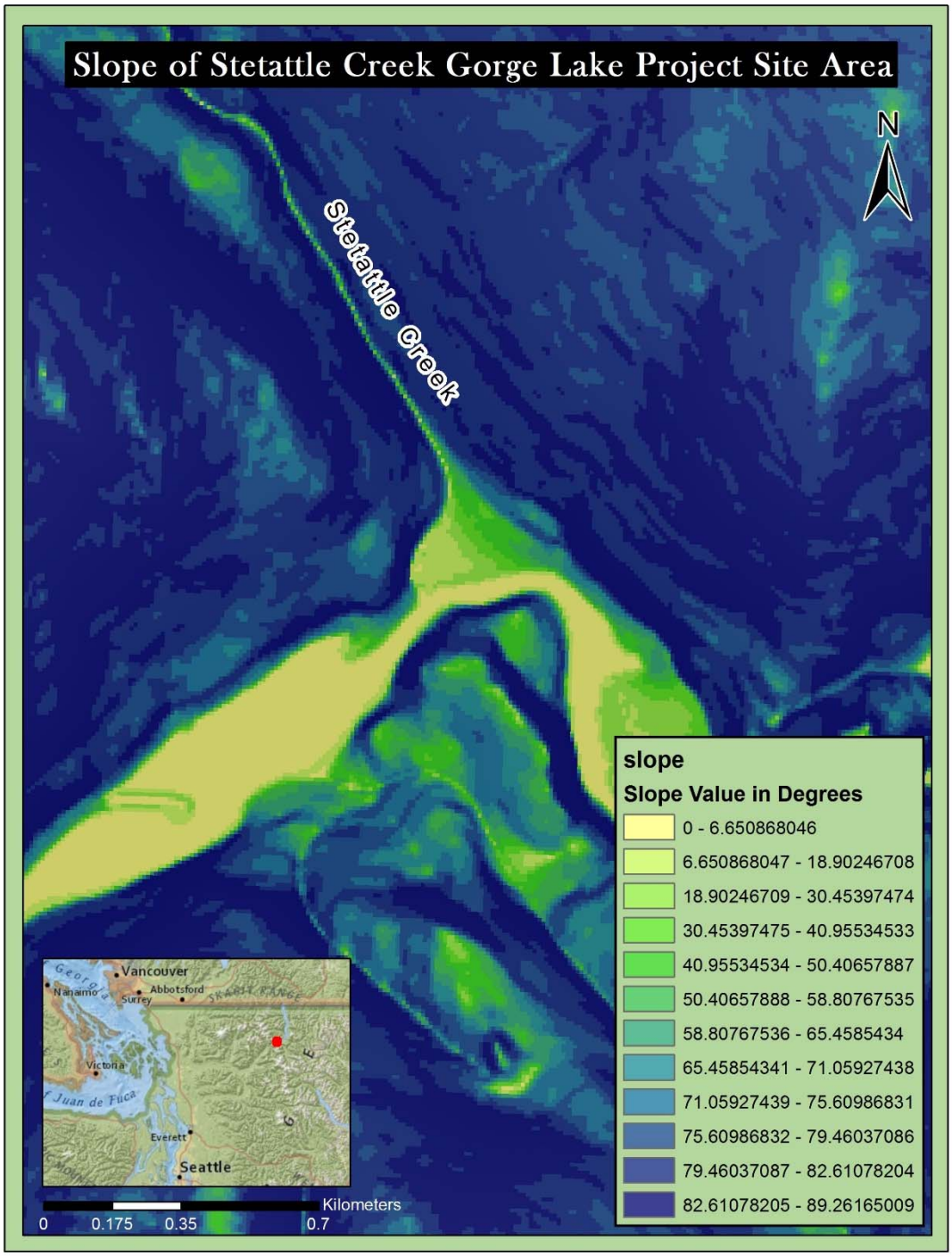

Figure 6. Map displays the slope gradients in degrees for the project site area.

3.1.3 Geology

Geologic formations in the Gorge Reservoir and Diablo area include amphidolite, banded gneiss, alluvial fan deposits (mostly granite and quartzite) from Stetattle Creek, and talus deposits. The dominant geologic formation beneath the Stetattle Creek and Skagit River confluence is banded gneiss as shown in the figure below (*Figure* 7).

3.1.4 Impacts to Geology

Proposed Action Impacts

The Proposed Action will have minimal effects on the bedrock geology of the area due to the superficial excavation that will be taking place. There is a small possibility that the bed rock may be reached, but excavation of the banded gneiss is unlikely as the cobble deposit is composed largely of unconsolidated cobble and sediments. The alluvial deposits (granite and quartzite) from Stetattle creek in Gorge Reservoir will be the target of removal.

In order to leave the bedrock geology undisturbed during excavation of the cobble bar, the assessment of the banded gneiss depth beneath the cobble bar must be determined. As long as the excavation does not exceed the depth of the bedrock, it will not be impacted.

Alternative Action Impacts

The Alternate Action will have minimal impacts on the geology of the project site. The levee that separates the town of Diablo from Stetattle creek is mostly composed of sediment but has large boulders along the bank of the stream. In the case of the Alternative Action, the removal of the large boulders along the stream bank will be necessary.

No Action Impacts

The No Action Alternative will have no impact on the geology of the site. The inevitable weathering that occurs during stream morphology will result in the erosion of some of the geologic formations in Stetattle Creek upstream from the confluence.

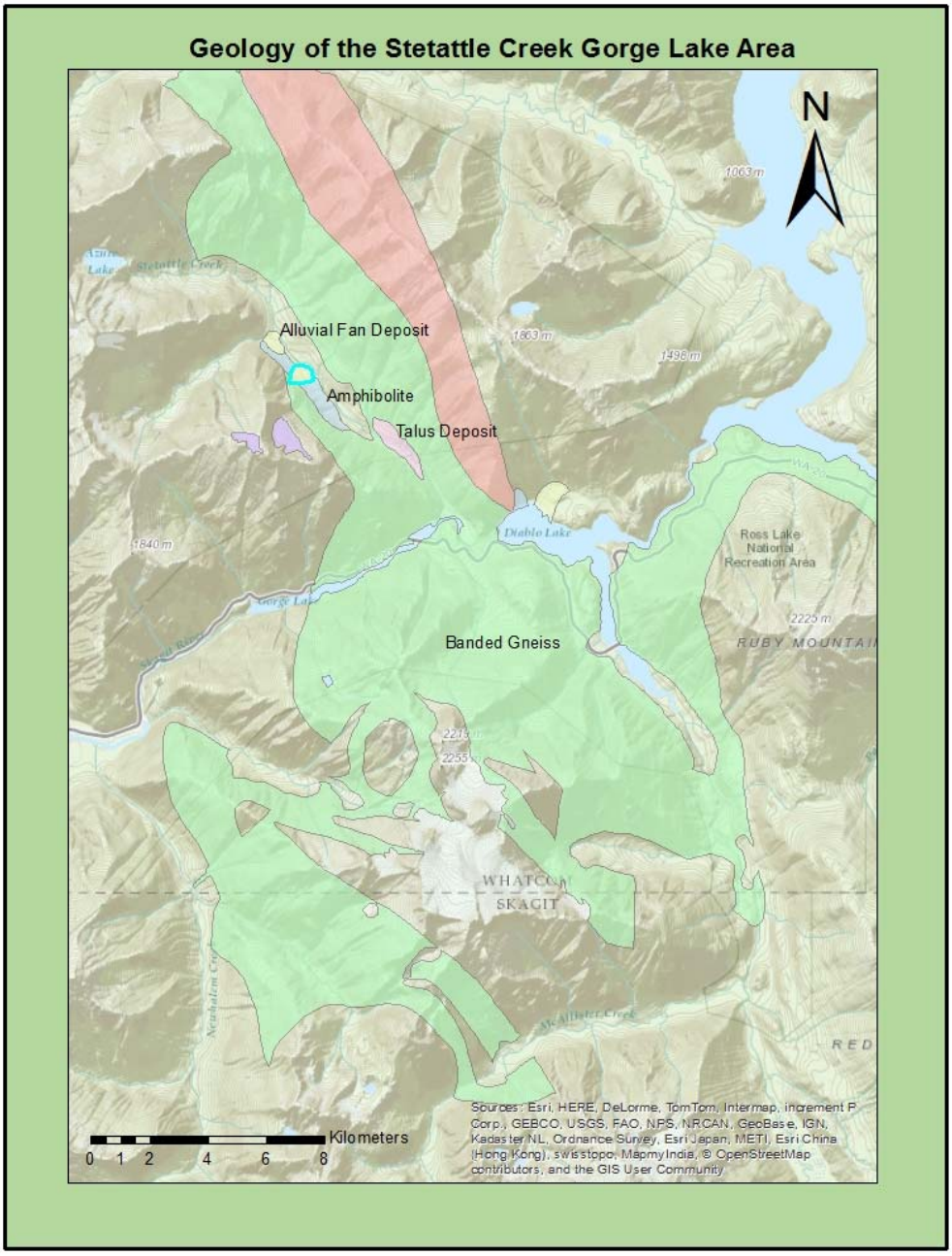

Figure 7. Map displaying the geologic structures of the Stetattle Creek - Gorge Reservoir area.

3.1.4 Soils & Sediments

The Stetattle Creek alluvial deposit in Gorge Reservoir consists primarily of granite and quartzite cobbles and boulders with an average surface size estimated to be 169 mm (7 inches) (*Figure 8*) (*R2 resource Consultants, 2013*). Stetattle Creek is the primary source of sediment deposition in the cobble bar. Due to the fact that Diablo Dam has actively trapped any incoming sediment in the Gorge Reservoir basin above Diablo Dam, the only major input of sediment comes from Stetattle Creek. Fine sediments in the alluvial cobble bar pose a risk for an increase in turbidity in the Gorge Reservoir and downstream in the Skagit River. The Stetattle Creek levee is largely composed of a sandy loam with low organic material. The levee also has large boulders lining the stream bank.

3.1.5 Impacts to Soils & Sediments

Proposed Action Impacts

The Proposed Action will have a significant impact on the sediments constituting the cobble bar. The action will remove approximately 13,000 cubic yards of sediment materials larger than 6 inches in diameter. (*R2 Resource Consultants, 2013*). The sediments left on site will be exposed to erosion and transport downstream from the cobble bar. The disturbance of the sediment could potentially increase turbidity past the maximum allowable level. After cobble is removed from the site, sediment will continue to deposit on the cobble bar and eventually be reestablished (*R2 Resource Consultants, 2013*).

In order to mitigate any impact on the turbidity levels resulting from the excavation of sediment from the cobble bar, measures must be taken. This includes waiting until the creek flow drops below 200 CFS, dewatering the site to an elevation of 871.15 feet, the installation of a silt fence along the waterline, and lastly the installation of a partial coffer dam to help reduce turbidity levels (*R2 Resource Consultants, 2013*).

Alternative Action Impacts

The Alternative Action will have impact on the sediment of the Stetattle Creek levee. The levee will be removed in order to restore the natural stream delta, and this sediment removal process could increase the turbidity in Stetattle Creek and Gorge Reservoir if proper mitigation techniques are not followed. The Alternative Action will allow for the reformation of the natural stream delta, therefore impacting the sediment distribution in Gorge Reservoir.

No Action Impacts

The No Action alternative will result in an increase in the size of cobble bar as more sediments are transported from Stetattle creek to Gorge Reservoir.

Figure 8. Image showing the cobble size and composition of the Stetattle creek Confluence Cobble bar.

3.1.6 Erosion & Head Cutting

In 2003, a landslide occurred approximately .4 km upstream from the confluence of Stetattle Creek and Gorge Reservoir (*Figure 10*). The landslide has contributed a significant amount of coarse sediment to Stetattle Creek, which has washed downstream (*R2 Resource Consultants, 2013*). Although, it has been noted that the majority of cobble and boulders in the Cobble Bar are from a source other than the 2003 landslide.

As there has been a history of loose and unconsolidated sediments/soils in the vicinity of the proposed project area, head cutting of the stream mouth is a potential threat in the case of the cobble bar removal. When large amounts of sediment are removed from a river, incision occurs, which can result in head cutting of the mouth of the stream. Head cutting would propose a significant threat to the structural integrity of the Stetattle Creek Bridge.

3.1.6 Impacts to Erosion & Head Cutting

Proposed Action Impacts

The Proposed Action will effectively remove material at the mouth of Stetattle Creek that adds to the mouth bank structure and may result in head cutting of the stream mouth and stream bank. Head cutting is a process that generally must be actively mitigated, due to the progressive nature of the process. The Proposed Action could cause erosion that would compromise the structural integrity of the Stetattle Creek Bridge (*Figure 9).* Head cutting will transport sediments that were temporarily stored 150 feet up the Stetattle Creek and will reestablish the cobble bar over time (*R2 Resource Consultants, 2013*).

In order to prevent head cutting resulting from the excavation of the cobble bar, the installment of head cutting prevention dikes along the sides of the bridge will be necessary. This will effectively curb the process of head cutting by providing a structural boundary for the Stetattle Creek sediments.

Figure 9. Image showing the mouth of Stetattle Creek, the Stetattle Creek Bridge and levee.

Alternative Action Impacts

The Alternative Action intends to restore the natural stream delta and will therefore encourage the process of head cutting and erosion. The bridge may have to be extended or rebuilt to accommodate a wider stream. The removal of the levee will allow for the transport of sediments from along the stream bank out into Gorge Reservoir.

No Action Impacts

The No Action Alternative will result in the normal deposition of sediment to the cobble bar and the normal erosion from Stetattle creek. Taking no action will result in an increase in the size of the cobble bar and the natural incision of Stetattle Creek over time.

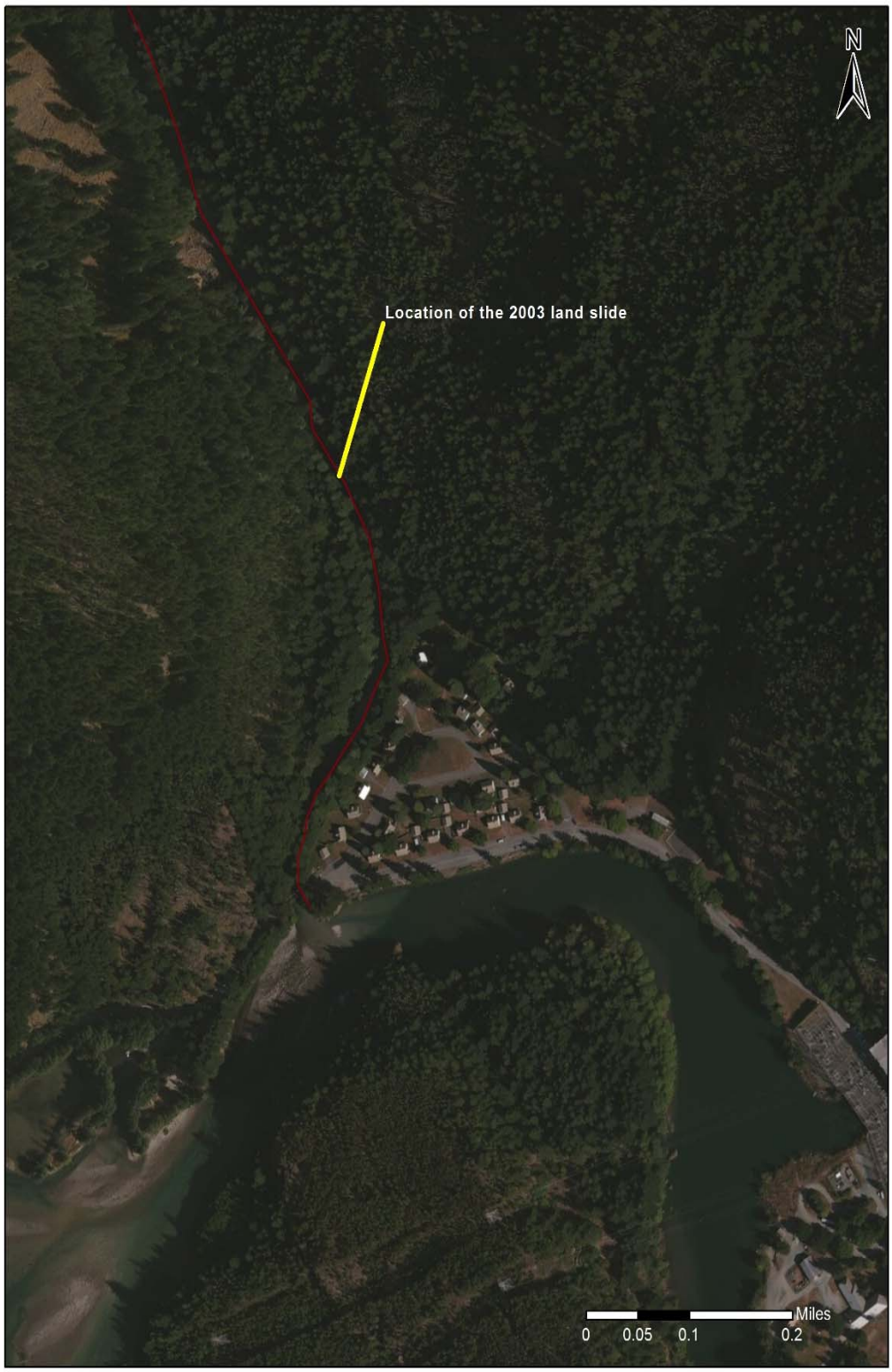

Figure 10. Aerial view of 2003 landslide area

Figure 11. Image of the Stetattle Creek rockslide of 2003 (Courtesy of R2 Resource Consultants, 2013).

3.1.7 Seismicity

Faults include the Straight Creek Fault and Entiat Fault southwest of the project area and northeast of Newhalem. In 2005, an earthquake of magnitude 3.2 at a depth of 0.2 kilometers was recorded approximately 4 kilometers north by northwest of the proposed dredging site. Roughly 40 kilometers from the Gorge Reservoir dredging site, the Straight Creek concealed strike-slip fault is currently active according to a USGS survey.

Historically, the majority of seismic activity in Washington has occurred in the Northern Cascades and Puget Sound Lowlands. Considering that there are two major active faults in the vicinity of Gorge Reservoir and Stetattle Creek, seismic activity does occur in the area and could potentially pose some impact on the project action. Earthquakes could trigger rock slides and landslides, which could increase sediment transport down Stetattle Creek.

3.1.8 Impacts to Seismicity

Proposed Action Impacts

The Proposed Action will have no impact on the seismicity of the site and region. Although, due to the fact that the area has been historically seismically active, it must be recognized that earthquakes are a potential threat in the area. During excavation and dredging, seismic activity could possibly disrupt or disturb the process. Earthquakes have the potential to cause landslides, rockslides or other potentially dangerous geomorphic events.

Mitigation might include the active monitoring of seismic activity in the area and ceasing any action if seismic activity is detected.

Alternative Action Impacts

The Alternative Action will have no impact on the seismicity on the site and in the region. Although, due to the fact that the area has been historically seismically active, it must be recognized that earthquakes are a potential threat in the area.

No Action Impacts

No Action will have no impact on seismicity on the site and in the area.

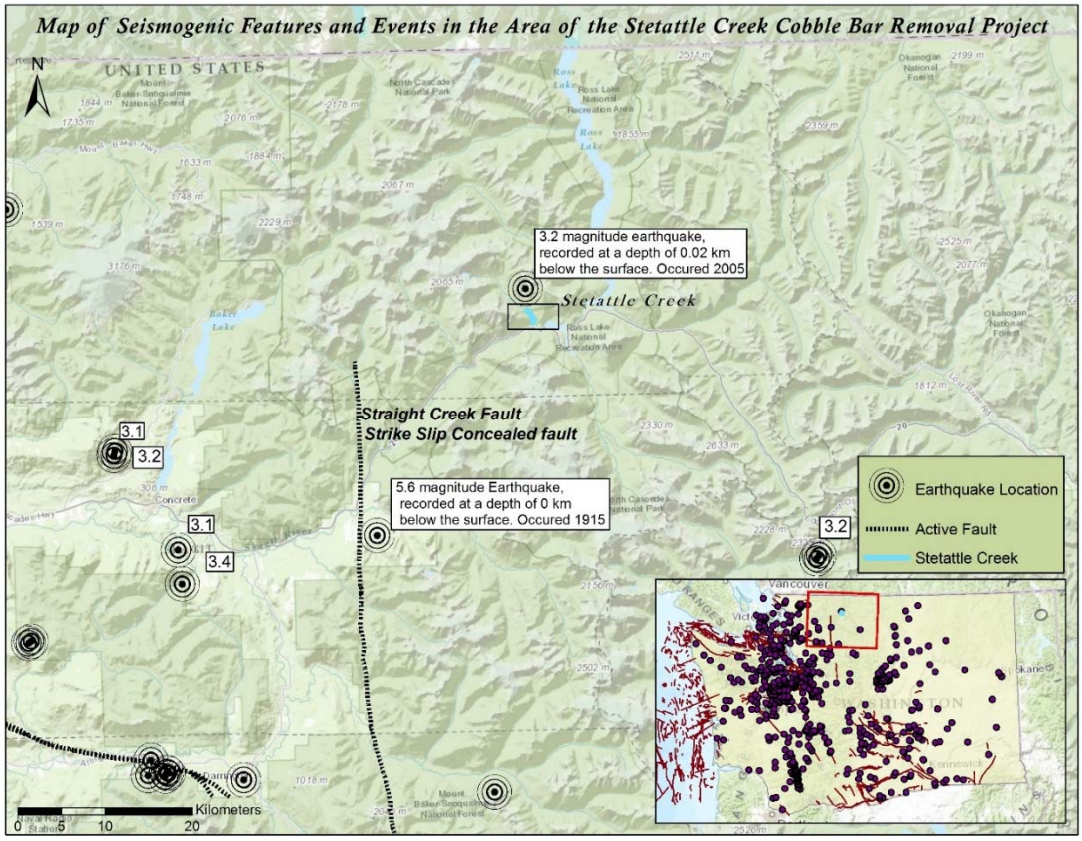

Figure 12. This map displays the location, magnitude and years of activity of earthquakes in the Gorge Reservoir Stetattle Creek area. This map also displays the active fault lines in the area that could have a potential effect on the project action.

Table 1. Table displaying the year, location, magnitude and type of seismic event in Washington since 1872 (*R2 Resource Consultants, 2013*).

Year/Location	**Magnitude**	**Type**
(Mechanism)		
1946 Vancouver Island	7.3	Intraplate
1872 North Cascades	7.3	Crustal
1918 Vancouver Island	7.0	Crustal

1949 Olympia	6.8	Intraplate
1965 Seattle-Tacoma	6.8	Intraplate
2001 Nisqually (Olympia)	6.8	Intraplate
1915 North Cascades	5.6	Unknown

3.2 AIR

3.2.1 Existing Environment and Air Quality

The United States Congress has designated the North Cascades National Park as a 'Class I' area in regards to air quality control, which ensures that it receives the highest level of air quality protection. Due to wind patterns, the area is susceptible to experience some pollution from more urbanized and industrialized areas from the west. Because of this, the United States Geological Survey and the National Park Service's Air Resources Division collectively monitor for several pollutants, including particulate matter, ozone, acid deposition, mercury and pesticides (*National Parks Service, 2014*).

Current deposition levels of pollutants are summarized in *Table 2*, with information provided by the U.S National Parks Service in conjunction with the U.S Geological Survey. The following data are for the year 2012, beginning with January 4th, 2012 and ending with January 2nd, 2013. The data for the North Cascades National Park are collected and recorded at the North Cascades National Park- Marblemount Ranger Station, listed as site ID WA19. Fifty-three samples were taken over the course of the year from rainwater collections.

Table 2. Deposition within Precipitation Samples

	Ca	Mg	K	Na	NH4	NO3	Cl	SO4
Winter	0.15	0.228	0.103	01.911	0.10	1.37	3.49	1.21
Spring	0.23	0.0064	0.047	0.387	0.21	1.54	0.69	0.9
Summer	0.06	0.012	0.021	0.060	0.14	0.97	0.10	0.52
Fall	0.22	0.070	0.077	0.432	0.14	1.24	0.82	0.85

ANNUAL	0.69	0.407	0.287	3.110	0.65	5.48	5.67	3.80

(*National Trends Network, 2012*)

Any probable impacts from the Proposed Action and the Alternative Actions will make comparisons to these values as the baseline.

3.2.2 Climate

The climate varies within the North Cascades National Park, as it extends over both sides of the mountain range. The west side is much more lush due to increased rain systems moving inland from the Pacific ocean, while the shielded east slopes of the North Cascades tend to be dryer throughout the yearand the air is typically warmer, especially in summer months.

The west side of the mountain range, where the Diablo Dam and the Gorge Reservoir are located, is a temperate evergreen forest. This is classified as a "marine west coast climate," due to moderate temperatures and minimal temperature swings between day and night, and between months throughout the year. (*Encyclopædia Britannica, 2014)*

3.2.3 Impacts to Existing Environment, Air Quality and Climate

Proposed Action Impacts

Increased motor traffic within the west side of Highway 20, due to the extraction and transport of spoils, will result in increased amounts of the criteria pollutants, particulate matter, hydrocarbons, nitrogen oxides, carbon monoxide, sulfur dioxide and carbon dioxide *(Belalcasar et al., 2014).* Vehicles moving the dredged material will be making trips between the designated dumping site 15.5 miles away and the cobble bar area.

Other motorized machines implemented for the dredging project will also release these pollutants. Equipment such as clamshell dredges, excavators, backhoes, pumps and generators will burn diesel and release pollutants. These operations will have a negative

effect on the current low levels of pollutants which have continually maintained levels to meet criteria for a 'class I' status.

To excavate and transport the cobble bar, which has a volume calculated at 19,500 cubic yards (*R2 Resource Consultants, 2013*), 1,083 trips would have to be made using standard 18 cubic yard dump trucks. Converted to miles, 33,583 miles would be traveled.

Driving 33,583 miles would burn approximately 4,797 gallons of fuel at 7 miles per gallon *(Federal Highway Administration, 1995).* The CO2 emissions from burning one gallon of diesel fuel is 22.38 pounds *(EIA, How Much Carbon Dioxide?).* Total emissions to transport all the spoils would be 107,356 pounds of CO2 released into the atmosphere.

Alternative Action Impacts

The Alternative Action plan also requires the use of machinery to remove the dirt and rock material, which accounts for the material within the berm on the west side of Diablo and currently restricts the natural delta of the Stetattle Creek. The air effects of the Alternative Action will be comparable to the Proposed Action Impacts, because there will be increased motor traffic from the removal and relocation of spoils from the berm area.

In order to lower the tail water 3.2 feet, approximately 19,500 cubic yards must be removed from the cobble bar according to the R2 Preliminary Engineering Design *(R2 Resource Consultants, 2013).* The same removal volume from the Diablo town infill should result in a 3.2 foot decrease of tail water height as well. The emissions calculated for the transport of 19,500 cubic yards of material would total 107,356 pounds, or 53.6 tons of carbon dioxide.

Because this action will be completed within an approximate two month time span in order to work in accordance with the water runoff and weather, the air pollution effects will likely be negligible over the long term due to emissions fixed within a relatively short time span.

No Action Impacts

The No Action Alternative will have no effect on the local air quality and the current levels of chemical or element deposition (measured within precipitation samples).

3.3 WATER

3.3.1 Water Quality

Water quality criteria depend on the designated uses of the water body as established by the state of Washington (WAC 173-201A) as seen in *Table 3.* In addition to these criteria, the State of Washington conducts an Integrated Water Quality Assessment every two years. This assessment looks at impaired water bodies on the 303(d) section of the Clean Water Act that fail to meet the Total Maximum Daily Load (TMDL) for a particular water quality parameter.

The water quality of streams, rivers, and lakes in North Cascades National Park is generally excellent. The Stetattle Creek watershed contains mostly glaciated peaks and forested foothills with no historic or current point sources of water pollution. A 1987 assessment of Stetattle Creek headwaters, Jeanita and Azure Lakes, indicated satisfaction of all water quality criteria indicated in Table 3 (*Agee and Wasem, 1987*).

Table 3. Washington State Water Quality Criteria listed under WAC 173-201

Parameter	**Water Quality Criteria**
Fecal Coliform	Not to exceed 50 colonies/ 100 ml sample in no more than 10% of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100 colonies/ 100 mL
Dissolved Oxygen	Lowest 1-Day Minimum: Char Spawning and Rearing: 9.5 mg/L Salmonid Spawning, core Rearing, and Migration: 9.5 mg/L Salmonid Spawning, noncore Rearing, and migration: 8.0 mg/L

Temperature	Maximum 7-day average of the daily maximum temperature (7-DADMax): Char Spawning and Rearing: 12°C (53.6°F) Core Summer Salmonid Habitat: 16°C (60.8°F) Salmonid Spawning, Rearing, and Migration: 17.5°C (63.5°F) Salmonid Rearing and Migration: 17.5°C (63.5°F)
Total Dissolved Gas	Not to exceed 110% of saturation at any point of sample collection
pH	Within 6.5 to 8.5 pH units with human caused variation of: less than 0.2 units above range for char spawning and rearing Less than 0.5 units above range for salmonids spawning, rearing, and migration
Turbidity	Shall not exceed either a 5 nephelometric turbidity unit (NTU) increase over background when background is 50 NTU or less; or a 10% increase in turbidity when background is greater than 50 NTU

3.3.2 Impacts to Water Quality

Proposed Action Impacts

The proposed dredging project has the potential to significantly affect turbidity in the waters downstream of the project site. Dredging has the potential to create a large flux of high turbidity water. Prior to excavation, a silt fence and coffer dam will be installed to capture the expected turbidity increase. The coffer dam will be effective as long as regular monitoring and maintenance is conducted.

Turbidity could also continue to be a problem if head cutting is not prevented on Stetattle Creek. Head cutting is expected to occur 150 ft. up Stetattle Creek with the majority of the eroded material being accumulated sediment from the elevated and impounded Skagit River (*R2 Resource Consultants, 2013*)

Alternative Action Impacts

The Alternative Action also has the potential to create high turbidity waters during the removal of the old levee and construction of the new levee. Silt screens and coffer dams will be implemented to prevent turbid waters from traveling downstream. Execution of careful monitoring and maintenance of turbidity controls is necessary to prevent adverse effects to water quality.

Restoration of vegetation must be implemented on the banks of the new levee to control erosion and shade Stetattle Creek to prevent increasing water temperatures.

No Action Impacts

No Action Alternative will have no major impacts on water quality of Stetattle Creek and Gorge Reservoir. Previous studies investigating water quality of the Stetattle Creek watershed concluded no violation of water quality criteria specified under WAC 173-201 (*Table 3*; *Agee and Wasem, 1987*).

3.3.3 Hydrology

The three dams comprising the Seattle City Light Hydro Project control hydrology of the Skagit River. Ross Reservoir is the largest of the three reservoirs and has the most effect on seasonal flows. Stetattle Creek is unregulated. Skagit River at Newhalem is 5.6 miles from Gorge Reservoir and is the closest Skagit River gauge to the Seattle City Light Hydroelectric Project.

Under typical conditions, the proposed excavation site is partially submerged by Gorge Reservoir and the cobble bar is partially submerged due to flows from Diablo Powerhouse and Stetattle Creek (*R2 Resource Consultants, 2013*). The project excavation is proposed during July 15 to September 15 to take advantage of low stream flows and minimize impacts to spawning fish (*Figure 13*). Drawdown of Gorge Reservoir will be done during the construction process for both the Proposed Action and Alternative Action.

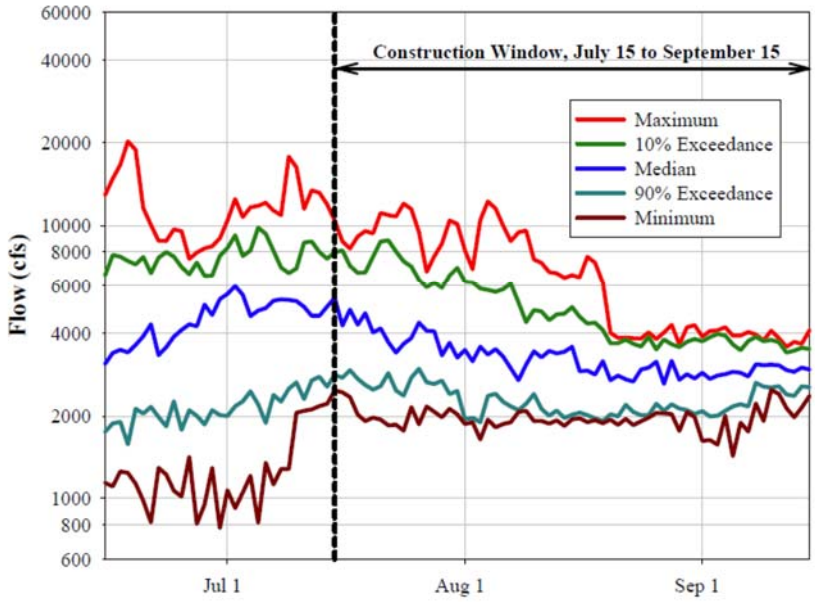

Figure 13. Seasonal flow duration in the Skagit River below Diablo Dam during the proposed construction window; July 15 through September 15 (R2, 2013)

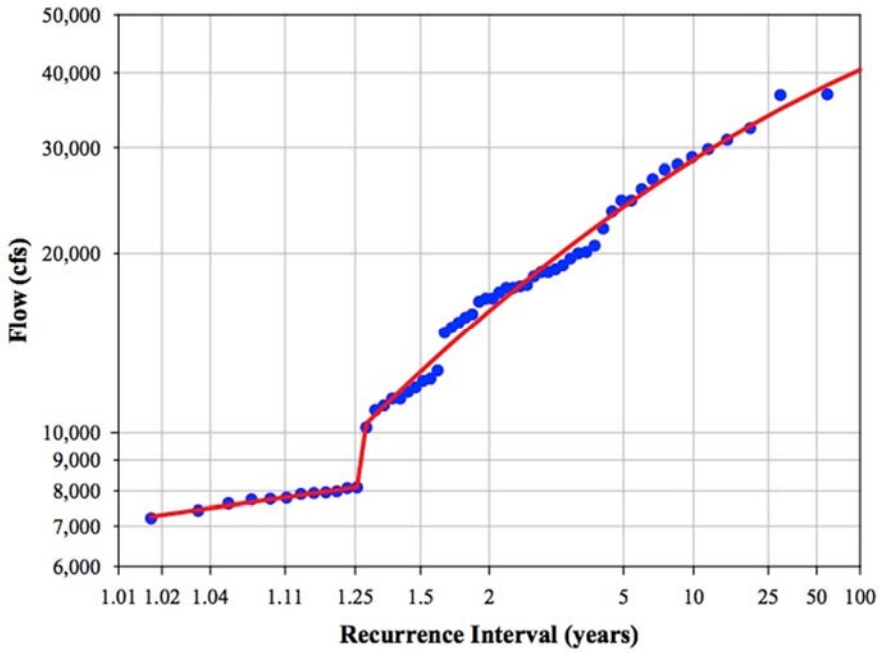

Figure 14. Flood frequency relationship for Skagit River at Newhalem, USGS Gage 12178000 (R2 Resource Consultants, 2013).

3.3.4 Impacts to Hydrology

Proposed Action Impacts

Construction on the cobble bar will start mid-July on a dry year and later on a wet year and continue into mid-September depending on water flows in the Skagit River (*Figure 13*). This time was chosen for its low average stream flow. The Gorge Reservoir water level will be lowered during construction to minimize coffer dam stress and other water related issues.

Alternative Action Impacts

Construction of the Alternative Action will begin mid-July and continue until mid-September to ensure maximum protection of spawning rainbow trout and native char (*Figure 13*). The stopping date will depend on seasonal precipitation and the detection of spawning native char. Gorge Reservoir will not be drawn down for the Alternative Action so impact to Skagit River hydrology will be minimal. Stetattle Creek will have silt screens and coffer dams installed to prevent erosion into the creek. Implementation of these water management systems will slightly impede hydrology of Stetattle Creek, but the majority of the creek will maintain flow during construction.

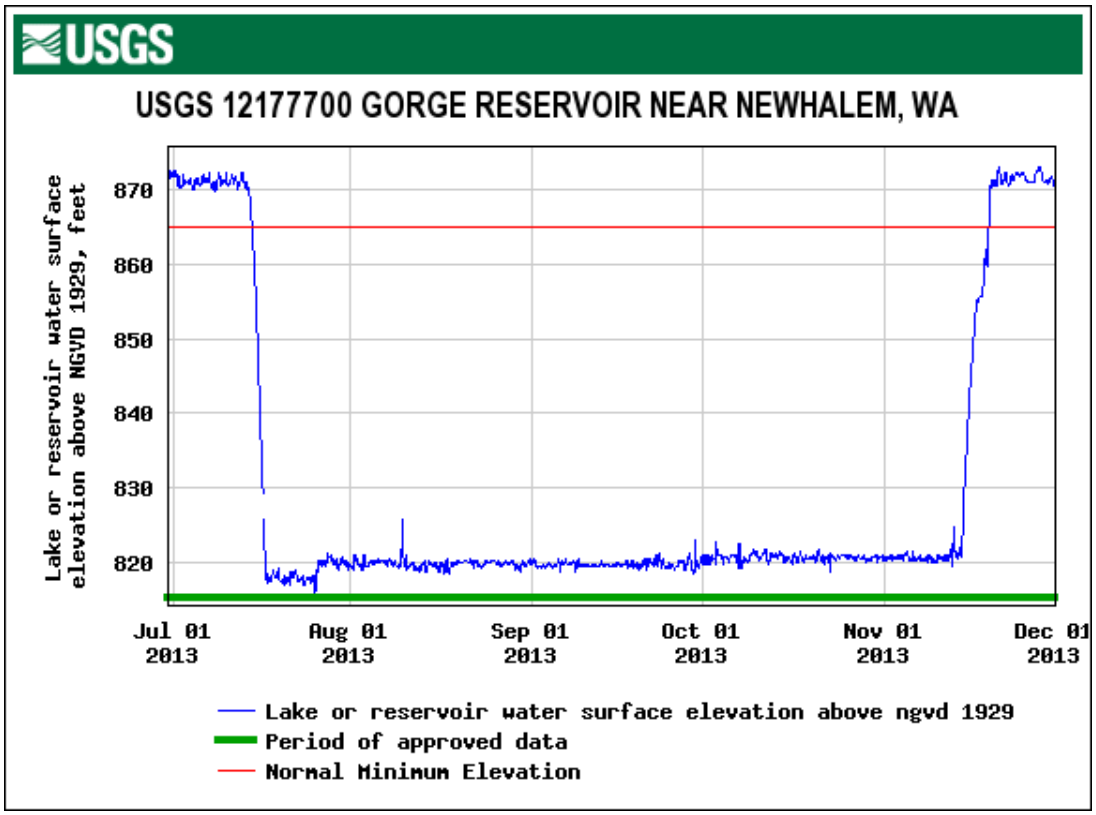

Figure 15. Water levels in Gorge Reservoir from July 1st to November 30th, 2013. Courtesy of Anthony and Rawhouser, 2013.

No Action Impacts

The no action alternative will have no immediate impacts to hydrology of Stetattle Creek or Skagit River. If the cobble bar continues to build in size, then hydrology will coincidently decrease on the Skagit River at the confluence of Stetattle Creek.

3.4 PLANTS & ANIMALS

Table 4. Animal Species of Concern in Gorge Reservoir Region

Species	**Status[a]**	**Use of Project Area**
Northern spotted owl *Strix occidentalis caurina*	State endangered, federally threatened	Possible nesting, feeding, and migration

Osprey *Pandion haliaetus*	--	Possible feeding and nesting habitat
Bull Trout *Salvelinus confluentus*	State concerned, federally threatened	Spawning, rearing, and migration
Dolly Varden *Salvelinus malma*	State concerned, federally threatened	Spawning, rearing, and migration
Rainbow Trout *Oncorhynchus mykiss*	--	Spawning, rearing, and migration
Marbled Murrelet *Brachyramphus marmoratus*	State threatened, federally threatened	Possible nesting and migration route
Benthic Macroinvertebrates (various species)	--	Habitat, fish food source, and ecosystem health monitoring

3.4.1 Habitat Diversity

The ecosystem surrounding Gorge Reservoir and Stetattle Creek is considered North Pacific Maritime Dry-Mesic Douglas-Fir Western Hemlock Forest (*Rocchio and Crawford, 2009*). This ecosystem is considered moist and somewhat mild lowlands with most of its precipitation in the form of rain. The forest is predominantly Douglas Fir with Western Hemlock ranging from co-dominant to occasional with sword fern often being the dominant species in the understory. Fire is the major natural disturbance (*Rocchio and Crawford, 2009*).

Stetattle Creek is the major uncontrolled tributary to Gorge Reservoir and enters into the reservoir about ⅓ mile below the Diablo Powerhouse. Stetattle Creek is

characterized as a third order stream with varied substrate and about 1.3 miles of accessible habitat for fish. Stetattle Creek originates at McMillan Spire above Azure Lake and is primarily fed by glacier and snowmelt.

3.4.2 Native & Non-Native Fish Species

Stetattle Creek and its alluvial fan contain habitat used by native Bull Trout/Dolly Varden (Native char), Rainbow Trout and non-native Eastern Brook Trout. Bull Trout were listed as a federally endangered species in 1999 and continue to decline in numbers due to habitat loss, water quality degradation, climate change, and past fisheries management practices (*U.S. Fish and Wildlife Service*).

Assessment of Stetattle Creek confirmed eleven suitable spawning habitats, seven on Stetattle Creek and four in the alluvial fan (*Anthony and Rawhouser, 2012*). These spawning habitats had depths ranging from 0m to 0.35 m (1.15 ft). Of the 570 fish observations made during the surveys, 86% of the fish seen were rainbow trout, 5% were native char, and only 1 single eastern brook trout was observed (*Anthony and Rawhouser, 2012*). This shows rainbow trout as the dominant species in Stetattle Creek, but native char are also of significant importance due to their listing as a federally threatened species.

Native char require some of the most specific habitat requirements which make them excellent indicators of water quality. Specifically, native char require what is known as the "Four C's": cold water, clean spawning substrate, complex riffle-pool habitat, and connected habitat between streams, rivers, lakes, and oceans (*U.S. Fish and Wildlife Service*). Any impact to these habitat requirements can adversely affect populations of native char.

3.4.3 Impacts to Native & Non-Native Fish Species

Proposed Action Impacts

Most of these eleven spawning habitats were found in area of the proposed project, and substrate size and makeup would likely be affected by the Proposed Action

(*Anthony and Rawhouser, 2012*). The Proposed Action will remove 19,500 yd^3 of material from the Stetattle Creek cobble bar and will reduce spawning habitats in the alluvial fan to deeper than 0.35 m, likely eliminating spawning capacity of these areas. Head cutting is expected to occur 150 ft up Stetattle Creek (*R2 Resource Consultants, 2013*) and will increase water depth as well as increase turbidity.

Alternative Action Impacts

The Alternative Action would help protect the spawning habitat found in the alluvial fan and lower reaches of Stetattle Creek. Increased output from Diablo Powerhouse would be created from the widening of Stetattle Creek alluvial fan, and dredging of fish habitats in the alluvial fan would not be necessary. Fine silts would likely be deposited in the alluvial fan as a result of the levee replacement upstream. Coffer dams and silt screens would mitigate this problem, but turbidity increases could occur with improper water management.

No Action Impacts

The No Action Alternative would not threaten native char spawning, rearing, or migration habitat. Stetattle Creek and its alluvial fan are confirmed spawning and rearing habitats for the native char (*Anthony and Rawhouser, 2012*).

3.4.4 Marbled Murrelet

Marbled Murrelet has been listed as federally threatened under the Endangered Species Act since 1992. A long-term project in Washington State is taking place to monitor the populations of Marbled Murrelet and has shown a 7.3% decrease from 2001-2010 (*Pearson et al., 2010*). Marbled Murrelet primarily reside in coastal environments, but they fly inland to nest. Nests of the Marbled Murrelet have been found as far as 50 miles inland in Washington State (*U.S. Fish and Wildlife Service*).

3.4.5 Impacts to the Marbled Murrelet

The largest threat to the Marbled Murrelet is removal of nesting habitat, and this is not a component of either the Proposed Action or Alternative Action. For precautionary measures, monitoring for potential Marbled Murrelet nesting sites should be conducted prior to beginning project construction. Given that the project site is 95.5 miles from Bellingham Bay, which is about 45 miles farther than any recorded nesting site in Washington State, disturbance of nesting/migrating Marbled Murrelet is highly unlikely during this project.

3.4.6 Northern Spotted Owl

The Northern Spotted Owl has been federally listed as threatened since 1990, and populations have been in steady decline for the last century (*Gutierez et al. 1995*). Northern Spotted Owls usually require dense, old growth forest for roosting and nesting habitats. Surveys within the North Cascade National Park Service Complex (NOCA) identified eleven active Spotted Owl sites (*Kuntz and Christophersen, 1996*). In years following, very few Spotted Owls were confirmed among the sites previously occupied, and a 2009-2010 extensive survey did not confirm Spotted Owl at any locations (*Siegel et al., 2012*). Occasional Spotted Owl detections still occur, but confirmed locations are difficult due to small populations and habitat loss.

3.4.7 Impacts to the Northern Spotted Owl

The Proposed Action at Stetattle Creek would likely not affect Spotted Owl habitat directly. No old growth habitat is within the construction site and therefore would not be removed in the construction of this project (*Figure 16*). A potential threat to the Spotted Owl is noise and air pollution which would affect foraging and migration patterns, but this is only applicable if roosting or nesting sites have been confirmed in the area.

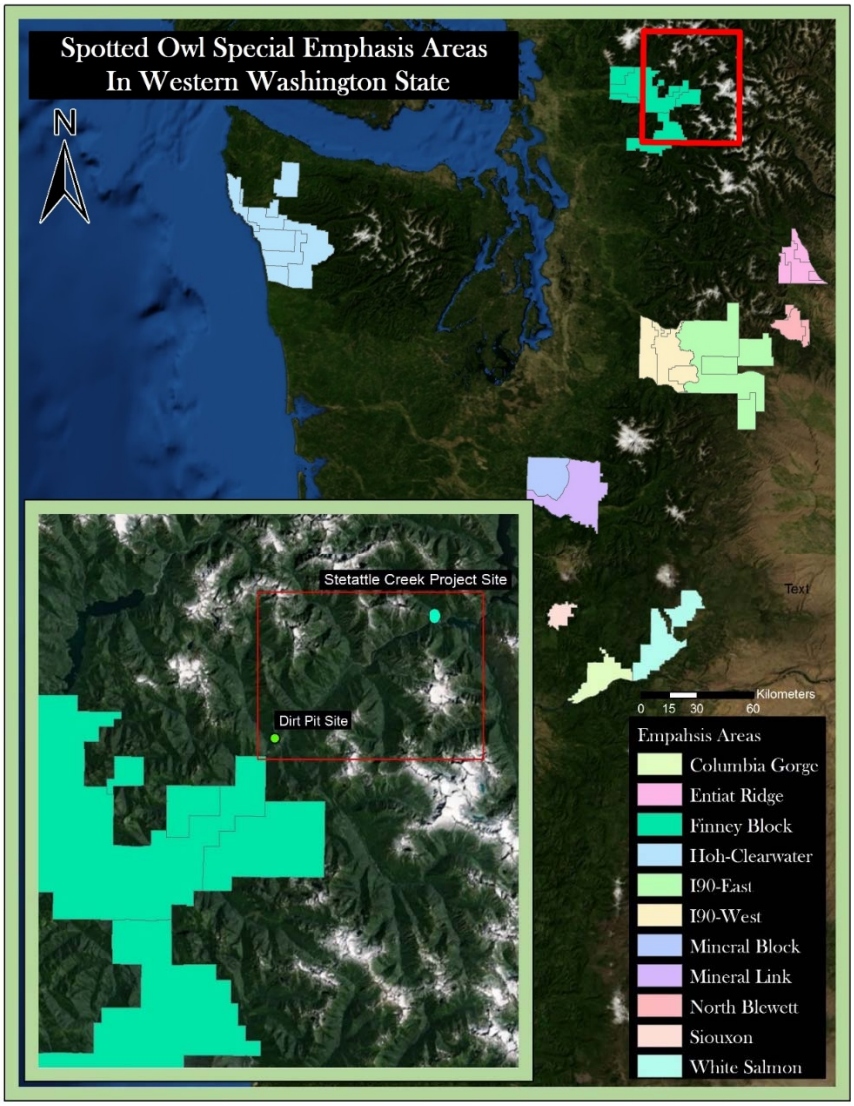

Figure 16. Spotted Owl Special Emphasis Areas in Western Washington State. Courtesy of Bjorn Ostenson

3.4.8 Osprey

Osprey, commonly called fish hawks or sea hawks, are migratory raptors that reside primary around salt or fresh water. Osprey usually arrive in the Pacific Northwest in early April and stay through September before migrating south (*USGS, 2002*). Fish make up more than 99% of Osprey diet, and their nests are often found in tall trees in sight of a body of water.

Osprey are currently not endangered or threatened in Washington state but are protected under the Migratory Bird Treaty Act of 1918 (16 U.S.C. 703-712). This means osprey are protected against anthropogenic disturbance, but other endangered, threatened, or sensitive species will be of higher concern.

3.4.9 Impacts to Osprey

Proposed Action Impacts

The Proposed Action would primarily effect osprey populations that prey on fish inhabiting Stetattle Creek and Gorge Reservoir. Fish spawning habitats in Stetattle Creek and its alluvial fan provide osprey with prey in the spring and summer months. Proposed construction time is mid-July through mid-September, which is when osprey are present in the Pacific Northwest. The Proposed Project will directly deter osprey from inhabiting the area during construction, and the elimination of fish habitat will also decrease food availability for osprey in the future.

Alternative Action Impacts

The Alternative Action will also deter osprey from inhabiting the area during construction. Replacement of the levee will cause heavy machinery to be used near Stetattle Creek which would prevent osprey from accessing that portion of the creek. The Alternative Action does not affect fish habitat as much as the Proposed Action and therefore will not affect future osprey feeding during summer months.

No Action Impacts

The No Action Alternative will not adversely affect osprey in the Stetattle Creek area.

3.4.10 Benthic Macroinvertebrates

Benthic macroinvertebrates (BMI) play a significant biological role as indicators of water quality and primary food source for many fish species. BMI communities

provide indication of localized conditions due to limited migration and a wide range of environmental tolerance between different species (*Barbour et al., 1999*).

Assessment of BMI can be compared to a reference site condition to analyze ecological health. Assessment of Stetattle Creek BMI habitat in alluvial fan and upstream sites indicated that lower sections of Stetattle Creek were not operating at full ecological potential (*Anthony and Rawhouser, 2012*). The alluvial fan BMI did not have a reference to compare to but a higher abundance of BMI was found in Stetattle Creek habitats compared to alluvial fan habitats (*Anthony and Rawhouser, 2012*).

Proposed Action Impacts

The Proposed Action will significantly impact BMI through disturbance of habitats in the alluvial fan and head cutting impacts in Stetattle Creek. The dredging of the cobble bar will turn the alluvial fan riffle habitats into 6 ft deep pools that will likely not support the diverse BMI communities previously found. Comparison to reference sites with similar conditions would provide assessment of which BMI are found in deeper habitats.

Alternative Action Impacts

The Alternative Action would not directly eliminate BMI habitat in Stetattle Creek or the alluvial fan. The major concern to BMI in the Alternative Action is potential turbidity increases that could blanket riffle habitat downstream of the levee replacement. BMI

No Action Impacts

No Action Alternative would have no adverse impacts to BMI communities in Stetattle Creek.

3.5 NATURAL RESOURCES & ENERGY

3.5.1 Existing Environment

The three dams discharge water in sequence into the Skagit River which typically flows between 3,000 and 14,000 cubic feet per second (*USGS Current Conditions, 2014*). The large hydroelectric dams use this flow to generate electricity for the greater Seattle area. This immense flow of water is also an integral part of a natural water cycle, as snowpack from the Cascade region melts away in warmer months. The Skagit River basin is the largest drainage in the Puget Sound region, covering over three thousand square miles with one hundred fifty-eight miles of major rivers and tributaries, which carry the water to the Salish Sea *(Hydropower Reform Coalition Success Story, 2009).* The Skagit River is one of main waterways for the runoff and is a carrier of salmon for portions of their life cycle. It meanders through the North Cascades National Park and the Cascade lowlands before outflowing into the Salish Sea. All throughout, the river carries nutrients and provides important habitat.

The three reservoirs and the North Cascades National Park area are inhabited with species such as Northern Spotted Owls, Osprey, Bull Trout, Dolly Varden, and Rainbow Trout *(Refer to 3.4, Plants and Animals).* The slopes are covered with coniferous trees, which gives Western Washington its "Evergreen" environment. Abundant tree species include cedars, firs, spruce, pines and hemlocks *(National Parks Service- Tree Checklist).* These resources and species are conserved by the National Parks Service as a division of the U.S Department of the Interior through the designation of the North Cascades National Park.

The Diablo Dam alone has the capacity to produce 132 megawatts of electricity, and the three dams combined can produce 690 megawatts for Seattle City Light customers *(The Concrete Herald, 1951).*

3.5.2 Provision of Electricity

The provision of electricity by hydroelectric projects also provides recreational uses, flood control and agricultural benefits through the manipulation of water flows *(U.S Department of Energy, Benefits of Hydropower).* Hydropower is unique in that it harnesses energy without depleting from other benefits, and Washington State has been building up a hydropower-rich portfolio over the years due to its low emissions,

abundance, and low production costs *(Energy Information Administration, Washington Profile).* Energy harnessed from the constant flow of the Skagit River is valuable to the greater Seattle Region.

Energy in fuels such as gasoline and diesel will be expended in order to achieve Seattle City Light's goal of increasing generating capacity. This will occur either through dredging efforts in the proposed action or through the removal of the levee and eight Diablo dwelling units in the alternative action in an effort to lower the tail water height. If the generation capacity is not restored and average demand remains steady, Seattle City Light will use other means of electricity generation to offset the decreases at Diablo Dam. This will likely involve the burning of fossil fuels, which accounts for much of the generation that is not hydroelectric in the state. Washington State uses several other generation methods, summarized in *Figure 17.*

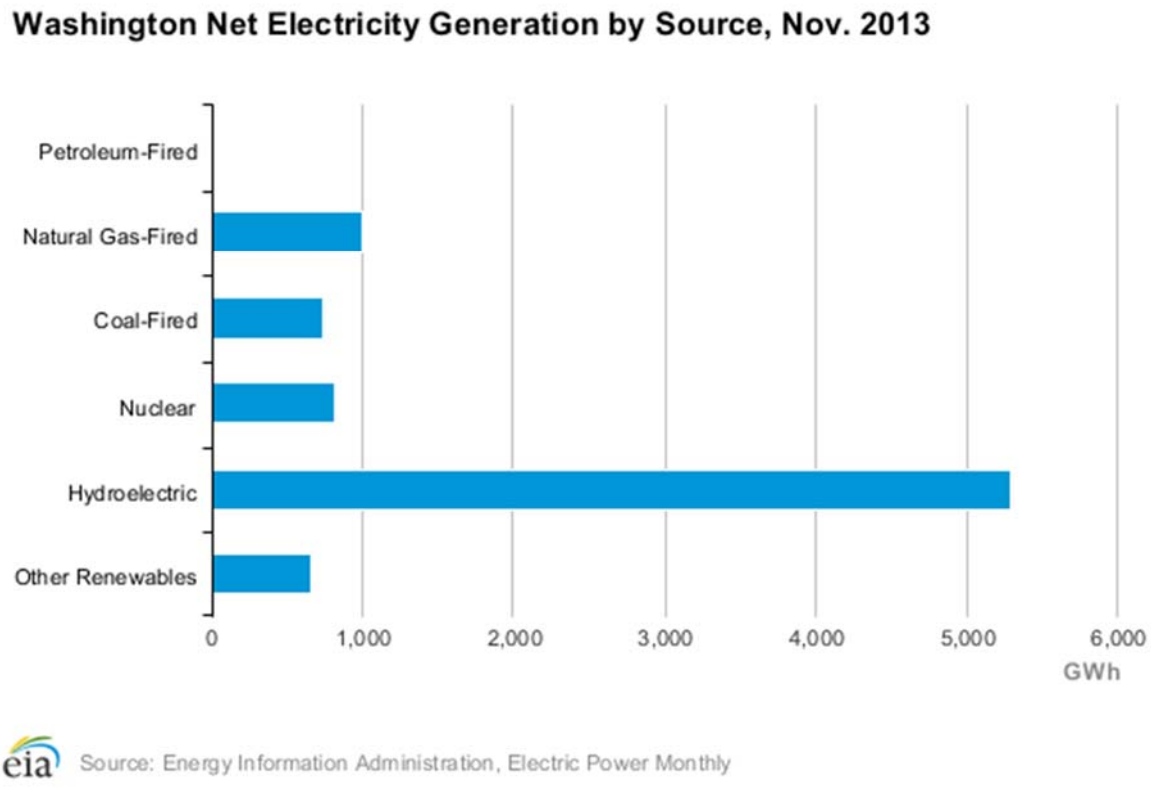

Figure 17. (U.S Energy Information Administration, 2013)

3.5.3 Non-Renewable Resources

Non-renewable fuels will be expended to achieve the results of the Proposed Action and to achieve the results of the Alternative Action. The non-renewable resources to be used for the Proposed Action and the Alternative Action include petroleum-based products such as diesel and gasoline to power equipment for dredging or berm removal, as well as to transport the spoils to the dirt pit which is 15.5 miles away *(R2 Resource Consultants, 2013).*

3.5.4 Renewable Resources

Hydropower is a renewable resource because energy can be extracted without altering its form into an unusable or harmful by-product *(House Committee on Natural Resources, 2014).*

Renewable energy is unlikely to be used within the process of any of the three actions, but the results of the Proposed Action and the Alternative Action will result in a larger percentage of electricity provided to Seattle City Light customers to be hydroelectric, versus natural gas-fired or imported coal-fired electricity generation.

3.5.5 Impacts to Natural Resources & Energy

Proposed Action Impacts

Resources will be expended for the removal of the cobble bar, as well as energy in fuel form to transport spoils 15.5 miles down Highway 20 to a designated Seattle City Light site at milepost 111.7. According to the Preliminary Engineering Design Report by R2 Resource Consultants, the full excavation of the cobble bar would result in 19,500 cubic yards (*R2 Resource Consultants, 2013*). A typical dump tuck holds 18 cubic yards of material, so approximately 1,083 trips would be made. Converted to miles, 33,583 miles would be traveled. Round trip, each truck would travel 31 miles.

Driving 33,583 miles would burn approximately 4,797 gallons of fuel at 7 miles per gallon *(Federal Highway Administration, 1995).*

Alternative Action Impacts

The energy expended to remove the berm as well as relocate the eight structures in the town of Diablo will be equal to the energy expenditures of the Proposed Action. The Alternative Action will reestablish a portion of the naturally occurring alluvial fan of the Stetattle Creek as it joins with Gorge Reservoir, thus allowing the stream mouth to return to a salmon habitat as sediment becomes more evenly distributed, creating shallow spots and riffles which are a vital natural resource for fish species.

Because the Alternative Action requires the removal and relocation of the berm, no excess spoils will need transport from the original berm site. The portion of the infill underlying the west side of the town of Diablo will be removed and those spoils will be transported to the dump site. The volume of material will be similar to the cobble bar, and transport mileage will be equal to the amount calculated in the Proposed Action-,; approximately 33,583 miles.

No Action Impacts

The No Action Alternative will require no energy expenditures on site. However, a continued decrease in generating capacity will cause Seattle City Light dispatchers to rely on other generation means to meet instantaneous demands. The emissions calculated can be compared with the emissions of hydropower, which are zero.

The effect of the No Action Alternative will preserve natural resources in the North Cascades National Park but displace energy resource use elsewhere. Using a 5 megawatt decrease of hydropower for purposes of calculation, the replacement emissions from an equal amount of generation with a coal-fired plant will total 13,918,666 pounds of carbon dioxide. The process follows:

1.8 MW of electricity can be produced from burning one ton of coal (2,000 pounds) *(How much coal? EIA, 2014).* An average coal-fired plant will produce 5,720 pounds of carbon dioxide emissions from each ton (2,000 pounds) of coal burned *(Hong, B.D., and E.R Slatick, 2014*). If the generating capacity of Diablo Dam has decreased by 5 megawatts, which has been dispatched to a coal-fired plant, 15,888 pounds of carbon dioxide emissions could be created every hour. With 8,760 hours in a year, 13,918,666 pounds of emissions could be added to the atmosphere.

CHAPTER FOUR
THE BUILT ENVIRONMENT

4.1 ENVIRONMENTAL HEALTH

4.1.1 Noise

Natural levels of noise exist within an area, which are known as ambient noise. Additional actions can increase levels of noise and can change the natural soundscape of an area. The operation and use of machinery for the dredging of the cobble bar is expected to increase the noise levels relative to the ambient noise levels in the project area during the dredging and hauling process. The noise created from the project site is classified as point source, which would spread noise spherically across the area. Increases in noise levels could have an effect on wildlife and disrupt the natural soundscape of the area. The measured ambient level of noise is 46 dBA (*Winings, 2009*). The noise created from the dredging and hauling of the gravel could be detectable to Marbled Murrelets and Spotted Owls that may inhabit the surrounding area.

4.1.2 Impacts to Noise

Proposed Action Impacts

Equipment being used for the project is both stationary and mobile. Project equipment includes, but is not limited to, excavating machinery used to remove the cobble bar and hauling trucks to move the excavated sediment to the designated disposal site. Measurements of common construction equipment were recorded by the Federal Highway Administration (FHWA) at an average distance of 50 feet. The recorded noise level for a dump truck is 76 dBA and an excavator is 81 dBA. In a biological assessment conducted by the Washington State Department of Transportation (WSDOT), noise levels created from stationary equipment can range from 68 to 88 dBA (*Washington State Department of Transportation, 2014*). Mobile equipment such as dump trucks creates

varying levels of noise due to volume of traffic and speed. The dredging of the cobble bar would create additional sources of noise from project equipment. Increased noise levels would negative impact humans within the project area by disrupting ambient noise levels for recreationalists in the Gorge Reservoir campground and individuals living in Diablo. Increased noise levels beyond ambient levels could also disrupt feeding, reproductive, and hunting patterns for wildlife, specifically Marbled Murrelets and Spotted Owls that may be present in the area.

Alternative Action Impacts

Alternative action plans require the movement of houses along the bank of Stetattle Creek. Project equipment for this action plan is estimated to increase noise levels of the area similar to those of the proposed action due to similar equipment necessary for the excavation of the Stetattle Creek levee. Increases in noise level would have slightly greater impact on residents due to increased proximity of levee excavation to adjacent homes. Impacts to wildlife present in the area would also be similar to the Proposed Action.

No Action Impacts

The No Action Alternative will not alter the noise level of the area. Gorge Reservoir facilities and daily human-induced noise would continue to operate as usual.

4.2 LAND & SHORELINE USE

4.2.1 Housing & Existing Land Use Plans

The Town of Diablo, also known as Hollywood in the National Historic Register, is the primary area containing housing and infrastructure that would be affected by project actions. Diablo provides housing for the employees of Seattle City Light (SCL) and National Park employees and other employees of organizations affiliated with the national park. The Town of Diablo is owned and operated by SCL and was constructed between 1920 and 1960. The area also contains two trailheads, campgrounds, and a boat

launch area. The land in the project area is primarily used for housing for company and park workers and recreationalists. In addition to the housing structures, there is a levee along the bank of the creek to protect the town from flooding.

4.2.2 Aesthetics

The project area provides natural scenery, which includes the Skagit River, Gorge Reservoir, and geologic formations. The viewscape also has components of the SCL infrastructure including Diablo Dam, the Gorge Reservoir powerhouse, Stetattle Creek Bridge, and the town of Diablo. The natural and built environments in their current condition add visual aesthetic values to the area that contribute to the enjoyment and scenic appreciation of residents and visitors to the area.

4.2.3 Impacts to Housing & Existing Land Use, and Aesthetics

Proposed Action Impacts

The proposed project action would cause a visible change in the Gorge Reservoir due to the removal of the cobble bar. The small rapids provided by the Stetattle Creek sediment present at the mouth of Stetattle Creek would be removed from the reservoir. This removal could detract from the aesthetics of the reservoir, where the cobble bar would no longer be a geologic formation characteristic of the reservoir.

Alternative Action Impacts

The proposed Alternative Action would create visible changes to the built and natural environments. The eight structures along the Stetattle Creek bank would be removed and relocated to designated areas within the town of Diablo. This structural removal would allow the creek to return to a more natural deltaic flow at the mouth of the creek. The creek widening would allow new sediment deposition patterns to occur instead of being concentrated at the current cobble bar location. The restoration of the creek to a more natural flow could enhance the natural aesthetics of the creek to more historical aesthetic disrupted by the erection of the Town of Diablo, which was once an alluvial fan.

No Action Alternative Impacts

The no action alternative would allow the area to maintain its current aesthetics. No terrestrial or aquatic changes would be made to disrupt the natural viewscape of Gorge Reservoir or the built environment.

4.2.4 Recreation

The Stetattle Creek area provides a number of activities ranging from hiking to kayaking that are a source of recreation and enjoyment to the public. The project area is surrounded by the Ross Lake National Recreation Area and the North Cascades National Park. These areas include activities including fishing, camping, boating, hiking, and guided tours of local facilities. The Ross Lake National Recreation Area main uses are primarily for recreation, preservation of the ecosystem, conservation management oriented towards areas of scientific, scenic, historic, and natural conservation. The recreational use of the area peaks from July to September when access to the area is at its greatest. Access is open to the public year-long but is subject to road closures during winter due to hazardous conditions.

4.2.5 Impacts to Recreation

Proposed Action Impacts

The proposed project action could restrict use of the area by recreationalists and visitors to these areas due to the proposed project dredging dates, which are estimated to last from July 15 to September 15 (*R2 Resource Consultants, 2013*). The proposed project would limit access to the Gorge Reservoir drive-in camping ground, limit access to the kayak/ canoe launching area, and limit access to two trailheads, the Stetattle Creek Trail and the Sourdough Trail. The cobble bar is a geomorphic feature that is important to kayakers and similar recreationalists that use Gorge Reservoir due to the “narrows” that the cobble bar creates. The sediment deposited by the creek creates a small rapids due to

the sediment build up from the cobble bar that pinches the water flow of the reservoir. The dredging of the cobble bar would eliminate this feature.

Alternative Action Impacts

The proposed Alternative Action of widening the creek mouth would not eliminate the narrows created by the cobble bar. Over time altered sediment distribution at the mouth of the creek due to widening could create a different character of water flow above and possibly over the existing cobble bar. Access to Stetattle Creek trailhead would be restricted for a limited period of time due to levee deconstruction and structural removal of the eight homes on the bank of Stetattle Creek.

No Action Impacts

The no action alternative will not alter or change recreational use of the area. Recreation in the area would neither be expanded nor restricted.

4.2.6 Historic and Cultural Preservation

Environmental review processes on the part of federal, state, and local governments generally require that a project take into consideration protecting historic, archaeological, and traditional cultural sites and resources that could be damaged or loss during the project. Compliance of this review derives from several statutes which include: Sec. 106 of the National Historic Preservation Act, SEPA, Forest Practices Act, Governor's Executive Order 05-05, United States Department of Housing and Urban Development Reviews, and Shoreline Management Act. In compliance with Sec. 106 of the NHPA and state laws listed in the section above, the Advisory Council on Historic Preservation must be given notification of the projects effecting historic structures in order to allow commenting by the public and proper consultation by the State Historic Preservation Officer.

The area of interest is identified and listed on the Washington State National Historic Register as the Skagit River and Newhalem Creek Hydroelectric Projects. The historic register includes an area of approximately 177.4 acres, which includes the Town

of Diablo, specified as Hollywood in the National Register of Historic Places Registration Form. There are eight structures, which include: The Hollywood Sewage Pump Station, Garage H-1 & H-2 (*Figure 18*), H-1 (*Figure 18*), H-2, H-3, Garage H-3 & H-4, H-4, and H-5, which are identified for removal and relocation along Stetattle Creek Street. The purpose of four of the eight structures proposed for removal are identified as housing and the remaining two structures are identified as garages and a sewage station. All of the structures were built in 1952, with the exception of the two garages, which were built in 1954. The historical significance of these structures is derived from a need to provide housing for company employees. Population declines over the years have brought the community into decline. Contributing factors include vacancies, school closure, and reduced public services, which are now provided by SCL. (*National Register of Historic Places Form, 2010*). These homes are currently inhabited by various employees.

In compliance with SEPA, tribes must be consulted on proposed project actions that could have a potential impact to cultural resources. In consultation with Skagit River tribes, there is no significant impact to cultural resources because the proposed project area does not include salmon habitat (*Walsh, 2014*).

Figure 18. Displaying Garage H-1 & H-2 and Hollywood House H-1, two of the eight structures prosed for removal and relocation.

4.2.7 Impacts to Historic Preservation

Proposed Action

The proposed project action would have no significant effects to these historical structures located along the bank of Stetattle Creek. The Stetattle Creek Bridge would require review due by the SHPO for the additional structures that would need to be installed on to the bridge to reduce head cutting of the stream.

Alternative Action

The proposed Alternative Action requires the moving of the eight identified historic structures listed above. The historic integrity of the eight structures is not anticipated to detract from the historic significance of the town because the structures

will serve the same purpose of resident housing in the designated relocation sites. The widening of the creek would also require an extension to the existing Stetattle Creek Bridge to accommodate for the increase of the creek mouth. A new levee would also have to be constructed along the new creek bank to ensure the stability of the bank and to protect the town from flooding.

No Action Alternative

The No Action Alternative would have no impacts to the current historical integrity of the town.

4.3 TRANSPORTATION

4.3.1 Transportation Systems

There are only two roads that provide access to this region, State Route 20 and Silver Skagit Road. These road ways provide a mode of transportation for employees in the area to get to Gorge Reservoir facilities and access to homes. The roadways also provide access to the area for recreational purposes.

4.3.2 Impacts to Transportation Systems

Proposed Action Impacts

Traffic levels on State Route 20 would increase due to the trips taken for moving the cobble bar material. An additional 1,083 trip are estimated to be taken by dump trucks. This increase in traffic would cause difficulty in access to the area for company employees, park workers, and recreationalists. The source of increased traffic is from the hauling by trucks from the cobble bar to an area identified as the “Dirt Pit”, which is located 15.5 miles from the Stetattle Creek cobble bar. Each trip taken for an individual load is approximately 31 miles. Alternative travel routes would have to be identified for alternate access to the Town of Diablo. There are limited expected impacts to transportation in the project area due to the low population density.

Alternative Action Impacts

The Alternative Action would have greater impacts for Diablo residents as well as individuals seeking to use the area for recreational purposes. Access to parts of the town would be restricted for residents and recreationalists during the removal and relocation of the eight identified homes in the Alternative Action proposal. Street access for residents would be blocked. Alternate routes would have to be provided and identified for residents during the period of removal and relocation of homes.

No Action Impacts

The no action alternative would have no impacts to transportation systems in the area.

4.4 PUBLIC SERVICES & UTILITIES

4.4.1 Sewer/Solid Waste

Public utilities and other services are typically provided by municipal governments. In the Town of Diablo, all public services are managed and provided for by Seattle City Light. SCL owns and is responsible for the operation of Diablo. The state of town services has declined in conjunction with declines in population. Many public services such as schools and postal service have shut down or have been reduced . The main services provided include water, sewer, and electric.

4.4.2 Impacts to Sewer/Solid Waste

Proposed Action Impacts

The Proposed Action is not expected to have any impacts on public services or utilities in regards to sewer or water. No structures of the built environment providing public services will be impacted by the dredging of the cobble bar.

Alternative Action Impacts

The Alternative Action includes the moving of the structure closest to Stetattle Creek Bridge, which was erected in 1952 as a sewage pump station. The Alternative Action proposal would negatively impact the provision of proper sewage services to the town due to removal. The sewage pump station would be relocated and infrastructure to support sewage functions would have to be installed.

No Action Impacts

The No Action alternative would have no impact on the provision of sewer or water public services. The level of service for town residents would remain the same and would continue to be provided for by SCL.

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

In conclusion, our evaluation of outcomes of the assessment of the three proposals put forth in this EIA finds that the Proposed Action will have the greatest negative impact to the environment. Our findings also conclude that the Alternative Action and No Action Alternative would have the same overall impact to the natural and built environment when evaluated systematically on a numbered scale.

Seattle City Light proposed the dredging of the Stetattle Creek cobble bar to restore power generation capacity to the Gorge Dam, and the Alternative Action proposal would allow for the restoration of generation capacity too, while lessening adverse impacts. A large portion of the adverse impacts in the adoption of the Alternative Action

would be to Diablo residents, who would be relocated and inconvenienced due to temporary closures in sewage services. The historical integrity of the town would also be diminished because these structures are listed on the National Historic Register, which takes into account the location as well as the structures.

Using the systematic approach of valuating the impacts to the environment, we found that the impact-minimizing proposals were the Alternative Action and the No Action Alternative, equally valued at -7 (*Decision Matrix*). Findings in the overall impact of Earth, Air, Water, and Transportation elements found the environmental impacts to be similar and adverse in both the Proposed and Alternative Actions.

Our recommendation to adopt the Alternative Action as a project plan is due to its low environmental impacts relative to other proposals, as well as its achievement of the project goal, which benefits Seattle City Light and their customers.

SOURCES:

Agee, James K. and Wasem, Robert C. Stetattle Creek Research Natural Area *Supplement No. 25* to "Federal Research Natural Areas in Oregon and Washington: A Guidebook for Scientists and Educators" U.S. Department of Agriculture, Forest Service

Anthony, H., and Rawhouser, A. 2012. Fish and Habitat Assessment of Stetattle Creek. North Cascades National Park Service

Barbour, M.T., J. Gerritsen, B.D. Snyder, and J.B. Stribling. 1999. Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic

Macroinvertebrates and Fish, Second Edition. EPA 841-B-99-002. U.S. Environmental Protection Agency; Office of Water; Washington, D.C.

"City Light Projects Harness Powerful Skagit River After Long, Hard Struggle." . The Concrete Herald, 21 June 1951. Web. 29 May 2014.

"Comprehensive Truck Size and Weight (TS&W) Study." . Federal Highway Administration U.S. Department of Transportation, 1 Feb. 1995. Web. 30 May 2014.

“Construction Noise Impact Assessment.”. Tech. Washington State Department of Transportation, 2 Apr. 2014. Web.

"EIA - How much carbon dioxide is produced by burning gasoline and diesel fuel?." *EIA*. U.S. Energy Information Administration, n.d. Web. 30 May 2014.

"EIA - How much coal, natural gas, or petroleum is used to generate a kilowatthour of electricity?." *EIA*. U.S Energy Information Administration, n.d. Web. 30 May 2014.

"Energy.gov." *Benefits of Hydropower*. U.S Department of Energy, n.d. Web. 29 May 2014.

"Hydropower as a Renewable Energy Source." *House Committee on Natural Resources*. N.p., n.d. Web. 28 May 2014.

"Hydropower Reform Coalition Success Story SKAGIT RIVER PROJECT." . Hydropower Reform Coalition, 1 Jan. 2009. Web. 29 May 2014.

"LIHI Certificate #5 - Skagit Project, Skagit River, Washington, (FERC #553)." *Low Impact Hydropower Institute*. N.p., 1 Jan. 2008. Web. 28 May 2014.

"National Atmospheric Deposition Program/National Trends Network 2012 Annual & Seasonal Data Summary for Site WA19." . N.p., 10 Oct. 2013. Web. 15 May 2014.

National Register of Historic Places Registration Form. N.p.: Washington State Historic Preservation Office, 10 Dec. 2010. PDF.

"Seattle City Light | A Brief History." *Seattle City Light | A Brief History*. N.p., n.d. Web. 30 May 2014.

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *U.S. Energy Information Administration (EIA)*. N.p., n.d. Web. May 3rd, 2014.

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis- Washington Profile Overview." *U.S. Energy Information Administration (EIA)*. U.S Energy Information Administration, n.d. Web. 29 May 2014.

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *U.S. Energy Information Administration (EIA) Washington- Net Electricity Generation by Source)*. EIA.gov, November 13th, 2011. Web. 19 May 2014.

"Upper Skagit River Hydroelectric Project." . N.p., n.d. Web. 30 May 2014.

"USGS Current Conditions for USGS 12194000 SKAGIT RIVER NEAR CONCRETE, WA." *USGS Current Conditions for USGS 12194000 SKAGIT RIVER NEAR CONCRETE, WA*. USGS, 19 May 2014. Web. 19 May 2014.

"R2 Resource Consultants - Stetattle Creek Cobble Car Project- Preliminary Engineering Design Report FINAL." R2 Resource Consultants. Published July 10th, 2013. May 7th, 2014.

Belalcazar, Luis Carlos, and Alain Clappier. "An alternative technique to estimate road traffic emission factors." . Environmental Protection Agency, n.d. Web. 30 May 2014.

Gutiérrez, R. J., A. B. Franklin, and W. S. LaHaye. 1995. Spotted Owl (*Strix occidentalis*). In A. Poole and F. Gill (Eds). The Birds of North America, no. 179. The Academy of Natural Sciences, Philadelphia, and The American Ornithologists' Union, Washington, D.C.

Hong, B.D., and E.R Slatick. "Carbon Dioxide Emission Factors for Coal." *Carbon Dioxide Emission Factors for Coal*. U.S Energy Information Administration, 1 Aug. 1994. Web. 30 May 2014.

Kuntz II, R. C. and R. G. Christophersen. 1996. A survey of Northern Spotted Owls in North Cascades National Park Service Complex. Technical Report NPS/CCSONOCA/NRTR- 96/05.

Pearson, S.F., M.G. Raphael, M.M. Lance, and T. D. Bloxton, Jr. 2011. Washington 2010 at-sea marbled murrelet population monitoring: Research Progress Report. Washington Department of Fish and Wildlife, Wildlife Science Division and USDA Forest Service Pacific Northwest Research Station, Olympia, WA.

Rocchio, J. and Crawford, R. 2009. Draft Field Guide to Washington's Ecological Systems. http://www1.dnr.wa.gov/nhp/refdesk/pubs/wa_ecological_systems.pdf, updated Oct 28, 2009; accessed May 17, 2014.

Siegel, R. B., R. C. Kuntz II, R. L. Wilkerson, K. D. Kuhlman, and M. C. Toshack. 2012. Surveying for Spotted Owls in the Upper Skagit Watershed of North Cascades National Park Complex, 2009-2010. Natural Resource Technical Report NPS/NOCA/NRTR—2012/597. National Park Service, Fort Collins, Colorado.

The Editors of Encyclopædia Britannica. "marine west coast climate (climatology)." *Encyclopedia Britannica Online*. Encyclopedia Britannica, n.d. Web. 15 May 2014.

United States. National Park Service. "Air Quality." *National Parks Service*. U.S. Department of the Interior, 15 May 2014. Web. 15 May 2014.

United States. National Park Service. "Tree Checklist." *National Parks Service*. U.S. Department of the Interior, n.d. Web. 29 May 2014.

Walsh, Stan. "Questions from Nicholas Zaferatos' Tribal Planning Class." Message to the author. 12 May 2014. E-mail.

Winings, Cathi J., and Evenlyn G. Neel. “North Cascades National Park Complex Acoustic Monitoring 2009-2011.”. Tech. *National Park Service*. U.S. Department of the Interior n.d. Web.

Tabor, R. W., and Ralph Albert. Haugerud. *Geology of the North Cascades: A Mountain Mosaic*. Seattle, WA: Mountaineers, 1999. Print.