

61st PI W Culvert Improvement Project Critical Areas Report

Prepared for

The City of Mukilteo
11930 Cyrus Way
Mukilteo, WA 98275

Prepared by



Northwest Environmental Consulting, LLC
3639 Palatine Avenue North
Seattle, WA 98103
206-234-2520

October 2015

SUMMARY

The City of Mukilteo is proposing to replace an existing deficient culvert with a new box culvert, improving both stream function and road conditions. The replacement will address current problems with stormwater flooding over the road, road deterioration, and erosion and headcutting downstream of the culvert outfall. The new culvert will not be fish passable, but the project includes improving structural stream conditions along approximately 230 linear feet of stream, including the reach approximately 120 feet downstream that may contain fish.

Project drawings showing the plans are attached (Appendix A) and referenced within the report where appropriate. The culvert is located along Smuggler's Gulch Creek in the City of Mukilteo, Washington, in Section 17, Township 28N, Range 04E.

Smuggler's Gulch Creek is a Type 4 stream as identified by the City of Mukilteo. Biologists from Northwest Environmental Consulting, LLC investigated the site on March 10, 2015 and determined that no wetlands are present within 100 feet upstream or to the next culvert about 600 feet downstream.

The project will create wildlife enhancements in Smuggler's Gulch Creek by improving the stream for fish downstream of the culvert, reducing erosion at the current culvert outfall and along the roadside downstream of the culvert, and enhancing 4,850 square feet of impacted stream buffer within the project limits by planting native trees and shrubs.

Table of Contents

1	INTRODUCTION	1
1.1	Report Purpose	1
1.2	Site Description.....	1
1.3	Project Purpose and Description	2
2	METHODOLOGY	3
2.1	Existing Document Review.....	3
2.2	Field Investigation.....	3
	Streams.....	3
	Wetlands.....	3
	Priority Wildlife Habitat.....	4
3	RESULTS	5
3.1	Stream Rating and Regulations	5
3.2	Wetland Investigation	5
3.3	Wildlife Habitat Assessment	6
5	IMPACTS	8
6	MITIGATION.....	9
6.1	Avoidance and Minimization	9
6.2	Mitigation Approach.....	10
6.3	Mitigation Goals	12
6.4	Performance Standards.....	12
6.5	Schedule and Maintenance	12
7	PROPOSED MONITORING, REPORTING AND CONTINGENCY	13
7.1	Plant Survival	13
7.2	<i>Monitoring Reports</i>	13
7.3	Contingency Actions	14
8	DOCUMENT PREPARERS	15
9	REFERENCES	16

APPENDICES

- A: Figures
- B: Photos
- C: Wetland Determination Forms
- D: Previous Habitat Assessments

1.1 Report Purpose

This report documents the current conditions of critical areas adjacent to the 61st Place West Culvert Improvement Project (the project) along Smuggler's Gulch Creek in Mukilteo, Washington. Smuggler's Gulch Creek is identified by the City of Mukilteo as a critical area. Northwest Environmental Consulting, LLC (NVEC) conducted a literature search and site visit to determine if other features such as wetlands or sensitive wildlife habitat were present in or adjacent to the project site.

The report also describes the temporary and permanent impacts to these critical areas and their buffers from the planned stream regrading and replacement of the current culvert with a larger diameter culvert. The culvert replacement is intended to reduce roadway flooding, roadway erosion, and streambank erosion, and to improve habitat for fish downstream of the crossing.

1.2 Site Description

The project is located in Snohomish County, in the City of Mukilteo adjacent to Puget Sound (Figure 1, Project Location in Appendix A). The project is located where 61st Place West in Mukilteo crosses Smuggler's Gulch Creek, in Section 17, Township 28N, Range 04E. The project site is within the City of Mukilteo's right of way, and also includes slopes and about 220 linear feet of stream and riparian area on portions of four adjacent residential properties (Figure 2, Existing Conditions). One of the four parcels is owned by the local community association.

Smuggler's Gulch Creek originates about a third of a mile east of the 61st Place West crossing. The creek is seasonal, and is usually dry during summer months.

The stream upstream of 61st Place West is in a narrow gulch descending through fairly steep terrain. The stream passes through red alder forest (*Alnus rubra*) with scattered western red cedar (*Thuja plicata*) and shrubs such as sword fern (*Polystichum munitum*) and salmonberry (*Rubus spectabilis*); Photos 1, 2 and 3 in Appendix B) and runs adjacent to a residential home with a steep embankment before passing under 61st Place West. The culvert's upper end had some debris partially blocking the entrance during the March 10, 2015 site visit (Photo 4). The lower end is perched about 10 feet above a pool. Stream banks are heavily eroded.

Below the 61st Place West culvert, the stream is a riffle run with cascades and an incised channel (Photo 5). The stream runs past a couple of residential homes and runs parallel to 88th Street SW, where a riprap bank along the road extends below the ordinary high water mark (OHWM) of the stream (Photo 6). The stream crosses under 88th Street SW through another culvert (Photos 8 and 9) that is a partial fish-passage barrier due to a perched outlet observed during the March 10, 2015 site visit. Finally, the stream crosses under the railroad tracks via a 36-inch-diameter concrete culvert that does appear fish-passable before entering Puget Sound (Photo 10).

1.3 Project Purpose and Description

This culvert improvement project will replace the existing, deficient stream crossing at 61st Place West with a new culvert, improving both stream function and road conditions. The existing 54-foot-long, 24-inch-diameter multi-sloped CMP culvert will be removed. The new box culvert will be 40 feet long, 6.5 feet wide, and 3 feet tall. The project will also reposition the culvert south of its original location, construct approximately 230 linear feet of stream channel, and raise the road 2 feet. These changes will accommodate the new culvert's size, the site's steep topography, and the existing, 8-inch-diameter sewer line running along the roadway and under the existing culvert.

The culvert replacement will fix several issues. The existing stream channel is undercutting a steep bank upstream of the existing culvert, on the north side. Moving the culvert south will protect this bank. Along the road, poor drainage and pavement failure has greatly deteriorated the road surface. Raising the road 2 feet will prevent these drainage issues while also allowing the culvert to fit above the existing sewer line and reduce roadway flooding during storm events.

Downstream, head cutting of the channel bottom has left a significant drop from the outfall. This headcutting is also leading to erosion along the western shoulder of the roadway, which has begun to slough into the stream. The redesigned crossing will eliminate the headcutting issue. Erosion will be further reduced by lining the streambed with new material (heavy material downstream and light material upstream) to create a roughened channel; planting native vegetation on streambanks and all other disturbed areas along the restored segments of stream; and installing headwalls at culvert ends to stabilize roadway fill. A traffic barrier will also be installed over the crossing to provide safety.

Figure 3, Proposed Conditions (Appendix A) provides a project overview and additional project plans and details are included in Figures 3 through 9.

2.1 Existing Document Review

Prior to performing a field investigation to assess the project site's critical areas, NWEC biologists reviewed several sources for existing information about wetlands, sensitive wildlife, and habitat near the project, including the following:

- Soil Conservation Service (SCS) Soil Survey of Snohomish County Area (USDA SCS 2015).
- U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory (NWI) map (USFWS 2015).
- Washington Department of Fish and Wildlife (WDFW) Priority Habitats and Species (PHS) List (WDFW 2008) and publicly accessible database (WDFW 2015a).
- WDFW Washington SalmonScape mapping database (WDFW 2015b).
- Stream Habitat Survey in Smuggler's Gulch. Technical Memorandum prepared by Otak for WDFW (Otak 2010). Included in Appendix D.
- Smuggler's Gulch Habitat Assessment. Technical Memorandum prepared by Cherry Creek Environmental for the City of Mukilteo (Cherry Creek Environmental 2010). Included in Appendix D.

2.2 Field Investigation

Streams

NWEC rated the site's stream and riparian buffers based on the City of Mukilteo's municipal code (Chapter 17.52, Critical Areas Regulations).

Wetlands

NWEC biologists walked the stream and nearby areas within 100 feet upstream of the 61st Place West culvert, and downstream between the 61st Place West culvert and the culvert downstream at 88th Street SW, looking for wetland characteristics as defined in the *U.S. Army Corps of Engineers Wetland Delineation Manual* (USACE 1987) and the *Regional Supplement to the*

Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region (USACE 2010). These methods were consistent with the routine approach described in the *Washington State Wetlands Identification and Delineation Manual* (Washington State Department of Ecology [Ecology] 1997).

For jurisdictional purposes, wetlands are defined as:

Those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

The presence of the three essential wetland characteristics (i.e., wetland vegetation, soils, and hydrology) is required for an area to be considered a wetland. NWECC evaluated the site for these characteristics, and investigated conditions at test plots where any of these characteristics were present. NWECC recorded the resulting observations on data forms regarding wetland vegetation, soils, and hydrology, and these forms were used to determine whether the sites of these test plots were a jurisdictional wetland.

The City of Mukilteo rates and regulates wetlands based on municipal code in Chapter 17.52B.

Priority Wildlife Habitat

During the site visit, NWECC biologists observed the habitat conditions for wildlife both in the wetland and in the surrounding buffer area. In particular, they looked for habitat that could support federally listed, state-listed, or PHS-listed species of wildlife.

During the site visit, NVEC biologists confirmed that no wetlands are present downstream of the 61st Place West culvert. Details of the wetland investigation, as well as stream and wildlife habitat investigations, are described below.

3.1 Stream Rating and Regulations

Smuggler's Gulch Creek is not a shoreline of the state, and is considered a Type 4 stream by the City of Mukilteo (Type 4 = waters that are perennial nonfish habitat streams). Washington Department of Natural Resources maps the stream below the 61st Place West culvert as perennial fish-bearing (perennial Type F), with a transition to non-fish bearing above the culvert (Otak 2010).

The City requires a 75-foot critical areas buffer along Type 4 streams with a high potential for erosion.

3.2 Wetland Investigation

Document Review

The USDA Soil Survey for Snohomish County maps all soils around the culvert site and the stream as Alderwood-Everett gravelly sandy loams, 25 to 70 percent slopes. The Alderwood series is made up of moderately well drained soils, which are considered upland soils. Figure 16 shows a map of soils found in the project vicinity.

The USFWS National Wetland Inventory (NWI) mapping for the area does not indicate any wetlands between the 61st Place West culvert and Puget Sound (Figure 17). The NWI maps the shoreline at the stream's outlet into Puget Sound as an estuarine/marine wetland. The nearest wetland mapped upstream of the culvert is approximately ½ mile to the east (a freshwater forested/shrub wetland).

Field Investigation

No wetlands are present within 100 feet upstream of the 61st Place West culvert, or between the culvert and the 88th Street SW crossing downstream.

NWEC biologists established one test-plot (TP-1) at the small streamside bench downstream of the 61st Place West culvert and just upstream of the 88th Street SW culvert (Photo 7 in Appendix B). NWEC excavated a test-pit in the center of this bench.

TP-1 was not a wetland. The plot did not qualify as containing wetland vegetation. Reed canarygrass (*Phalaris arundinacea*), a facultative wetland species, was present but the majority of plants present were facultative upland species growing throughout the plot, including sword fern, trailing blackberry (*Rubus ursinus*), and bleeding-heart (*Dicentra formosa*). TP-1 did contain hydric soils starting at 10 inches deep, but TP-1 did not display wetland hydrology. The bench contains a remnant channel/swale from past overflow water from the stream, but the bench is several feet above the OHWM, the test pit showed no water at 18 inches deep, and the bench contains numerous animal burrows (likely mountain beaver) that would not occur in regularly inundated areas. The wetland assessment form is included in Appendix C.

3.3 Wildlife Habitat Assessment

Document Review

The WDFW's publically available database for PHS species (WDFW 2015a) does not list any documented occurrences of PHS species at the site or between the site and Puget Sound. The database does list four bald eagle breeding areas about 2 miles north and 2 miles south of the project area. Bald eagles are state sensitive.

WDFW's SalmonScape mapping database (WDFW 2015b) does not indicate any documented presence of salmon in Smuggler's Gulch Creek. The database does indicate modeled presence of coho salmon (Federal Species of Concern) in the creek downstream of the 61st Place West culvert. WDFW maps the general area (lands adjacent to Puget Sound) as accessible to coho salmon, pink salmon, chum salmon, and the Puget Sound Distinct Population Segment (DPS) of steelhead (Federally Threatened).

During technical reviews of the site's habitat in 2010, Otak and Cherry Creek Environmental identified the 61st Place West culvert as a fish barrier, and both companies identified additional fish barriers (formed by steeper gradients) about 375 feet upstream of the culvert. Otak noted that the upstream 375 feet could be suitable for overwintering use by salmonids, but the seasonal nature of the stream and lack of pool habitat for high-flow refugia would preclude summertime/rearing use.

Field Investigation

The project site contains second-growth forest with a fairly open understory. This habitat forms a corridor of vegetation connected to similar habitat up- and downstream of the project site. The riparian community along the stream consists of a red alder canopy with scattered young western red cedar. Shrubs include salmonberry, a few red elderberry (*Sambucus racemosa*), and twinberry honeysuckle. The herb layer along the stream includes sword fern, large-leaf avens (*Geum macrophyllum*), English ivy (*Hedera helix*), and buttercup (*Ranunculus repens*), with scattered occurrences of trailing blackberry, Himalayan blackberry (*Rubus armeniacus*), and some honeysuckle vines (*Lonicera* sp., along the road prism and riprap area of 88th Street SW, possibly planted for slope stabilization).

The stream itself contains riffles and pools, with some large woody debris present (see Appendix D for previous habitat surveys of stream conditions). Logs, snags (including a large cottonwood snag) and other woody debris are present along the stream; some of these features are large enough to be considered priority features by WDFW. The project site also includes two PHS habitats: riparian habitat and instream habitat.

The second-growth mixed forest may support foraging and nesting songbirds (several species were observed during the March 10 site visit), as well as foraging woodpeckers, including the PHS species pileated woodpecker (*Dryocopus pileatus*) and band-tailed pigeon (*Patagioenas fasciata*). The riparian habitat could support the PHS species western toad (*Bufo boreas*), though this toad is not normally observed to occur in urban/suburban areas. Deer may also use the site.

There are no prominent trees for roosting or waterways for foraging directly adjacent to the project site that would attract bald eagles. If eagles are present, they are likely to be roosting or perching in trees adjacent to the Puget Sound shoreline.

Construction of the new culvert, as well as removal of the old culvert, will take place directly in Smuggler's Gulch Creek and its 75-foot critical areas buffer (see Figures 3 through 9). The culvert alignment and stream alignment will be slightly altered and the grade of the creek will be evened out downstream of the culvert outfall. The construction activities will take place when the stream is dry to avoid impacts to the stream's waters. The road will be restored and will not encroach further into the critical areas buffer than the existing condition.

Impacts to the creek and buffer areas will include clearing and grading in critical areas buffer, and disturbance during the regrading of the creek up and downstream of 61st Place West.

Work in dry – The project will be phased and a gravity diversion used so that all work will be completed in the dry.

Clearing and grading – The project plans estimate that the project will impact approximately 4,854 square feet of critical areas buffer (see Figure 3). After construction, these disturbed areas will be revegetated by hydro-seeding or planted with native trees and shrubs to restore cover (See Figures 10 through 15 for the planting plan, details and schedule).

Stream channel regrading activities – About 222 linear feet of stream channel (104 feet upstream and 118 feet downstream) will be regraded to create stable stream gradients and tie into existing stream contours. Small and large streambed materials (gravel) will be added to create a roughened stream channel. The stream will also be straightened along this corridor, and the upstream portion will be moved slightly south, to protect the bank to the north that is currently an erosion concern. Best management practices will be used to minimize erosion during these activities.

6.1 Avoidance and Minimization

Impacts to critical areas are required to follow mitigation sequencing. Mitigation sequencing requires the following steps be taken:

- Avoiding the impact altogether by not taking a certain action or parts of actions;
- Minimizing impacts by limiting the degree or magnitude of the action and its implementation by using appropriate technology or by taking affirmative steps to avoid or reduce impacts;
- Rectifying the impact by repairing, rehabilitating, or restoring the affected environment
- Reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action;
- Compensating for the impact by replacing or providing substitute resources or environments; and/or
- Monitoring the impact and the compensation projects and taking appropriate corrective measures.

In order to complete the project, impacts to the stream and buffer are unavoidable. The stream channel must be regraded to match the existing upstream and downstream channel contours, the roadway must be excavated and rebuilt, and the roadway must be raised two feet, which will cause impacts to the critical areas buffer during construction. These impacts are unavoidable.

Project impacts will be minimized by performing work during the dry season when the stream will not be flowing. A stream diversion will be used so that all work will occur in the dry. The footprint of disturbance to the critical area will be minimized during construction, and critical area buffer will be restored with plantings and stream channel roughening to a condition that improves upon the current condition.

6.2 Mitigation Approach

The project is designed to be as positive an action for fish and wildlife habitat as feasible, and to protect nearby properties and the 61st Place West and 88th Street SW roadways. The existing stream channel is undercutting a steep bank upstream of the existing culvert, head-cutting the channel bottom at the culvert outfall, and causing erosion along the westerly shoulder of the roadway, which has begun to slough into the stream. These areas of erosion are also causing excess sediment delivery to the stream channel downslope of the culvert. The new culvert and rebuilt stream channel will reduce or eliminate these erosion issues. The upstream section will be farther from the northern slope; overflow during storm events will be minimized by the larger box culvert; and the headcutting issue and roadside erosion will be eliminated by the new stream grading and placement of heavy streambed material in the stream, and boulders at the culvert ends.

Turbidity and sediment delivery to the stream is not an issue during construction, as construction will occur during the dry season. Best management practices such as temporary erosion fences and tarps over loose materials will minimize the movement of soil during any summer rainstorms during construction. After construction, any woody debris that was moved during regrading of the stream will be placed back below the ordinary high water mark (OHWM) of the stream. Potential erosion in new areas of topsoil will be reduced or eliminated by erosion control blankets, and replanting with native trees, shrubs, and grasses (see Figures 10 through 15, Planting Plan). The plantings, stream reconstruction, and culvert are designed to reduce sediment delivery to the stream and subsequently to Puget Sound downstream.

The culvert will remain a barrier to fish passage, but will improve water quality, stream erosion, and stream structures downstream, where anadromous fish could occur. The site's steep grade and existing sewer line running through the roadway are constraints that prevent construction of a new culvert at a fish-passable gradient. As only about 400 feet of suitable anadromous fish habitat exists upstream of the culvert (Otak 2010), WDFW has concurred that the fish barrier will remain, and that the project should focus on improving downstream fish habitat conditions (WDFW 2015c). The reach approximately 120 feet downstream of the culvert will be restored as a roughened channel, which will benefit fish by reducing the chances of ongoing erosion and creating some instream structure that will create varied discharge velocities.

Restoring the buffer to existing conditions, and enhancing areas with native trees and shrubs will mitigate impacts to the critical areas buffer. Areas that are currently maintained as roadway right-of-way or landscaped will be restored to their existing conditions by hydroseeding and replacing existing trees and shrubs in kind. In total, approximately 4,850 square feet will be replanted (Figure 10).

6.3 Proposed Mitigation

To offset temporary impacts to stream buffers, 4,850 of buffer, all disturbed areas, will be restored by covering with compost and erosion control fabric, and then planted with native trees and shrubs. Table 1 shows the proposed species to be planted in the buffer. The planting plan in Figures 10 through 15 (Appendix A) provides more detail on the planting installations and locations of these plantings.

Table 1. Tree and Shrub Species in Planting Plan

Common Name	Scientific Name	Amount planted
Trees		
Red alder	<i>Alnus rubra</i>	3
Douglas-fir	<i>Pseudotsuga menziesii</i>	2
Western red cedar	<i>Thuja plicata</i>	2
Pacific willow	<i>Salix lucida</i>	67
Scouler's willow	<i>Salix scouleriana</i>	67
Shrubs		
Black twinberry	<i>Lonicera involucrate</i>	67
Salmonberry	<i>Rubus spectabilis</i>	4

Red osier dogwood	<i>Cornus sericea</i>	68
Snowberry	<i>Symphoricarpos albus</i>	4
Indian plum	<i>Oemleria cerasiformis</i>	6
Vine maple	<i>Acer circinatum</i>	4
Sword fern	<i>Polystichum munitum</i>	4
Hydroseeded Grasses		
Tall fescue	<i>Festuca arundinacea</i>	60 pounds per acre total hydroseeding
Creeping bentgrass	<i>Agrostis palustris</i>	
Meadow foxtail	<i>Alepocurus pratensis</i>	
Alsike clover	<i>Trifolium hybridum</i>	
Redtop bentgrass	<i>Agrostis alba</i>	

6.4 Mitigation Goals

Mitigation goals include the following:

- Restore 4,850 square feet of stream buffer.
- Stabilize approximately 200 feet of stream channel.
- Control Himalayan blackberry and other invasive plant species in the enhancement area.

6.5 Performance Standards

The following performance standards will be met to ensure the enhancement measures are performing to enhance the critical areas buffer functions.

- Riparian buffer plantings shall maintain a 100% survival for the first year and achieve 80% survival in years two and three.
- The stream channel structure will not significantly degrade or cause erosion for the three-year monitoring period.
- Invasive plant species will be limited to 10% coverage in the restored and enhanced areas for a period of three years.

6.6 Schedule and Maintenance

Plantings shall be containerized plants or bare root. Watering of the installed plants may be required if drought conditions occur during the summer months. Invasive plants will be removed throughout the year as they occur.

7 PROPOSED MONITORING, REPORTING AND CONTINGENCY

7.1 Plant Survival

To ensure that the performance standards are met, plantings will be counted in August or September for survival for the first year. The site will be monitored for three years from the time of completion of site construction by a qualified individual(s) who is experienced or trained in wetland vegetation and monitoring techniques.

Valid monitoring data are critical to making meaningful management decisions that help the mitigation site meet its objectives. Monitoring plans are based on mitigation site conditions and plant community development. These factors together with the mitigation objectives are to be incorporated into a site-specific monitoring plan that will be developed at the beginning of each monitoring season. Photo documentation of the stream channel will be included during annual plant monitoring activities.

The monitoring team will be responsible for taking a representative sample of the site and determining an appropriate sample size.

7.2 Monitoring Reports

Monitoring reports will be completed and submitted to the City by December 31 for each of the monitoring years.

- Site plan and location
- General background information
- Goals of the mitigation plan
- Performance standards
- Monitoring methodology
- Photographic documentation
- Results of the monitoring to date
- Contingency actions, if needed

7.3 Contingency Actions

All dead plantings will be replaced so that 100% survival is reached for the first year. A sub-sample can be completed to assure that the 100% survival is reached. In years 2 and 3 all plantings will maintain an 80% survival rate for three years.

If erosion of the stream channel or banks is occurring, the City will be notified so that proper actions can occur to remedy the situation.

Himalayan blackberry and other invasive species identified will also be manually removed from the property if they occur during the three-year period.

8 DOCUMENT PREPARERS

Brad Thiele	Biologist	18 years of experience	Northwest Environmental Consulting LLC. (NVEC)
Emily Drew	Ecologist	16 years of experience	NVEC

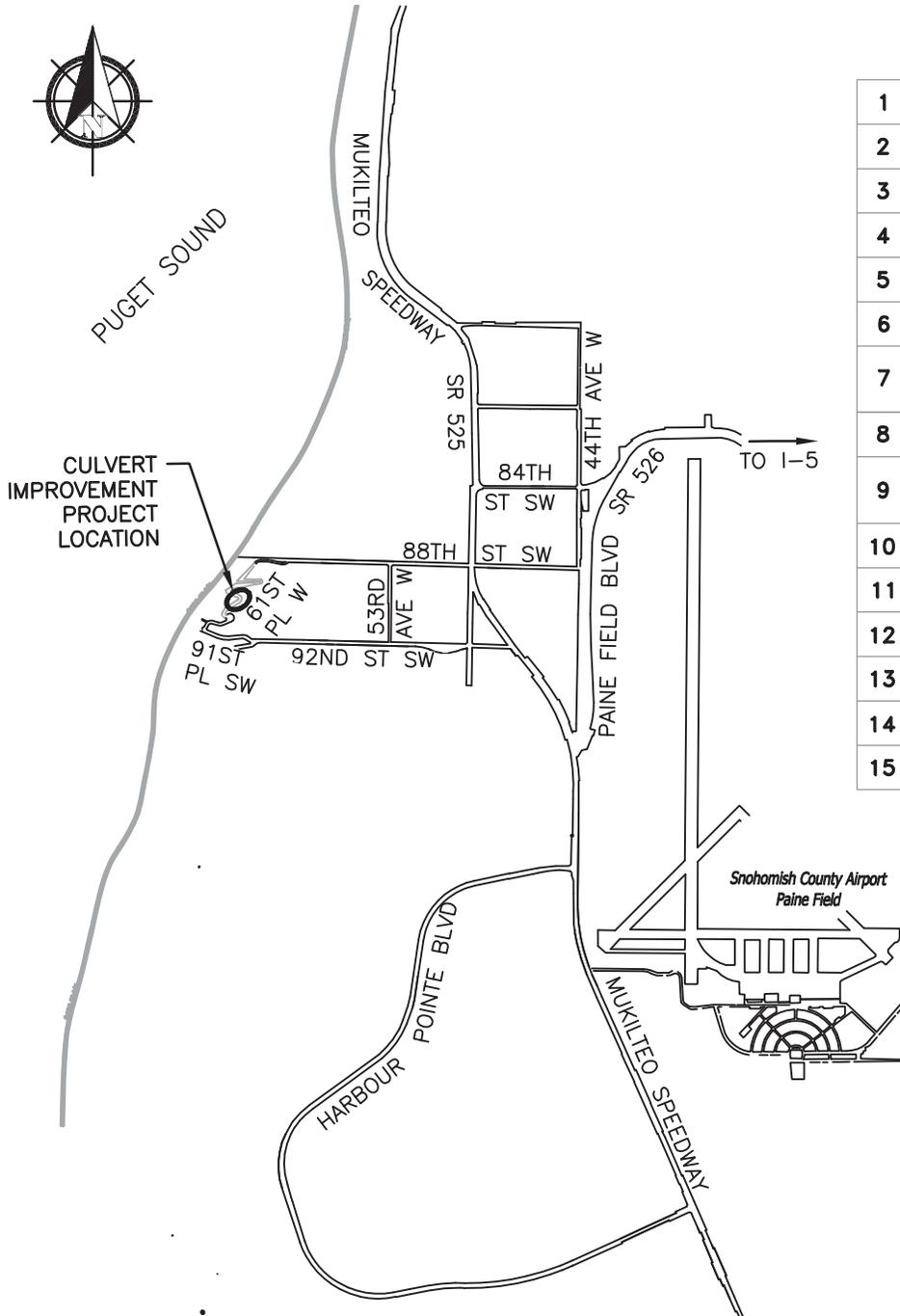
Northwest Environmental Consulting, LLC followed standard acceptable field methods and protocols at the time work was performed. These standards include delineation of wetland and stream boundaries, characterization, rating, functional analyses, impact assessments and mitigation of impacts. The conclusions and findings in this report are based on field observations and measurements and represent our best professional judgment and to some extent rely on other professional service firms and available site information. Within the limitations of project scope, budget, and seasonal variations, we believe the information provided herein is accurate and true to the best of our knowledge. Northwest Environmental Consulting does not warrant any assumptions or conclusions not expressly made in this report, or based on information or analyses other than what is included herein.

9 REFERENCES

- Cherry Creek Environmental. 2010. Smuggler's Gulch Habitat Assessment. Technical Memorandum prepared for the City of Mukilteo. August 18.
- City of Mukilteo Municipal Code, Chapter 17. Accessed at <http://codepublishing.com/wa/mukilteo/>
- Environmental Laboratory. 1987. Corps of Engineers Wetland Delineation Manual (1987 Manual). Technical Report Y-87-1, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi.
- Otak. 2010. Stream Habitat Survey in Smuggler's Gulch Technical Memorandum prepared for Washington Department of Fish and Wildlife. February 5.
- U.S. Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region (Version 2.0). Report ERDC/EL TR-10-03. May.
- U.S. Department of Agriculture (USDA) Soil Conservation Service (SCS). 2015. Soil Survey, Snohomish County Area Washington. Database. Accessed March 2015 at <http://websoilsurvey.sc.egov.usda.gov>
- U.S. Fish and Wildlife Service. 2015. National Wetlands Inventory (NWI). Wetlands mapper database. Accessed in April 2015 at <http://www.fws.gov/wetlands/Data/Mapper.html>
- Washington Department of Ecology (Ecology). 1997. Washington State Wetlands Identification and Delineation Manual. Ecology Publication 96-94.
- _____. 2014. Washington State Wetland Rating System, 2014 Update. Effective January 2015. Ecology Publication 14-06-029.
- Washington Department of Fish and Wildlife (WDFW). 2008. Priority Habitats and Species List. Olympia, WA. 177 pages.
- _____. 2015a. Priority Habitats and Species (PHS) database. Accessed September 2015 at <http://apps.wdfw.wa.gov/phsontheweb/>
- _____. 2015b. Washington SalmonScape mapping database. Accessed September 2015 at <http://apps.wdfw.wa.gov/salmonscape/>
- _____. 2015c. Personal communication (e-mail) on June 15, 2015 between Jaime Bails, WDFW and Brad Thiele, Northwest Environmental Consulting regarding fish-passage design and project approval.

Appendix A:
Figures

SEC. 17, TWP. 28N, RNG. 4E., W.M.



VICINITY MAP

FIGURES

1	PROJECT LOCATION
2	EXISTING CONDITIONS
3	PROPOSED CONDITIONS
4	EXISTING PROFILE
5	DESIGN PROFILE
6	DOWNSTREAM CROSS SECTION
7	DOWNSTREAM CULVERT END CROSS SECTION
8	UPSTREAM CROSS SECTION
9	UPSTREAM CULVERT END CROSS SECTION
10	PLANTING PLAN
11	PLANTING QUANTITIES
12	SEEDING MIX
13	TREE PLANTING DETAIL
14	PLANTING DETAILS
15	PLANTING NOTES

Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location.

Figure: Project Location

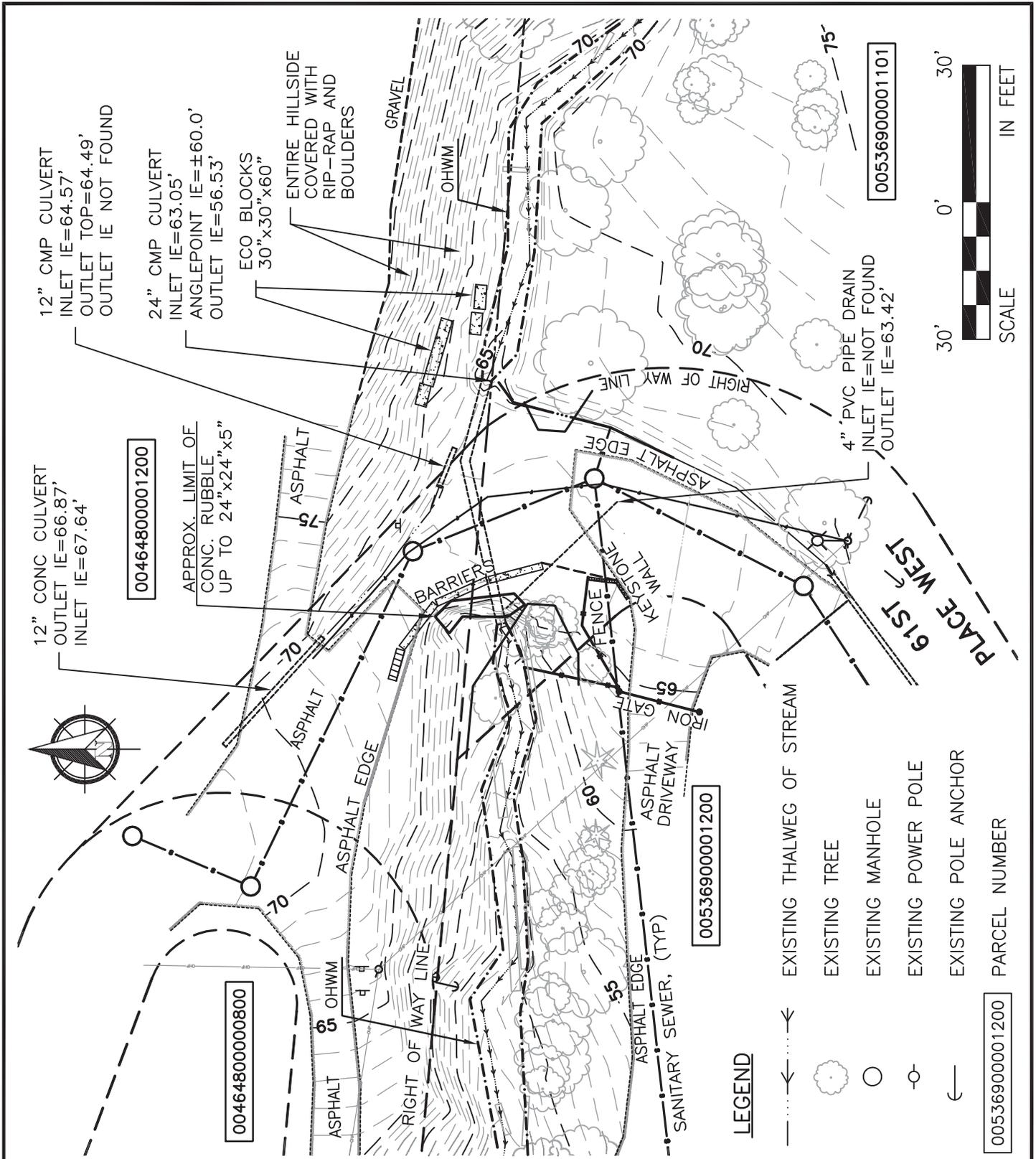
Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Permit #: _____

Scale: NTS - 1" = ± 3000'

Date: 08/31/2015 Figure 1



Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Existing Conditions

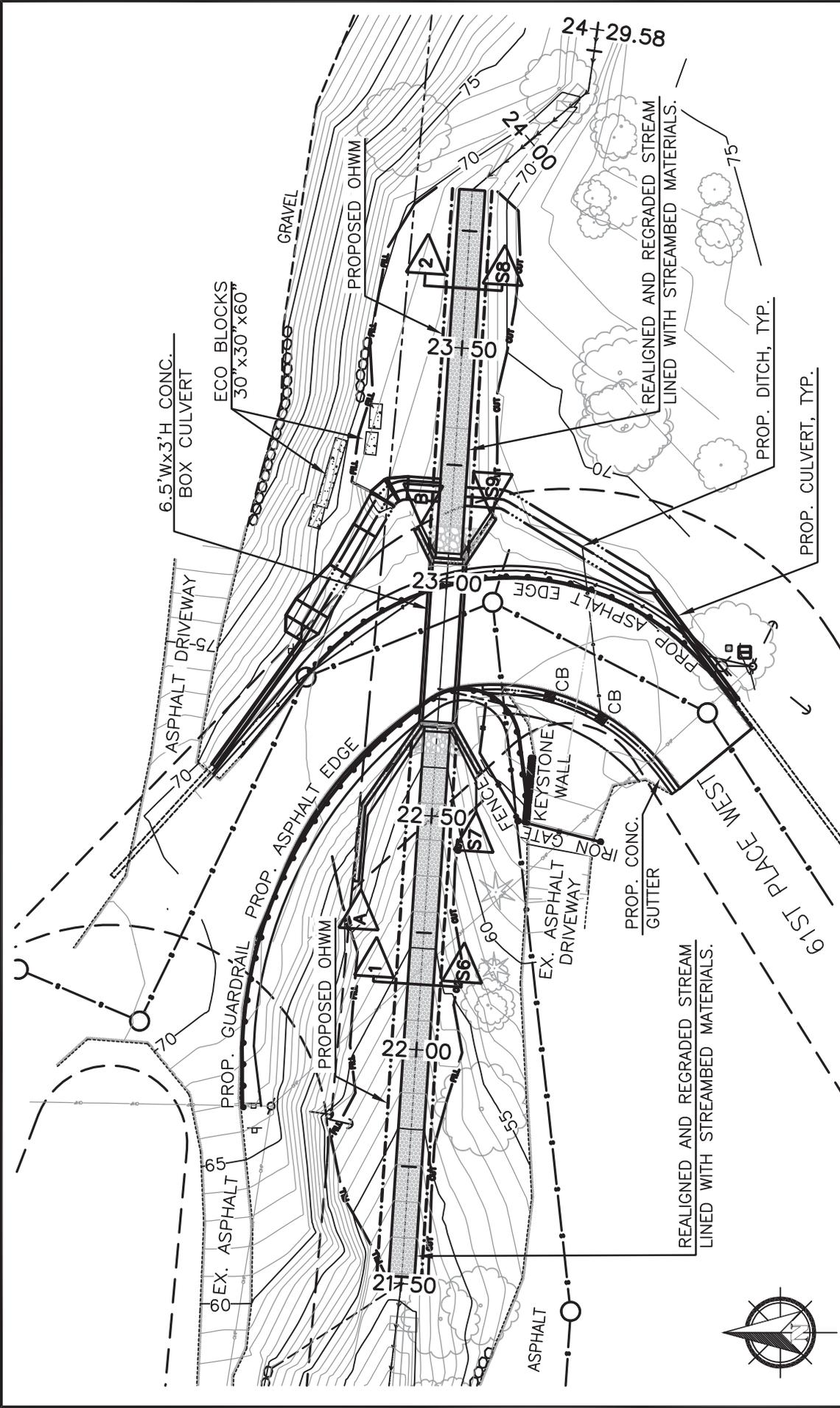
Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Permit #: _____

Scale: 1"=30'

Date: 08/31/2015 Figure 2



Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See attached

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long cox culvert

Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

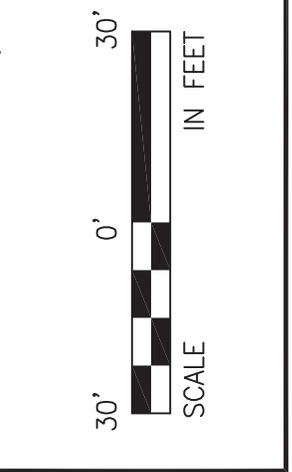
Figure: Proposed Conditions

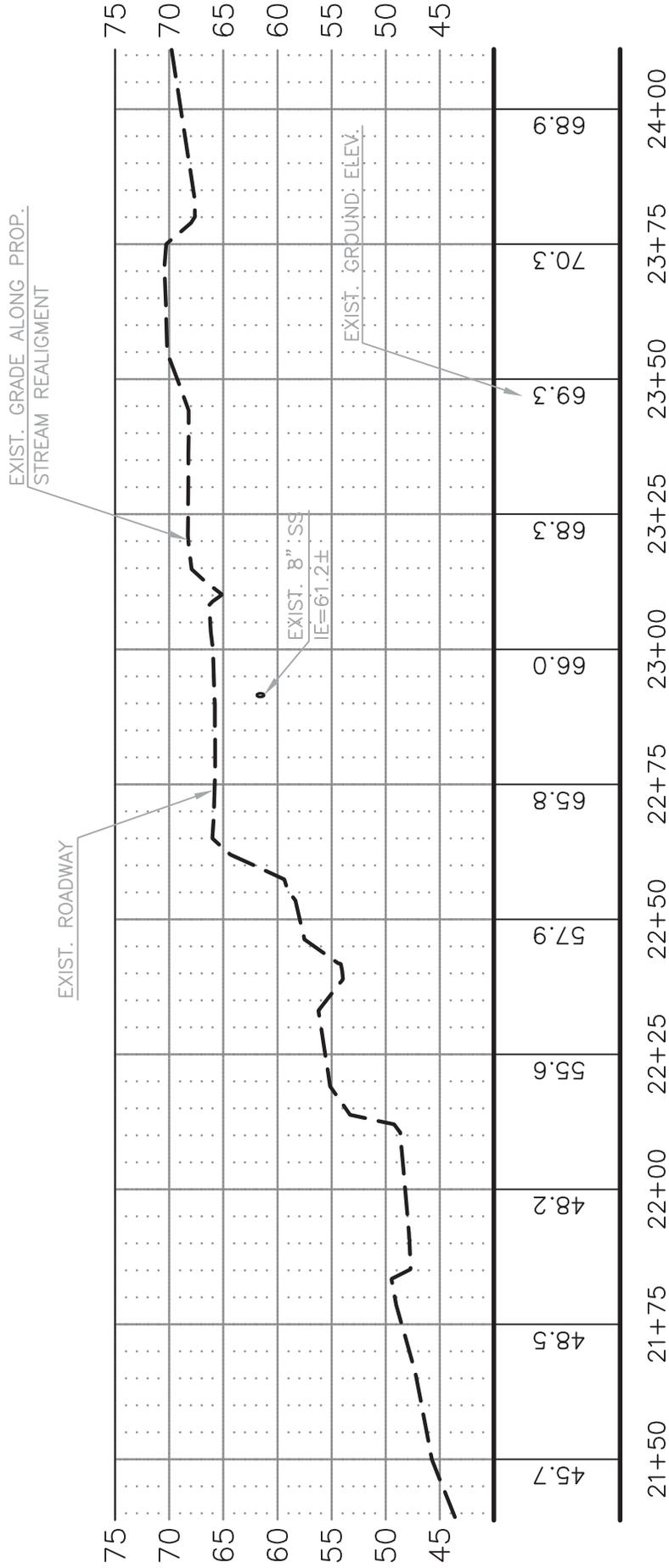
Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Scale: 1" = 30'

Date: 8/31/2015 **Figure 3**





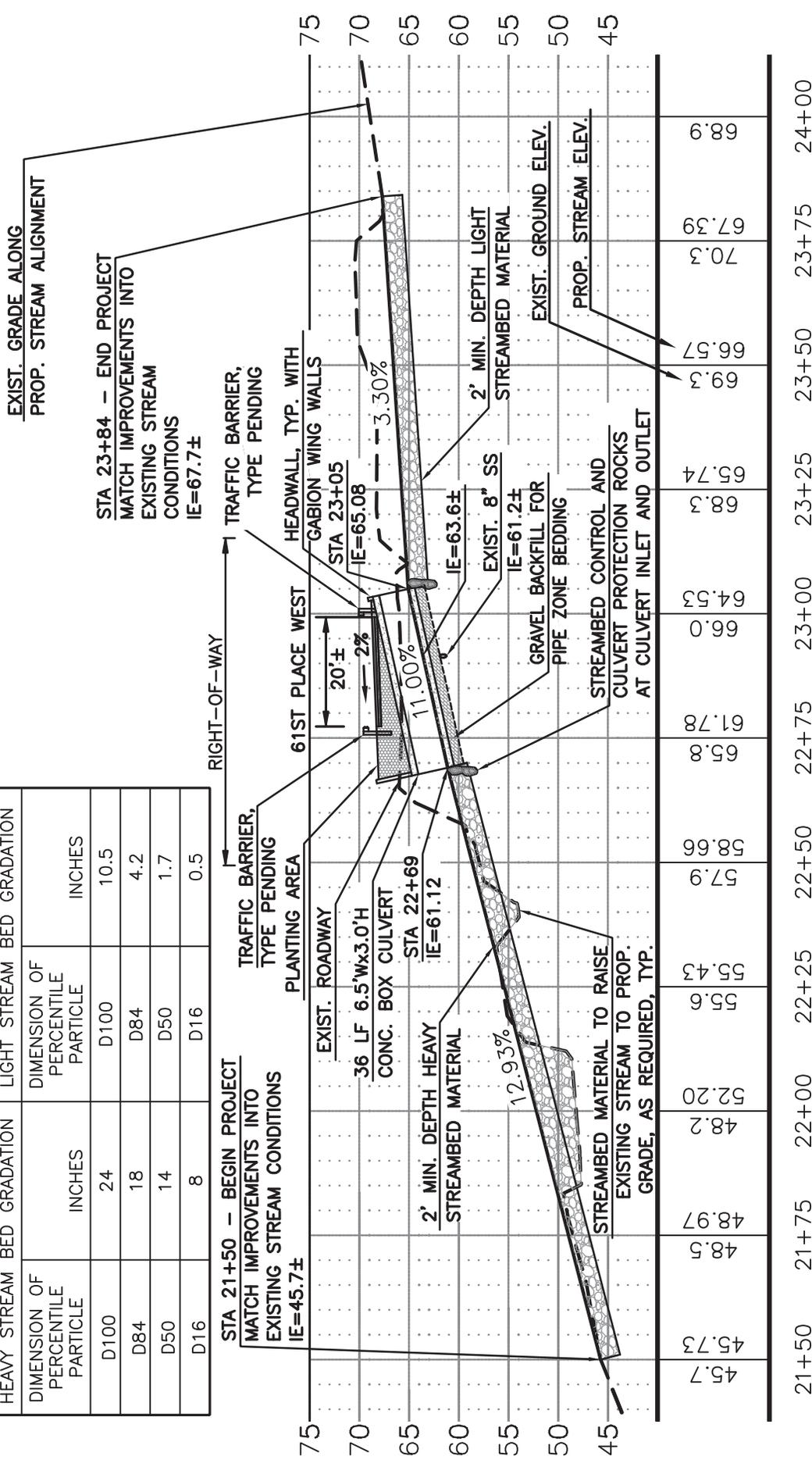
Project Title: 61st Place West Culvert Improvement Project
Purpose: To replace existing substandard culvert
Adj. Prop. Owners: See attached
City: City of Mukilteo
County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert
Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Existing Profile Along Proposed Stream Alignment
Vert. Datum: NAVD88
Location: +47.917019, -122.315146
Scale: 1"=30' HORIZ. 1"=15' VERT.
Date: 8/31/2015 **Figure 4**

STREAM GRADATION TABLE

HEAVY STREAM BED GRADATION	LIGHT STREAM BED GRADATION	DIMENSION OF PERCENTILE PARTICLE	INCHES
D100	D100		10.5
D84	D84		4.2
D50	D50		1.7
D16	D16		0.5



Station	45.7	45.73	48.5	48.97	52.20	55.6	55.42	57.9	58.66	65.88	61.78	66.0	64.52	68.3	65.74	69.3	66.57	70.3	67.39	68.8
21+50																				
21+75																				
22+00																				
22+25																				
22+50																				
22+75																				
23+00																				
23+25																				
23+50																				
23+75																				
24+00																				

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

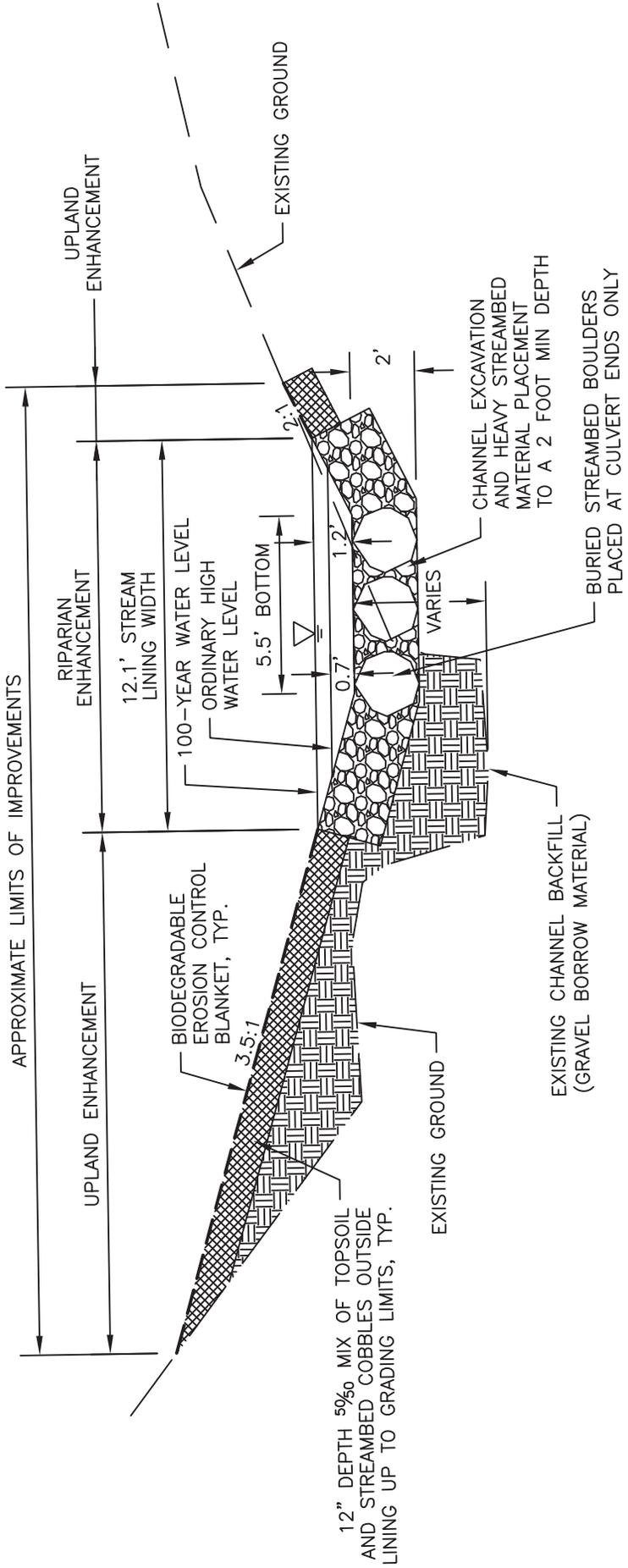
Figure: Design Stream Profile

Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Scale: 1"=30' HORIZ. 1"=15' VERT.

Date: 8/31/2015 Figure 5



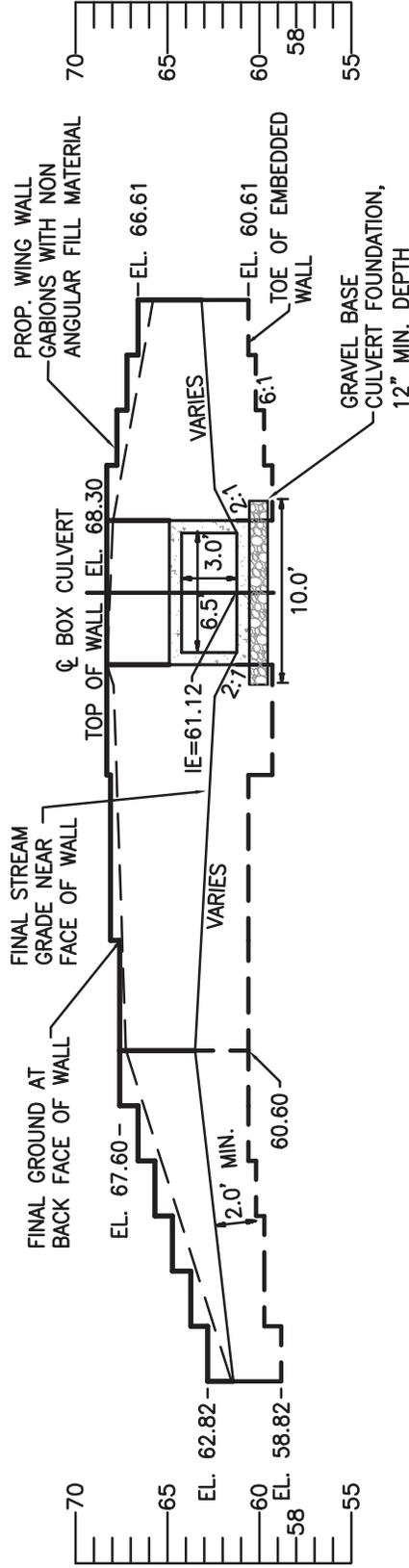
1

DOWN STREAM CROSS SECTION DETAIL
DOWNSTREAM OF PROPOSED BOX CULVERT
LOOKING UPSTREAM TO THE EAST
STA 21+50 TO STA 22+70

Project Title: 61st Place West Culvert Improvement Project
Purpose: To replace existing substandard culvert
Adj. Prop. Owners: See within
City: City of Mukilteo
County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert
Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Downstream Cross Section
Vert. Datum: NAVD88
Location: +47.917019, -122.315146
Scale: NTS
Date: 8/31/2015 **Figure 6**



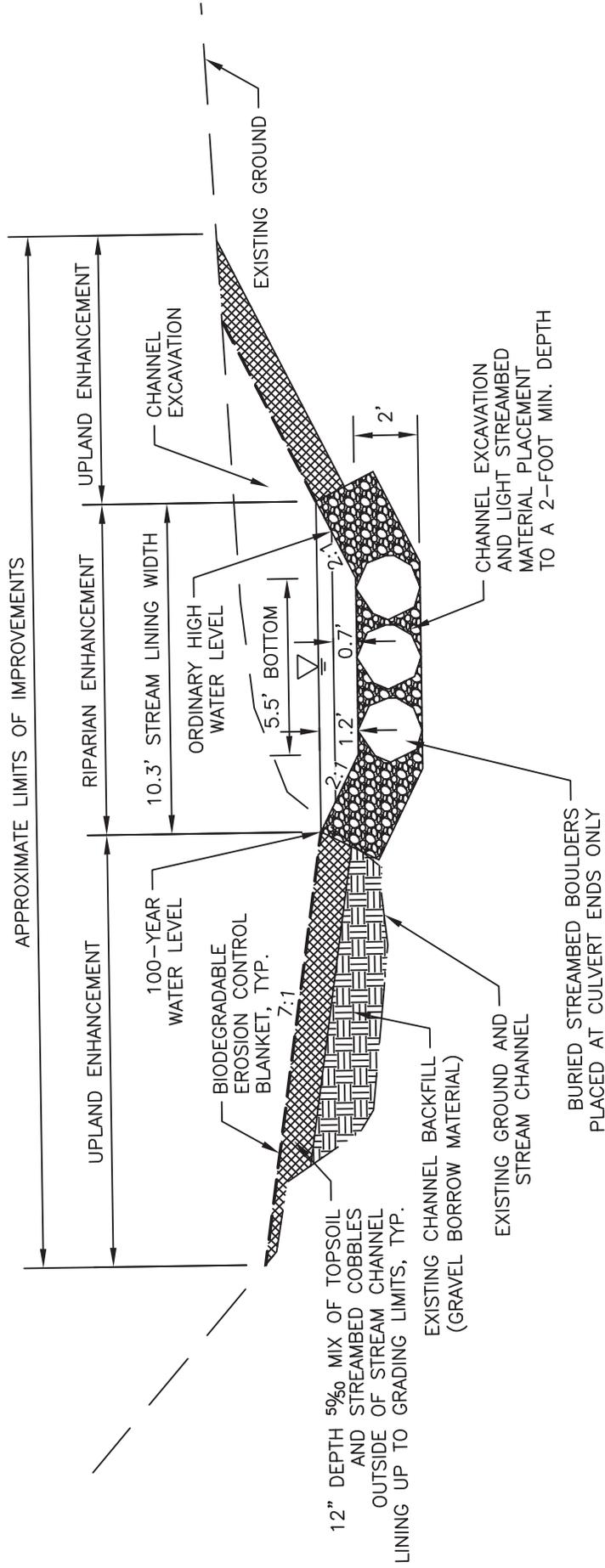
A

DOWNSTREAM CULVERT END CROSS SECTION DETAIL
 DOWNSTREAM OF PROPOSED BOX CULVERT NTS
 LOOKING UPSTREAM TO THE EAST

Project Title: 61st Place West Culvert Improvement Project
Purpose: To replace existing substandard culvert
Adj. Prop. Owners: See within
City: City of Mukilteo
County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert
Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Downstream Culvert End Cross Section
Vert. Datum: NAVD88
Location: +47.917019, -122.315146
Scale: NTS
Date: 8/31/2015 **Figure 7**



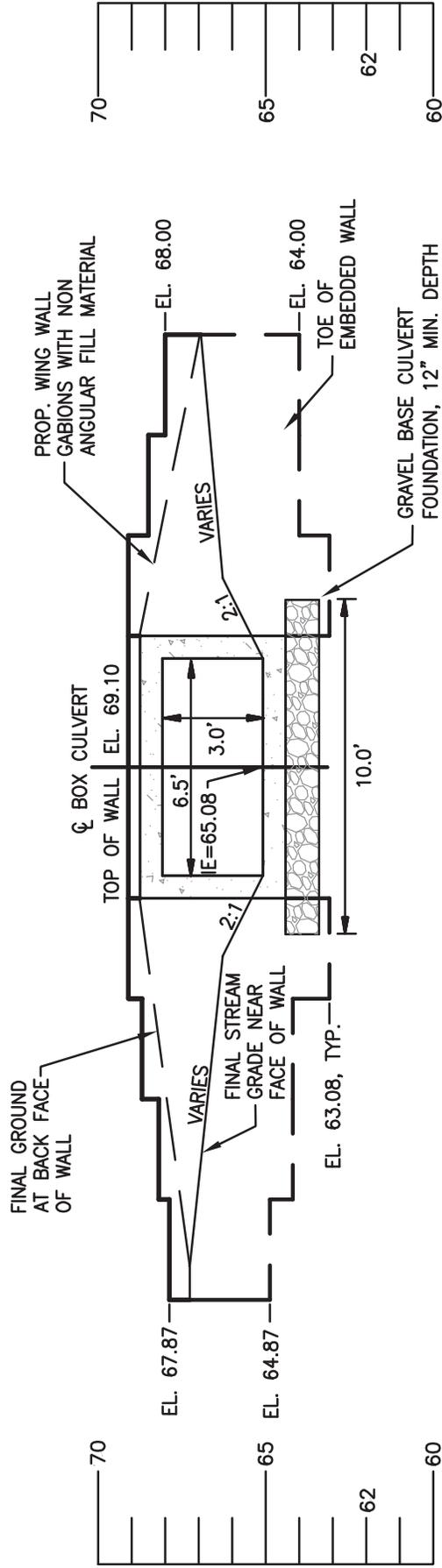
2

UPSTREAM CROSS SECTION DETAIL
UPSTREAM OF PROPOSED BOX CULVERT NTS
LOOKING UPSTREAM TO THE EAST
STA 23+06 TO STA 23+84

Project Title: 61st Place West Culvert Improvement Project
Purpose: To replace existing substandard culvert
Adj. Prop. Owners: See within
City: City of Mukilteo
County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert
Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Upstream Cross Section
Vert. Datum: NAVD88
Location: +47.917019, -122.315146
Scale: NTS
Date: 8/31/2015 **Figure 8**



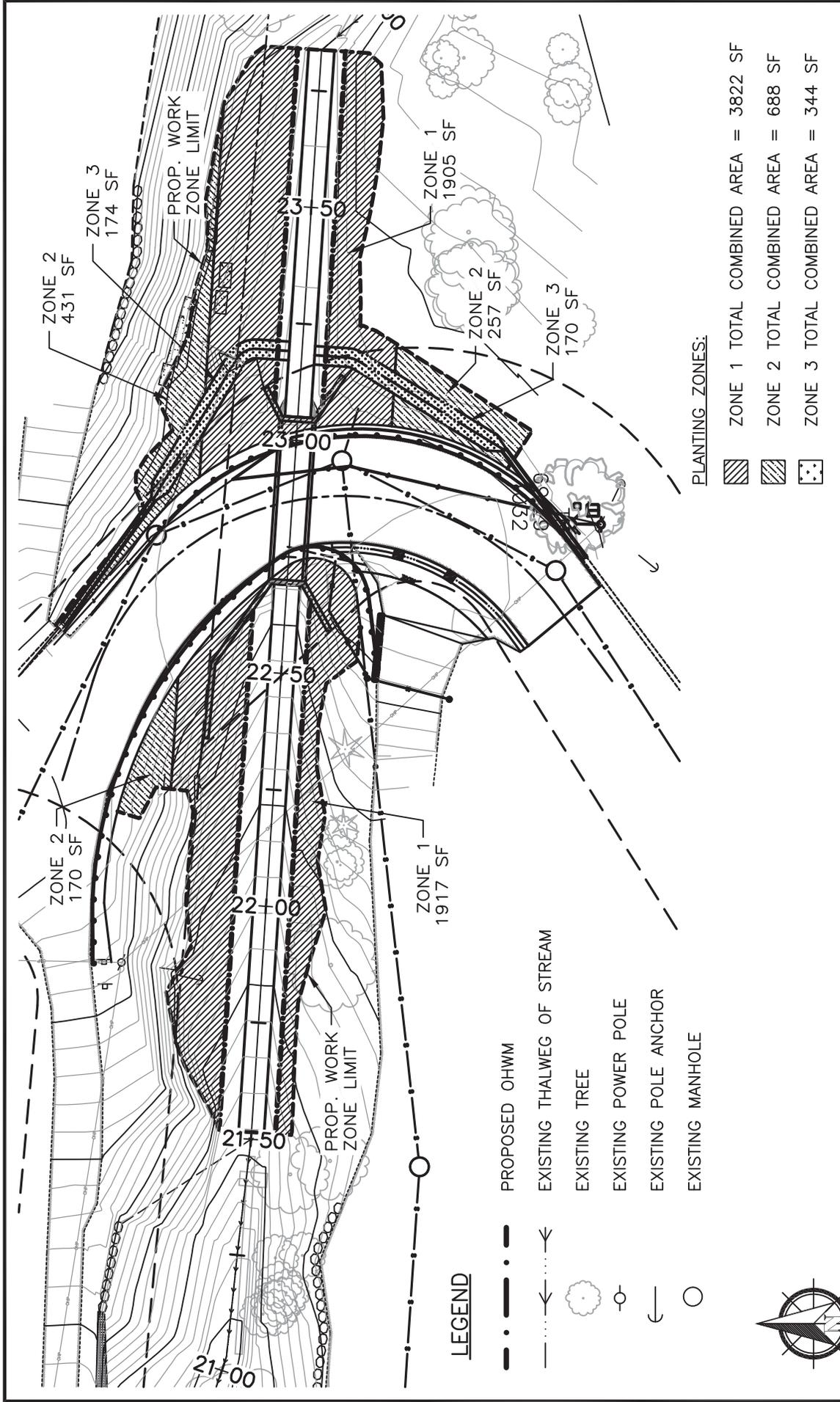
UPSTREAM CULVERT END CROSS SECTION DETAIL
 UPSTREAM OF PROPOSED BOX CULVERT NTS
 LOOKING DOWNSTREAM TO THE WEST

B

Project Title: 61st Place West Culvert Improvement Project
Purpose: To replace existing substandard culvert
Adj. Prop. Owners: See within
City: City of Mukilteo
County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert
Directions To Site: From I-5 exit 189 take SR 526 west. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Upstream Culvert End Cross Section
Vert. Datum: NAVD88
Location: +47.917019, -122.315146
Scale: NTS
Date: 8/31/2015 **Figure 9**



LEGEND

- PROPOSED OHWM
- EXISTING THALWEG OF STREAM
- ☁ EXISTING TREE
- EXISTING POWER POLE
- ← EXISTING POLE ANCHOR
- EXISTING MANHOLE

PLANTING ZONES:

- ▨ ZONE 1 TOTAL COMBINED AREA = 3822 SF
- ▨ ZONE 2 TOTAL COMBINED AREA = 688 SF
- ▨ ZONE 3 TOTAL COMBINED AREA = 344 SF

Project Title: 61st Place West Culvert Improvement Project
Purpose: To replace existing substandard culvert
Adj. Prop. Owners: See within
City: City of Mukilteo
County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert
Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Planting Plan
Vert. Datum: NAVD88
Location: +47.917019, -122.315146
Scale: 1" = 30'
Date: 8/27/2015 **Figure 10**

TREE AND SHRUB PLANTING SCHEDULE

SEE SHEET 10 OF 15 FOR AREAS

Common Name	Scientific Name	Minimum Height	Spacing on center	Zone 1 Qty	Zone 2 Qty	Total
Trees						
Red Alder	Alnus rubra	18"	4'		3	3
Douglas fir	Pseudotsuga menziesii	18"	4'		2	2
Western red cedar	Thuja plicata	18"	4'		2	2
Pacific willow	Salix lucida	36"	4'	67		67
Scouler's willow	Salix scouleriana	36"	4'	67		67
Total Trees				134	7	141
Shrubs						
Black Twinberry	Lonicera involucrata	12"	4'	67		67
Salmonberry	Rubus spectabilis	12"	4'		4	4
Redosier Dogwood	Cornus sericea	12"	4'	68		68
Snowberry	Symphoricarpos albus	12"	4'		4	4
Indian plum	Oemleria cerasiformis	12"	4'		6	6
Vine maple	Acer circinatum	12"	4'		4	4
Sword fern	Polystichum munitum	12"	3'		4	4
Total Shrubs				135	22	157
Total				269	29	298

Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Planting Quantities

Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Scale: NTS

Date: 8/27/2015 **Figure 11**

HYDROSEED MIX SCHEDULE

SEE SHEET 8 OF 13 FOR AREAS

Zone 3 - Hydroseed Mix				
Common name	Scientific Name	% weight	% purity	% germination
Tall fescue	<i>Festuca arundinacea</i>	60-70	98	90
Creeping bentgrass	<i>Agrostis palustris</i>	10-15	98	85
Meadow foxtail	<i>Alepocurus pratensis</i>	10-15	90	80
Alsike clover	<i>Trifolium hybridum</i>	1-6	98	90
Redtop bentgrass	<i>Agrostis alba</i>	1-6	92	85
Application Rate: 60 pounds per acre				

Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Seeding Mix

Vert. Datum: NAVD88

Location: +47.917019, -122.315146

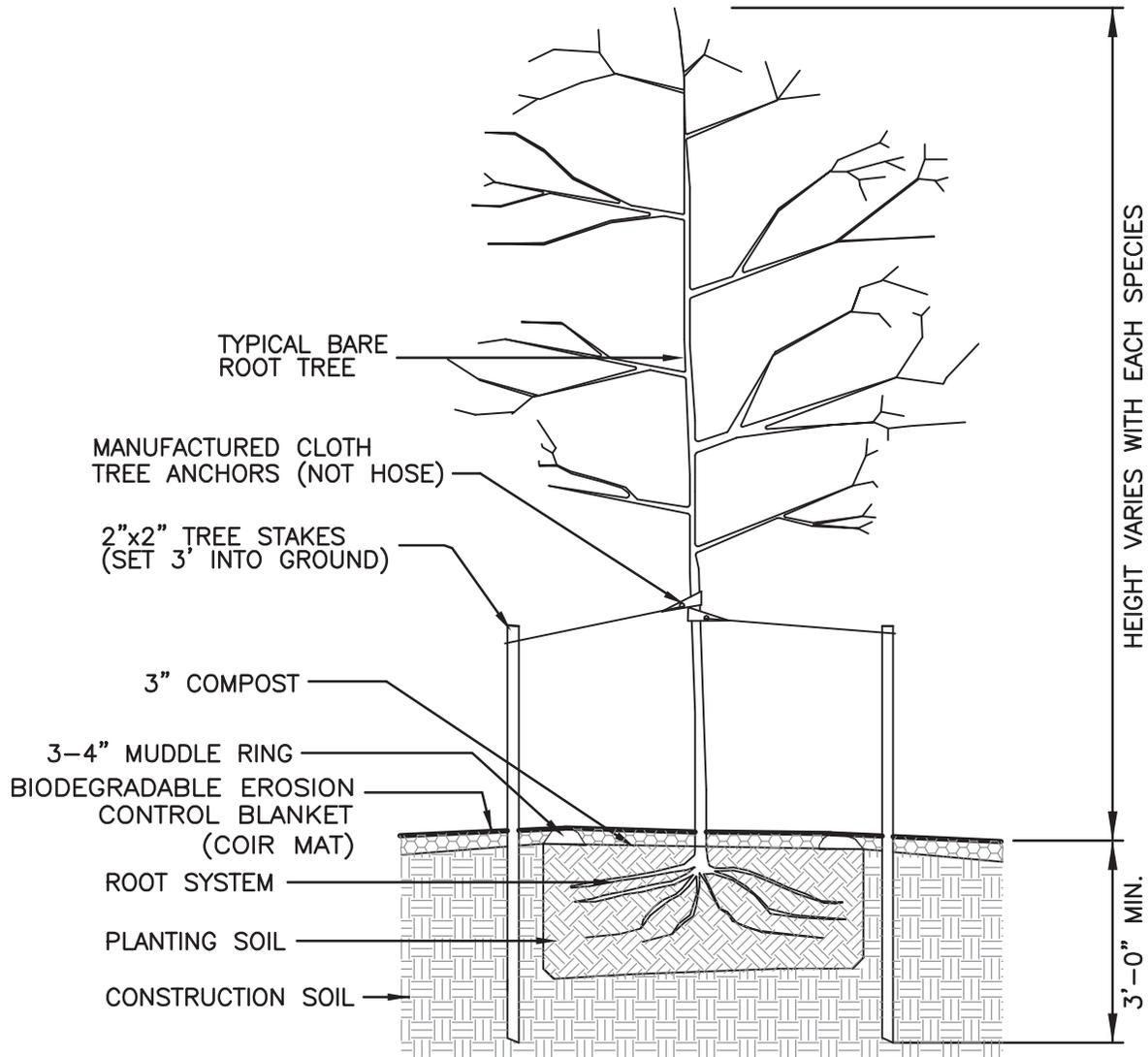
Scale: NTS

Date: 8/27/2015 **Figure 12**

Figure 14

NOTES:

1. ALL TREES OVER 1-1/4" DIAMETER ARE TO BE STAKED (2 PER TREE).
2. PLANTING PIT SHALL BE DEEP ENOUGH TO ENCOMPASS PLANTING ROOTS WITHOUT BENDING AND PLACEMENT OF FERTILIZER PACKS PER GENERAL NOTES ON SHEET 15 OF 15.



BARE ROOT DECIDUOUS TREE PLANTING DETAIL

NOT TO SCALE

Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Tree Planting Detail

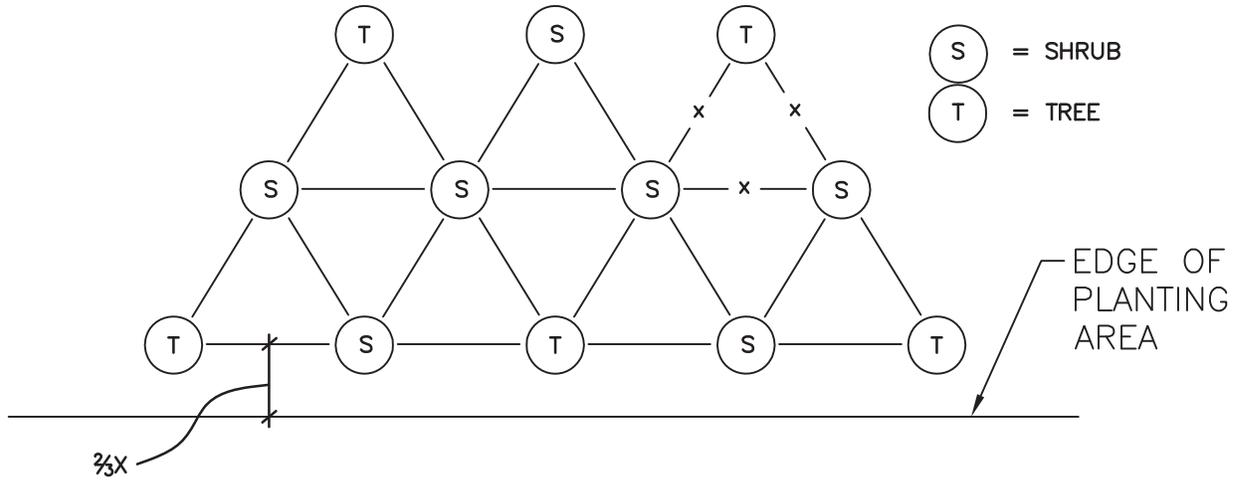
Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Permit #: _____

Scale: NTS

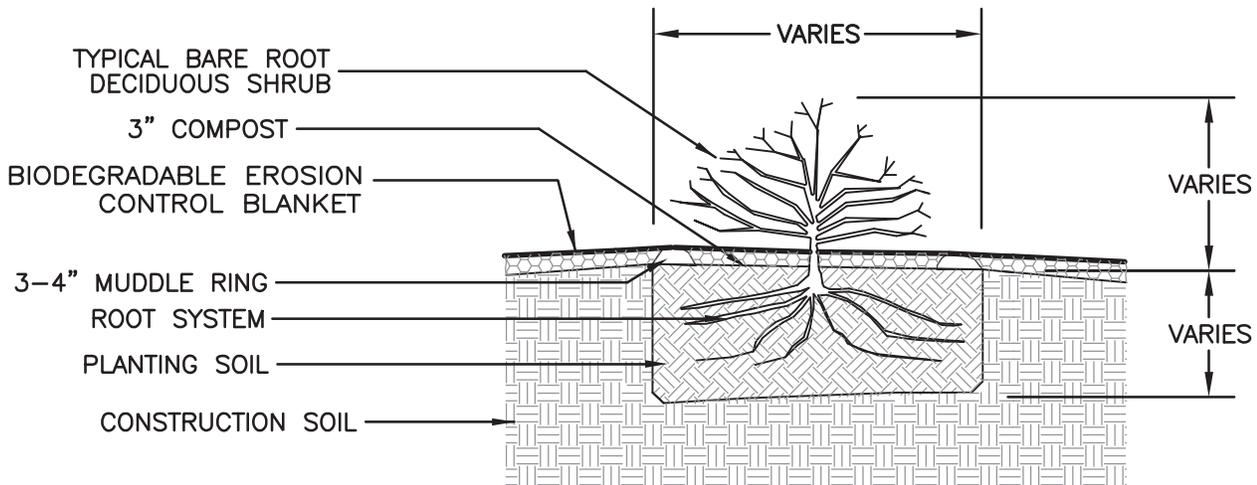
Date: 08/27/2015 **Figure 13**



NOTE:
 GROUP LIKE SHRUBS IN GROUPS OF 3, 5 OR 7.
 TREES SHOULD NOT BE PLACED NEXT TO EACH OTHER.

TYPICAL PLANT SPACING DETAIL

X = PLANT SPACING



BARE ROOT PLANTING DETAIL

NOT TO SCALE

NOTES:

1. PLANTING PIT SHALL BE DEEP ENOUGH TO ENCOMPASS PLANTING ROOTS WITHOUT BENDING AND PLACEMENT OF FERTILIZER PACKS PER GENERAL NOTES ON SHEET 15 OF 15.

Project Title: 61st Place West Culvert Improvement Project

Purpose: To replace existing substandard culvert

Adj. Prop. Owners: See within

City: City of Mukilteo

County: Snohomish

Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert

Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location

Figure: Planting Details

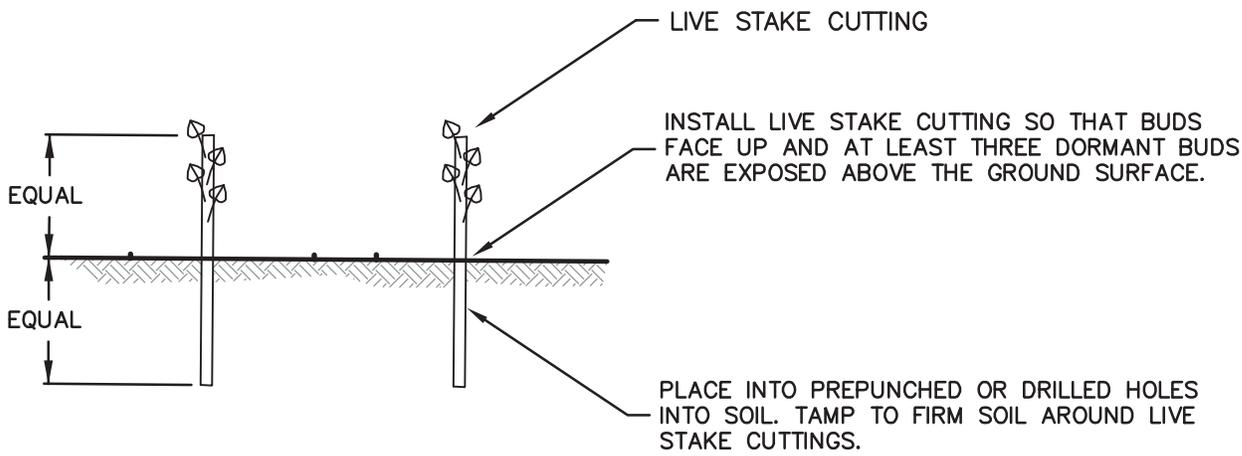
Vert. Datum: NAVD88

Location: +47.917019, -122.315146

Permit #: _____

Scale: NTS

Date: 08/27/2015 Figure 14



NOTE:
LIVE STAKE CUTTING SHALL BE A
MINIMUM 36 INCHES IN LENGTH.

LIVE STAKE INSTALLATION DETAIL
NOT TO SCALE

SITE PREPARATION NOTE

1. REMOVE ALL LITTER AND WASTE DEBRIS FROM PROPOSED PLANTING AREAS AND BELOW THE ORDINARY HIGH WATER MARK PRIOR TO INITIATION OF PLANTING WORK.

GENERAL NOTES

1. THE PLANTING AREA INCLUDES THE ENTIRE GROUND SURFACE REGARDLESS OF SURFACE COVER BETWEEN PLANTS.
2. VERIFY IN-WATER WORK RESTRICTIONS WITH THE CITY OF MUKILTEO PRIOR TO PLANTING.
3. FOR A NATURAL APPEARANCE, SPACE ALL PLANTS IRREGULARLY AT THE DESIGNATED LOCATIONS AND SPACING.
4. AFTER FINAL GRADING, FINISH AREA BY SPREADING THREE (3) INCHES OF FINE COMPOST, FOLLOWED BY BIODEGRADABLE EROSION CONTROL BLANKET (COIR MAT), AND THEN PLANT AS SPECIFIED. BIODEGRADABLE EROSION CONTROL BLANKET SHALL BE CUT AND LAID BACK TO ALLOW FOR PLANTING. BIODEGRADABLE EROSION CONTROL BLANKET SHALL BE REPLACED AROUND PLANTS FOLLOWING PLANTING.
5. INTERMIX SPECIES IN GROUPS OF THREE, FIVE, OR SEVEN.
6. PLANT MATERIAL SHALL CONFORM TO THE AMERICAN STANDARD FOR NURSERY STOCK (ANSI Z60.1-2001) FOR PLANT SIZE AND CONDITION.
7. PLANT MATERIAL SHALL BE LOCALLY GROWN (PUGET SOUND REGION) AND SHALL BE IN HEALTHY AND VIGOROUS GROWING CONDITION.
8. PLANTS LOCATED ON THE PLAN ARE SCHEMATIC AND MAY NEED ADJUSTMENT TO MEET ACTUAL FIELD CONDITIONS. WHEN A CONFLICT WITH FIELD CONDITIONS IS APPARENT, CONSULT WITH THE PROJECT BIOLOGIST.

<p>Project Title: 61st Place West Culvert Improvement Project Purpose: To replace existing substandard culvert Adj. Prop. Owners: See within City: City of Mukilteo County: Snohomish</p>	<p>Proposed Work: Replacement of existing 24" culvert with 3' high by 6.5' wide by 36' long box culvert Directions To Site: From I-5 exit 189 take SR 526 West. Turn right on 84th St. SW. Turn left on Mukilteo Speedway. Turn right on 92nd St. SW. Turn right on 91st Pl. SW and proceed to project location</p>	<p>Figure: Planting Notes Vert. Datum: NAVD88 Location: +47.917019, -122.315146 Permit #: _____ Scale: NTS Date: 08/31/2015 Figure 15</p>
--	--	---

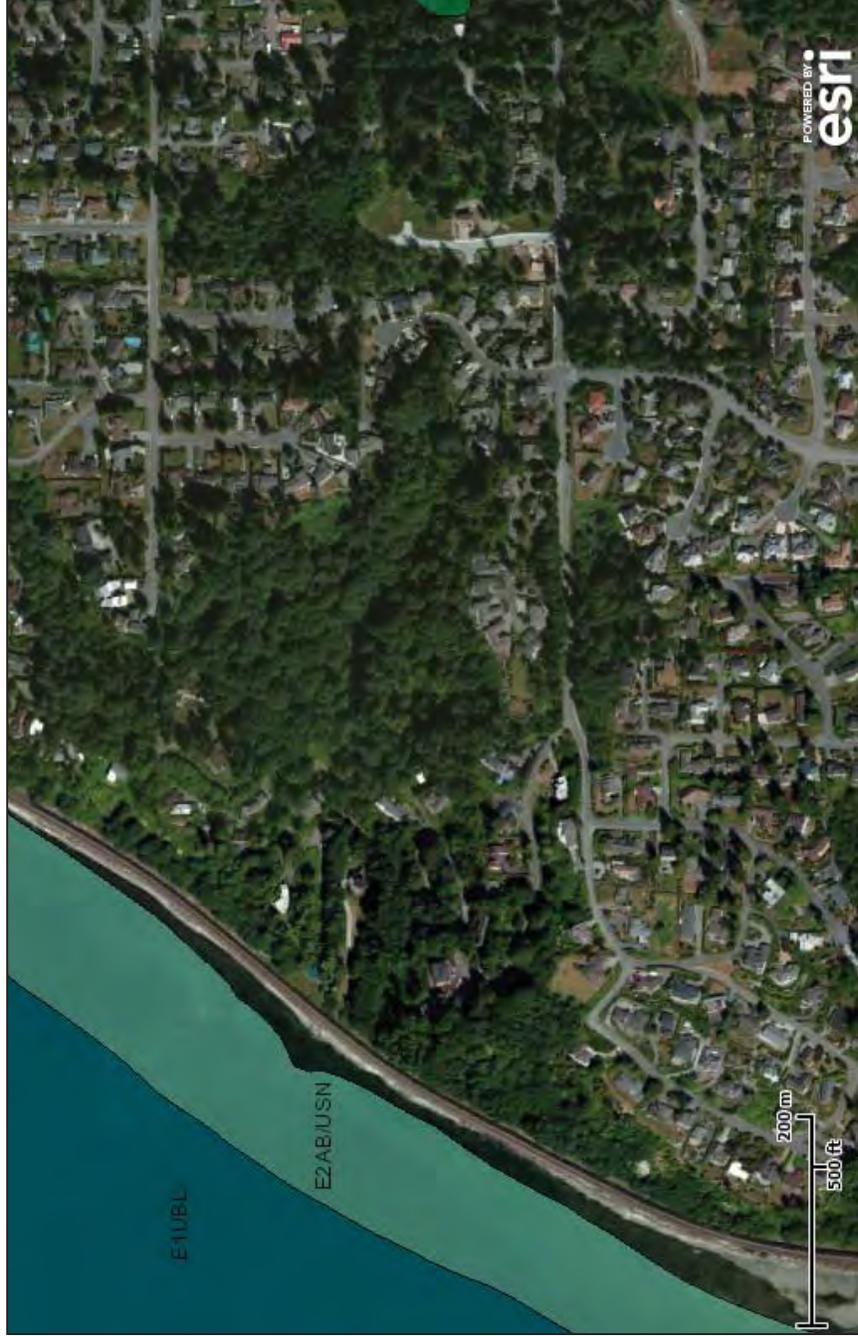


U.S. Fish and Wildlife Service

National Wetlands Inventory

61st PI W Culvert
Area

Mar 16, 2015



Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

Riparian

- Herbaceous
- Forested/Shrub

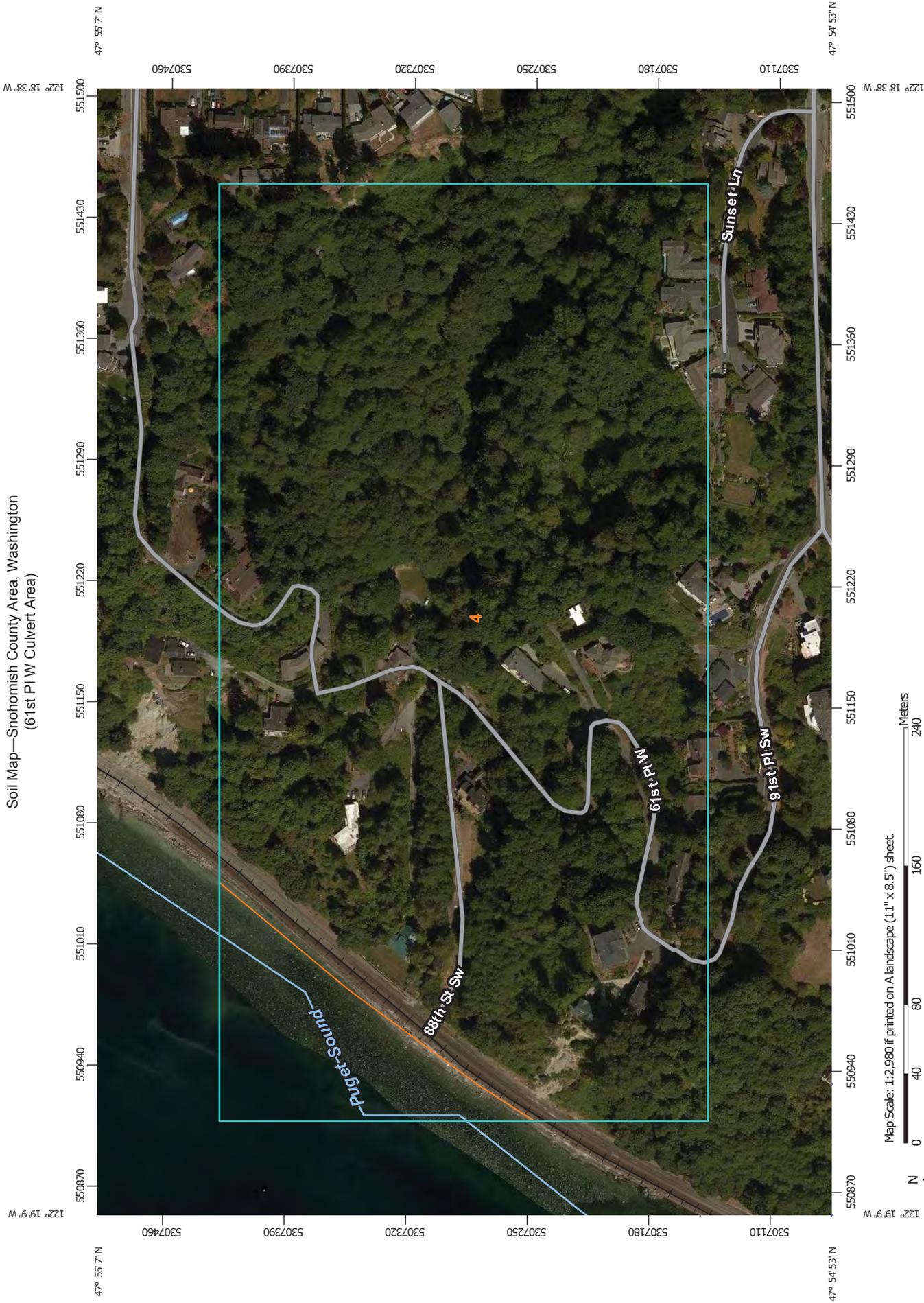
Riparian Status

- Digital Data

User Remarks:

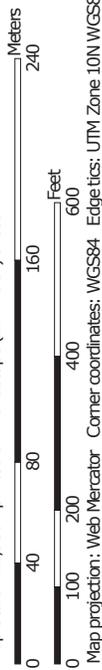
This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

Figure 16 - NWI Map



Soil Map—Snohomish County Area, Washington
(61st Pl W Culvert Area)

Map Scale: 1:2,980 if printed on A landscape (11" x 8.5") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

MAP LEGEND

 Area of Interest (AOI)	 Spoil Area
 Soils	 Stony Spot
 Soil Map Unit Polygons	 Very Stony Spot
 Soil Map Unit Lines	 Wet Spot
 Soil Map Unit Points	 Other
 Special Point Features	 Special Line Features
 Blowout	 Streams and Canals
 Borrow Pit	 Transportation
 Clay Spot	 Rails
 Closed Depression	 Interstate Highways
 Gravel Pit	 US Routes
 Gravelly Spot	 Major Roads
 Landfill	 Local Roads
 Lava Flow	 Background
 Marsh or swamp	 Aerial Photography
 Mine or Quarry	
 Miscellaneous Water	
 Perennial Water	
 Rock Outcrop	
 Saline Spot	
 Sandy Spot	
 Severely Eroded Spot	
 Sinkhole	
 Slide or Slip	
 Sodic Spot	

MAP INFORMATION

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

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 12, Sep 30, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 9, 2010—Jul 8, 2014

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

Figure 17 - Soils Map

Map Unit Legend

Snohomish County Area, Washington (WA661)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4	Alderwood-Everett gravelly sandy loams, 25 to 70 percent slopes	34.9	92.2%
Subtotals for Soil Survey Area		34.9	92.2%
Totals for Area of Interest		37.8	100.0%

**Appendix B:
Site Photos,
Mukilteo 61st Place W Culvert Replacement**



Photo 1. Stream channel about 100 feet upstream of 61st Pl W culvert



Photo 2. Stream channel about 100 feet upstream of 61st Pl W culvert, showing woody debris in stream



Photo 3. Stream channel at 61st Pl W Culvert, looking downstream at culvert



Photo 4. Upstream end of culvert under 61st Pl W



Photo 5. Barrier along stream, downstream of 61st Pl W culvert



Photo 6. Riprap bank descending into stream, downstream of 61st Pl W culvert



Photo 7. Streambank at site of Test Plot 1



Photo 8. Upstream end of second culvert under 88th Street SW, downstream of 61st Pl W culvert



Photo 9. Outlet of second culvert under 88th Street SW, downstream of 61st Pl W culvert



Photo 10. Stream outlet into Puget Sound; concrete culvert under railroad tracks

Appendix C:
Wetland Determination Form,
Mukilteo 61st Place W Culvert Replacement

WETLAND DETERMINATION DATA FORM – Western Mountains, Valleys, and Coast Region

Project/Site: 61st PI W Culvert Replacement City/County: Mukilteo, Snohomish Co. Sampling Date: March 10, 2015
 Applicant/Owner: _____ State: WA Sampling Point: Test Plot 1
 Investigator(s): Brad Thiele, Emily Drew Section, Township, Range: S17 T28N R4E
 Landform (hillslope, terrace, etc.): Hillslope, Gully Local relief (concave, convex, none): Concave Slope (%): _____
 Subregion (LRR): _____ Lat: 47°55'01.53" Long: 122° 18' 55.15" Datum: WSG84
 Soil Map Unit Name: Alderwood-Everett gravelly sandy loams, 25-70 percent slopes NWI classification: N/A
 Are climatic / hydrologic conditions on the site typical for this time of year? Yes No (If no, explain in Remarks.)
 Are Vegetation , Soil , or Hydrology significantly disturbed? Are "Normal Circumstances" present? Yes No
 Are Vegetation , Soil , or Hydrology naturally problematic? (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	Is the Sampled Area within a Wetland?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>
Hydric Soil Present?	Yes <input checked="" type="checkbox"/>	No <input type="checkbox"/>			
Wetland Hydrology Present?	Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>			
Remarks:					

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size: <u>10'</u>)	Absolute % Cover	Dominant Species?	Indicator Status	Dominance Test worksheet:		
1. <u>Alnus rubra</u>	60	Y	FAC	Number of Dominant Species That Are OBL, FACW, or FAC:	3	(A)
2. <u>Thuja plicata</u>	10	N	FAC	Total Number of Dominant Species Across All Strata:	6	(B)
3. _____				Percent of Dominant Species That Are OBL, FACW, or FAC:	50	(A/B)
4. _____						
70 = Total Cover				Prevalence Index worksheet:		
Sapling/Shrub Stratum (Plot size: <u>5'</u>)				Total % Cover of:	Multiply by:	
1. <u>Rubus spectabilis</u>	50	Y	FAC	OBL species	0	x 1 = 0
2. <u>Rubus ursinus</u>	20	Y	FACU	FACW species	10	x 2 = 20
3. _____				FAC species	200	x 3 = 600
4. _____				FACU species	50	x 4 = 200
5. _____				UPL species	0	x 5 = 0
70 = Total Cover				Column Totals:	260 (A)	820 (B)
Herb Stratum (Plot size: <u>5'</u>)				Prevalence Index = B/A = <u>3.15</u>		
1. <u>Ranunculus repens</u>	70	Y	FAC	Hydrophytic Vegetation Indicators:		
2. <u>Phalaris arundinacea</u>	10	N	FACW	1 - Rapid Test for Hydrophytic Vegetation		
3. <u>Dicentra formosa</u>	10	N	FACU	2 - Dominance Test is >50%		
4. <u>Hedera helix</u>	15	Y	FACU	3 - Prevalence Index is ≤3.0 ¹		
5. <u>Polystichum munitum</u>	5	N	FACU	4 - Morphological Adaptations ¹ (Provide supporting data in Remarks or on a separate sheet)		
6. <u>Geum macrophyllum</u>	10	N	FAC	5 - Wetland Non-Vascular Plants ¹		
7. <u>Athyrium filix-femina</u>	Trace	N	FAC	Problematic Hydrophytic Vegetation ¹ (Explain)		
8. <u>Grass sp.</u>	15	Y	Unk	¹ Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.		
9. _____				Hydrophytic Vegetation Present?		
10. _____						
11. _____				Yes <input type="checkbox"/>	No <input checked="" type="checkbox"/>	
135 = Total Cover						
Woody Vine Stratum (Plot size: <u>5'</u>)						
1. _____	0					
2. _____	0					
0 = Total Cover						
% Bare Ground in Herb Stratum <u>5%</u>						

Remarks:
 Unknown grass does not appear to be a wetland-obligate species.
 No sharp divisions are evident between FACW, FAC and FACU species at the test plot; all indicator-types are growing interspersed around the test plot.

SOIL

Sampling Point:

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)								
Depth (inches)	Matrix		Redox Features				Texture	Remarks
	Color (moist)	%	Color (moist)	%	Type ¹	Loc ²		
0-3"	10YR 3/2						Duff layer	
3-8"	2.5Y 5/1						Granular clay clumps	Hard and dry
8-12"	2.5Y 4/2						Clay loam	
12-18"	2.5Y 4/1		10YR 4/4	30%			Sand-loam	Coarse mottles
18"+								Gleyed matrix

¹Type: C=Concentration, D=Depletion, RM=Reduced Matrix, CS=Covered or Coated Sand Grains. ²Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)	Indicators for Problematic Hydric Soils ³ :
<input type="checkbox"/> Histosol (A1)	<input type="checkbox"/> 2 cm Muck (A10)
<input type="checkbox"/> Histic Epipedon (A2)	<input type="checkbox"/> Red Parent Material (TF2)
<input type="checkbox"/> Black Histic (A3)	<input type="checkbox"/> Very Shallow Dark Surface (TF12)
<input type="checkbox"/> Hydrogen Sulfide (A4)	<input type="checkbox"/> Other (Explain in Remarks)
<input type="checkbox"/> Depleted Below Dark Surface (A11)	
<input type="checkbox"/> Thick Dark Surface (A12)	
<input type="checkbox"/> Sandy Mucky Mineral (S1)	
<input type="checkbox"/> Sandy Gleyed Matrix (S4)	
<input type="checkbox"/> Sandy Redox (S5)	
<input type="checkbox"/> Stripped Matrix (S6)	
<input type="checkbox"/> Loamy Mucky Mineral (F1) (except MLRA 1)	
<input type="checkbox"/> Loamy Gleyed Matrix (F2)	
<input type="checkbox"/> Depleted Matrix (F3)	
<input type="checkbox"/> Redox Dark Surface (F6)	
<input type="checkbox"/> Depleted Dark Surface (F7)	
<input type="checkbox"/> Redox Depressions (F8)	

³Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic

Restrictive Layer (if present): Type: _____ Depth (inches): _____	Hydric Soil Present? Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>
--	---

Remarks:
Saturated at 12"
Hydric soil at 10"

HYDROLOGY

Wetland Hydrology Indicators:		Secondary Indicators (2 or more required)	
Primary Indicators (minimum of one required; check all that apply)			
<input type="checkbox"/> Surface Water (A1)	<input type="checkbox"/> Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)	<input type="checkbox"/> Water-Stained Leaves (B9) (MLRA 1, 2, 4A, and 4B)	
<input type="checkbox"/> High Water Table (A2)	<input type="checkbox"/> Salt Crust (B11)	<input type="checkbox"/> Drainage Patterns (B10)	
<input checked="" type="checkbox"/> Saturation (A3)	<input type="checkbox"/> Aquatic Invertebrates (B13)	<input type="checkbox"/> Dry-Season Water Table (C2)	
<input type="checkbox"/> Water Marks (B1)	<input type="checkbox"/> Hydrogen Sulfide Odor (C1)	<input type="checkbox"/> Saturation Visible on Aerial Imagery (C9)	
<input type="checkbox"/> Sediment Deposits (B2)	<input type="checkbox"/> Oxidized Rhizospheres along Living Roots (C3)	<input type="checkbox"/> Geomorphic Position (D2)	
<input type="checkbox"/> Drift Deposits (B3)	<input type="checkbox"/> Presence of Reduced Iron (C4)	<input type="checkbox"/> Shallow Aquitard (D3)	
<input type="checkbox"/> Algal Mat or Crust (B4)	<input type="checkbox"/> Recent Iron Reduction in Tilled Soils (C6)	<input type="checkbox"/> FAC-Neutral Test (D5)	
<input type="checkbox"/> Iron Deposits (B5)	<input type="checkbox"/> Stunted or Stressed Plants (D1) (LRR A)	<input type="checkbox"/> Raised Ant Mounds (D6) (LRR A)	
<input type="checkbox"/> Surface Soil Cracks (B6)	<input type="checkbox"/> Other (Explain in Remarks)	<input type="checkbox"/> Frost-Heave Hummocks (D7)	
<input type="checkbox"/> Inundation Visible on Aerial Imagery (B7)			
<input type="checkbox"/> Sparsely Vegetated Concave Surface (B8)			

Field Observations: Surface Water Present? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Depth (inches): _____ Water Table Present? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> Depth (inches): _____ Saturation Present? (includes capillary fringe) Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> Depth (inches): 10"	Wetland Hydrology Present? Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
---	---

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:
Several mountain-beaver burrows present at the test plot, indicating non-inundated soils
No water present in the 18-inch-deep pit.
Remnant channel/swale in the test plot's bench, indicating past events when water might flow through the area

Appendix D:
Previous Habitat Assessments,
Mukilteo 61st Place W Culvert Replacement



CLIENT REVIEW DRAFT

August 18, 2010

Mr. Dean Franz, P.E.
Surface Water Manager
Pertee, Inc.
2707 Colby Avenue, Suite 900
Everett, WA 98201

RECEIVED

JUN 22 2011

CITY OF MUKILTEO

Re: Smugglers Gulch Habitat Assessment

Dear Dean:

On August 11, 2010, Cherry Creek Environmental, Inc. (CCE) evaluated fish habitat and enhancement opportunities in Smugglers Gulch. During a storm event a few years ago a debris torrent blocked a culvert under Sunset Lane which threatened the integrity of the road. Subsequently the stream has incised its channel through the debris deposit to a depth of about 4 ft. CCE conducted a field reconnaissance of the stream network to assess the opportunities for in stream fish habitat enhancement actions that may assist in stormwater management while at the same time stabilizing the stream channel to control erosion and the introduction of sediment into the stream to enhance water quality. In addition, the assessment evaluated the feasibility of stabilizing the reach upstream of the debris torrent deposits to reduce the potential for similar events in the future.

The evaluation began downstream of 49th Avenue West in Mukilteo, Washington and ended at the discharge of Smugglers Gulch into Puget Sound (Figure 1). The goal of the assessment was to assess the feasibility of providing enhancements in stream habitat in ways that would also enhance stormwater management, increasing the capacity of stormwater facilities especially in the middle and upper portions of the watershed, and enhancing water quality conditions in the stream. The focus in the upper watershed was on engineering solutions to stormwater management by enhancing existing stormwater facilities and identifying areas where new facilities for management of both stormwater volume and treatment of water quality could be installed, if determined feasible.

DEVIATIONS FROM ORIGINAL SCOPE OF WORK

The original scope of work indicated that CCE would perform a qualitative and quantitative assessment of Smugglers Gulch Creek from 49th Avenue West downstream to Puget Sound in the portions of the creek that are accessible. Within the majority of the stream channel length surveyed the channel was dry with no flow. Stream flow was observed in the vicinity of the stream crossing at Sunset Lane. The originally planned assessment would have used standard approaches and protocols used in watershed assessments in Washington State and elsewhere on the west coast of the United States. However these approaches typically require flowing water to be present during the survey and could not be used in

Smugglers Gulch Creek. In addition, the lack of flow prohibited the measurements of other quantitative habitat metrics, such as pool and riffle ratios, pool size and configuration.

Once it became obvious during the survey work that these standard approaches and protocols could not be used, CCE changed the focus of the survey from fish habitat conditions to evaluating opportunities for enhancing of other important habitat features, such as wetlands, with a focus in improving habitat and water quality functions as well as stormwater management.

EXISTING PHYSICAL AND ECOLOGICAL CONDITIONS

The creek channel daylights from a series of pipes and ditches immediately west (downstream) of 49th Avenue West. The open channel runs adjacent to a small detention pond and large wetland just west of 50th Avenue West. The open channel continues until 53rd Avenue West, where the stream is piped under the street and through the yard of the private residence located immediately downstream of the culvert under 53rd Avenue West. The creek daylights again just west (downstream) of the property and remains open until it reaches Puget Sound, except where it is culverted under 61st Place West and the Burlington Northern railroad tracks. During the survey, water was not present throughout most of the survey reach. Water was not observed flowing in the creek channel until well west (downstream) of 55th Avenue West. Where flow was observed in the vicinity of Sunset Lane, water depth was between 1 and 4 inches deep. Throughout the survey area, the dominant substrate was gravel and cobble.

In addition to the low flows posing a fish barrier, two culverts were identified as fish barriers. The first culvert is located under 61st Place West. The downstream end of the culvert is perched and there is not a sufficient pool depth below the culvert to allow fish to jump into the culvert. Additionally, the upper end of the culvert is partially buried by sediment. The second fish passage barrier is another culvert, located on an abandoned road just north of 55th Avenue West. The upstream half of this culvert is completely filled and blocked by sediment.

The field reconnaissance included observations of the stream channel in the vicinity of Sunset Lane and the sediment deposits resulting from the debris torrent. At this location, we observed flowing water in the stream and a gravel substrate. The debris torrent deposit exposed in the stream banks was approximately 4 ft in height from the present stream bed to the depositional surface. Exposed surfaces and cut banks along the creek indicated that multiple debris torrent deposits had been placed over a longer period of time. The highest deposit surface included alder trees approximately 10 – 14 inches diameter at breast height (DBH) growing on it. These deposits indicate a long term chronic pattern of channel instability that would interrupt the successful persistence of a fish population within the small amount of potential habitat.

During the assessment, two inaccuracies in the Comprehensive Surface Water Management Plan (CSWMP) (TetraTech 2001) were identified. The first inaccuracy in the CSWMP is the depiction of Smugglers Gulch being an open channel immediately downstream of 53rd Avenue West. While this may have been accurate during the survey work for the CSWMP, this is not the current condition. As described above, Smugglers Gulch is piped under 53rd Avenue West as well as through the private property located immediately downstream of the culvert under 53rd Avenue West. The pipe located

Mr. Dean Franz, P.E.
August 18, 2010



under the property daylight into a dry open channel approximately 150 feet west (downstream) of 53rd Avenue West.

The second inaccuracy is the depiction of a small tributary beginning at the northwest corner of the intersection of 53rd Avenue West and 92nd Street Southwest. The CSWMP depicts this tributary as an open channel flowing west/northwest until it discharges into Smugglers Gulch, just north of 56th Avenue West. However, during this survey, no open channel was observed in this area until an outfall located within an active residential development construction project.

Smugglers Gulch does not provide habitat utilized by fish since most of the channel is dry and inaccessible to fish. In areas where flow was present, flows were too low to provide fish habitat.

OPPORTUNITIES FOR COMBINED HABITAT ENHANCEMENT AND STORMWATER MANAGEMENT

There is little to no opportunity to enhance fish habitat in the creek because of the lack of continuously flowing water, the isolation of potential habitat resulting from fish passage barriers, and the instability of the channel bed resulting from sediment delivery to the stream from the ravine it flows through in the lower watershed.

The most promising location to provide habitat enhancement along with increasing water quality functions and increase stormwater storage is the existing wetland located between 50th Avenue West and 53rd Avenue West. In its present configuration, the stream channel flows along the northern perimeter of the wetland and during high flow events water likely fills the wetland from both upstream sources and from the adjacent stream channel. This configuration could be modified to increase the beneficial effects of the wetland for improving water quality by directing the stream through the wetland and increasing the flow path for low and modest flow events. Any reconfiguration would need to consider and avoid the potential for increasing flooding of properties adjacent to the wetland. Realigning the channel to the middle of the wetland would allow the wetland to provide more flood storage when the creek overtops its banks.

If you have any comments or questions, please feel free to contact us. Our contact information is below.

Respectfully yours,

KERRIE MCARTHUR, FP-C
Senior Biologist
206-999-6201
kerrie.mcarthur@cherrycrk.com

SHANE CHERRY
Principal Geomorphologist
425-218-9748
shane.cherry@cherrycrk.com

Mr. Dean Franz, P.E.
August 18, 2010



REFERENCES

TetraTech (TetraTech/KCM, Inc.). 2001. City of Mukilteo Comprehensive Surface Water Management Plan. Prepared for City of Mukilteo, Mukilteo, WA by TetraTech/KCM, Inc., Seattle Washington.

Technical Memorandum



10230 NE Points Drive
Suite 400
Kirkland, WA 98033
Phone (425) 822-4446
Fax (425) 827-9577

To: Ginger Holser, WDFW
From: Kevin O'Brien
Copies: Lori McFarland, Project File
Date: February 5, 2010
Subject: Stream Habitat Survey in Smuggler's Gulch
Project No.: 31350B

Introduction:

This technical memo presents the results of a stream habitat survey conducted along a reach of Smuggler's Gulch, upstream of the culvert crossing beneath 61st Place West in Mukilteo, Washington. The survey was conducted to provide an assessment of stream and riparian habitat in general, and for salmonid species in particular. Specifically, the habitat survey was intended to provide additional information concerning the value of stream habitat above the culvert, which under existing conditions imposes a velocity and gradient barrier to fish and precludes upstream movement.

Methodology:

A section of stream habitat of Smuggler's Gulch was surveyed by a pair of Otak scientists on February 3, 2010, starting from the upstream invert of the culvert crossing beneath 61st Place West and extending upstream for 500 feet. Visual assessments were made for the purpose of assessing fish access, identifying surrounding land use and factors that may affect water quality, and describing the site as it may affect use by fish. Quantitative and qualitative field measurements were taken for the purpose of assessing habitat unit complexity, wood quantity, spawning gravel, and other measurable features. Surveys were conducted in accordance with methods modified from Timber, Fish, and Wildlife monitoring protocols (Pleus *et al.*, 1999).

The stream reaches were walked using hip chains, and data were taken on habitat units (pool, riffle, glide); gradients; substrate composition; substrate embeddedness; LWD/rootwad presence, diameters, lengths, and positions; mean wetted width and depth of habitat units; mean and maximum pool depths and tail-out depth; and bankfull width and depth. Observations concerning bank or bed scour, riparian vegetative community and condition, percent canopy cover measurements, presence and relative abundance of invasive species, and photo-documentation of the stream were performed. For the survey, LWD elements were defined as those elements that

were greater than 6 inches in diameter and longer than 6 feet in length. Additional information was derived from WDFW, DNR, and Snohomish County databases in order to supplement the field survey work.

Results:

The first 385 feet of surveyed reach is characterized primarily as riffle habitat of a moderately steep gradient—averaging a 4 to 6% slope. Above 385 feet, stream habitat altered to cascades with small step pools and the gradient steepened to approximately 24%, imposing a fish passage barrier. Although the survey was continued to 500 feet, the majority of habitat and geomorphic data was collected for the lower 385 feet.

Within the lower 385 feet of the surveyed reach, riffles comprised 96% of the stream habitat, with only 4% of the habitat units consisting of pools—for a total of three pools ranging from 4 to 6 feet in length and with residual depths less than 1 foot. The stream is a small one, with a weighted mean bankfull width in the reach of 9.3 feet and a weighted mean bankfull depth of 2.4 feet, measured across all habitat units in proportion to their frequency. At the time of the survey, the weighted mean wetted width of the channel was 4.3 feet for the reach, with a weighted mean wetted depth of 0.6 feet, also measured across all habitat units in proportion to their frequency.

Substrate in this reach of Smuggler's Gulch consisted primarily of gravels in the riffle habitat units, along with fines as the predominant substrate type in the pools. Cobbles and bedrock/till were co-dominant in areas, particularly further upstream within the reach. The majority of reach showed 0-25% embeddedness scores, generally and unsurprisingly associated with riffle habitat. Fines in the system appeared to be more predominantly associated with pool habitat, with embeddedness scores ranging from 50-100% for these habitat units. Evidence of substantial sediment deposition along the stream edge was very apparent in the lower portion of the reach near the culvert, indicating that the system periodically is transporting and depositing fairly large amounts of sediment for a relatively small stream.

Large woody debris (LWD) elements in the reach occurred at a density of 24 LWD elements over the course of the 385-foot reach. Many of these LWD units occurred in association with one another as debris jams, with the two largest debris jams occurring at the upper end of the reach. Mean length of the LWD elements was 21.3 feet, with a mean diameter of 15.0 inches. Bank instability was noted in the form of bank undercutting and erosion, particularly in the lower part of the reach along the right bank. Much of the lower portion of the reach appeared subject to substantial channel incision, with downcutting observed and a number of bed control structures obviously placed in the channel in an attempt to control the incision. The channel appeared fairly stable higher up in the reach largely due to erosion-resistant till providing some armoring, but the steeper slopes higher in the reach appeared to contribute substantial amounts of sediment to the system in the form of ravine wall sloughing and mass wasting.

The vegetative cover in the surveyed reach's riparian corridor consisted mostly of a deciduous forested and mixed deciduous/coniferous forested habitat, with a shrub and herbaceous layer understory. Dominant species included red alder, big leaf maple, western red cedar, and Douglas fir in the overstory. Salmonberry was the dominant shrub species, with Indian plum becoming more prevalent higher in the system. At the time of the site visit, sword fern was the dominant herbaceous species. Near the residence and culvert at the lower portion of the reach, non-native invasive species such as Himalayan blackberry and spirea were present and comprised a significant proportion of the vegetative cover (>20%), but were absent higher in the reach. Canopy cover estimates ranged from 60% to 80+% in the system.

Fish passage appeared to be relatively unimpeded upstream of the 61st Place West culvert and below the steep cascades in the system, although two gradient jumps occur due to knick points or debris jams—one with a 2-foot perch and the other with a 3-foot perch. As noted above, cascades appear at 385 feet above the culvert and the gradient steepens to 24%, imposing a fish passage barrier to any potential movement further upstream. The culvert itself appears to pose a gradient and velocity barrier to upstream passage as well. During the course of the survey, no fish or evidence of fish activity were noted in the stream reaches.

Stream Typing and Characterization

The lower portion of Smuggler's Gulch is currently categorized as a perennial Type F stream by DNR, extending from the Sound to approximately 500 feet upstream. At that point, which appears to be very close to the 61st Place West culvert, the stream transitions to a non-fish habitat stream with an unknown/unclassified flow regime. The stream typing is based on DNR's habitat modeling approach. Although DNR now rates Smuggler's Gulch as perennial and providing potential fish habitat for a portion of its length, previously the stream was categorized as a Type 5 stream (seasonal, non-fish bearing stream), per the interim water typing system codified in WAC 222-16-031.

WDFW indicates that no anadromous species of salmon are known to occur in Smuggler's Gulch. Snohomish County maps Smuggler's Gulch as a non-fish bearing, seasonal waterbody. Smuggler's Gulch does not occur on Ecology's 303(d) water quality impairment lists. The WRIA 8 watershed maps do not indicate salmonid usage of Smuggler's Gulch, although they indicate rearing habitat for coho and presence of coastal cutthroat in Big Gulch to the south.

No known fish passage barriers on Smuggler's Gulch appear in the WDFW database, although a number of gradient jumps, generally perched from 1 to 3 feet above the downstream stream substrate, occur both upstream and downstream of the culvert. The database shows a 4 to 8% gradient for the first 500 feet of stream, with the rest of the Gulch mapped as 12 to 20% gradient. Based on generally accepted definitions of gradient barriers to fish (20% or greater, 16% or greater

for smaller streams) and field verification of the stream habitat, it appears that the upper reaches of Smuggler's Gulch pose a naturally occurring, gradient-based fish passage barrier to anadromous salmon.

Based on available data and field-based characterization of the system, it seems that approximately 385 feet of seasonal, small-stream habitat upstream of the 61st Place West culvert might be available for overwintering use by certain species of salmonids, during the portion of the year when stream flow is likely to be present. Species for which such habitat might be suitable include coho salmon and steelhead, and cutthroat trout in particular. The seasonal nature of the flow regime upstream of the culvert most likely precludes the use of this habitat by salmonids for rearing or spawning purposes, however. In addition, the paucity of pool habitat and relative steepness of the gradient indicate that high flows are bound to occur in the rainy seasons and that high flow refugia are virtually absent—imposing high energy costs to fish in the system or potentially forcing them downstream. While the actual quantities of sediment moving through the system are unknown, it appears that relatively large quantities of sediment are mobilized into Smuggler's Gulch from both in-stream and steep slope sources. Such large volumes of sediment, coupled with high flow conditions, may further limit the habitat functions for fish during periods when stream flow is present.

Reference

Pleus, A.E., D. Schuett-Hames, and L. Bullchild. 1999. *TFW Monitoring Program method manual for the habitat unit survey*. Prepared for the Washington State Dept. of Natural Resources under the Timber, Fish, and Wildlife Agreement. TFW-AM9-99-003. DNR #105. June 1999.



Photo 1: Typical section in lower portion of surveyed reach. Note sediment deposition on either side of channel



Photo 2: Stream channel with exposed sewer pipe crossing stream in foreground, indicative of historic downcutting and channel incision



Photo 3: Typical LWD element spanning channel



Photo 4: Gradient jumps/drops in system, ranging from 2 to 3 feet in height



Photo 5: Debris jam and beginning of cascade sequence. Gradient increases to approximately 24% above the jam