Final Pre-Design Report - Volume II

25th Avenue NE Flood Reduction Project

City of Shoreline

Louis Berger

In association with BergerABAM, Herrera, Perteet and Terracon

BergerABAM

HERRERA

Perteet

Terracon

March 2018

25th Avenue NE Flood Reduction Project

City of Shoreline

Table of Contents – Volume II

Final Pre-Design Report – Volume II

Appendix H
Utility Potholes

DATE 6-22-16

Applied Professional Services Inc.

JOB # 4149
CLIENT
POC

PROJECT: Shol

Pothole Date	Pothole # Core #	Target Utility	Depth to top of util. In inches	Depth to Bot of util. In inches	Pipe/Conduit size inches	Pipe Material	Asphalt Thickness	Concrete Thickness	Subsurface Composition/Comments
6-22-16	1	H20	37.5"	45.5"	8"	Steel	7"	—	Rocky
6-22-16	2	H20	38"	104"	66"	Steel	6"	—	Rocky
6-22-16	3	F.O.	See	Test	hole data	sheet			
6-23-16	4	Water	47"	53"	6"	Steel	—	—	Rocky + Wet
6-23-16	5	com	26"	28"	2"	PVC	—	—	Rocky
6-23-16	5A	COM	34.5"	38.5"	(2)x4"	PVC	—	-	Rocky
6-23-16	6	COM	35.5"	40"	(2)x4"	PVC	—	—	Rocky + Wet
6-23-16	7	COM	30"	35"	(2)x4"	PVC	—	-	Rocky
	7A	PWR	37"	42"	(1)x3" (2)x1" (2)x2"	PVC	—	-	Rocky
6-22-16	8	Water	51"	51 5/8"	5/8"	coper	6"	—	Rocky + Coese Soil + Wet
6-22-16	9	COM/PWR	55"	59"	(4)x4" (1)x2"	PVC	—	—	Rock + Sand + wet
6-22-16	10	COM	30"	37"	2x4"	PVC	5"	—	Rocky
6-22-16	11	COM	36"	40.5"	(2)x4"	PVC	4"	—	Rocky
	11A	Sewer	See	Test hole	data	Sheet	"	"	Rocky/Sand/Wet

TEST HOLE DATA SHEET

APS Job #: 4149 Date: 6-22-16

Overlay layers:	Pothole #: 1 Overlay Thickness: 7" inches Utility type: Water (gas, water, etc)
asphalt | 7"	Utility Size: 8" inches Utility Material: (Rusty) Steel Soil Cond: Rocky
Dirt	Pipe Direction (circle one): E & W / N & S / **SW & NE** / SE & NW Top of utility from grade: 37.5" inches Bottom of utility from grade: 45.5" inches Width of Structure if necessary: ______ inches

Additional utilities found in same location:	E & W	N & S	SW & NE	SE & NW
Test hole#: ______				
Utility Type: ______ Top: ______ Bott: ______ Size: ______ Ut Material: ______ Overlay Thick: ______				

Utility Configuration: Facing NE

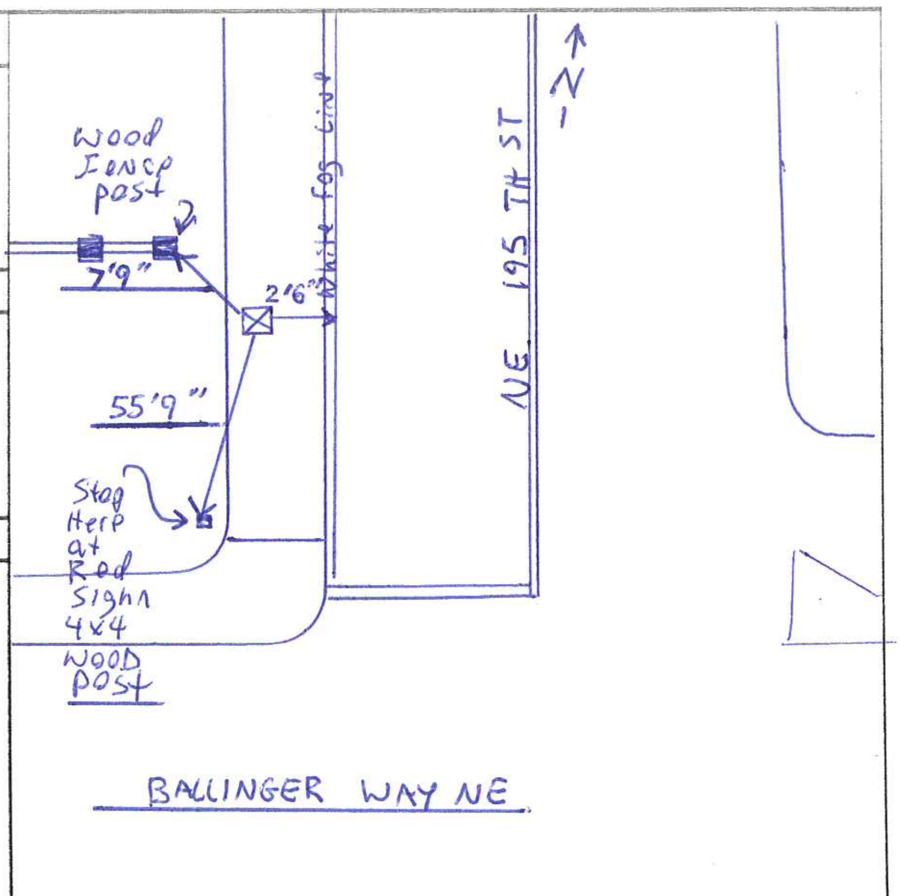
Water
8" Steel

Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

APS Job # 4149 Date 6-22-16

Pothole # 2 Overlay Thickness 6" inches Utility type Water
gas, water, etc.

Utility Size 66" inches Utility Material Steel Soil Cond. Rocky

Pipe Direction (circle one): Top of utility from grade 38" inches

- E & W
- N & S (circled)
- SW & NE
- SE & NW

Bottom of utility from grade 104" inches

Width of Structure if necessary: ______ inches

Overlay layers:

asphalt	6"
Dirt	

Additional utilities found in same location: E & W N & S SW & NE SE & NW

Test hole#____________

Utility Type:__________ Top:______ Bott:______ Size:______ Ut Material:________ Overlay Thick:_________

Utility Configuration: Facing North

H2O
66" Steel

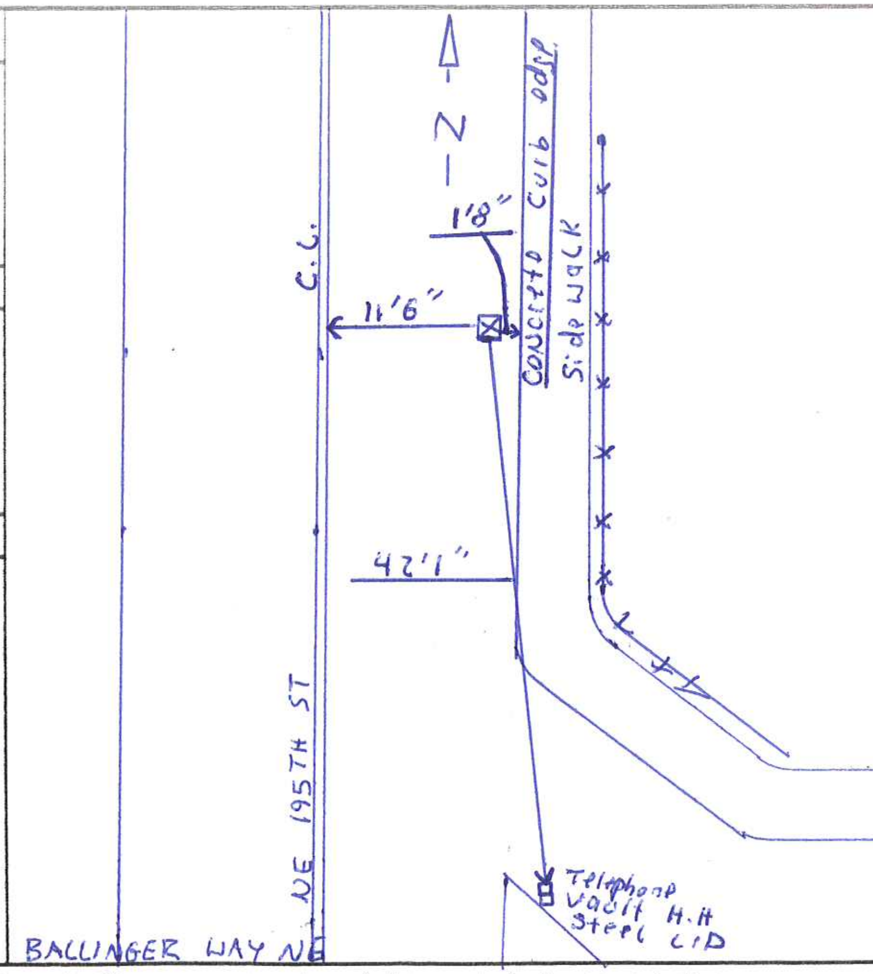
Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

Could not get a good Size measurement with tape because water pipe was to big. Ground was painted 66"



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

[illegible] # 4149 [illegible] 6-22-16

Did not pothole see notes

Pothole # 3 Overall Thickness ______ inches Utility type F.O.

(gas, water, etc.)

Overlay layers:	Utility Size ______ inches Utility Material ______ Soil Cond. ______
	Pipe Direction (circle one) Top of utility from grade ______ inches
	E & W
	N & S Bottom of utility from grade ______ inches
	SW & NE
	SE & NW Width of Structure (if necessary) ______ inches

Additional utilities found in same location:	E & W N & S SW & NE SE & NW
Test hole# ______	
Utility Type ______ Top ______ Bott ______ Size ______ Ut Material ______	Overlay Thick ______

Utility Configuration:

Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

Did not find F.O. at one call Locates. Found a 66" water pipe only. Located F.O. in sidewalk but City of Shoreline did not want us to breack sidewalk panel.

Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

Applied
Professional
Services, Inc.

APS Job # 4149 Date: 6-23-16

Pothole#: 4 Overlay Thickness — inches. Utility type: Water (gas,water, etc.)

Overlay layers:

Soft

Utility Size: 6" inches Utility Material: Steel Soil Cond. Rock + wet

Pipe Direction (circle one)

- E & W
- N & S
- SW & NE
- SE & NW

Top of utility from grade: 47" inches.

Bottom of utility from grade: 53" inches.

Width of Structure if necessary: ______ inches.

Additional utilities found in same location: E & W N & S SW & NE SE & NW

Test hole# ______

Utility Type: ______ Top: ______ Bot: ______ Size: ______ Ut Material: ______ Overlay Thick: ______

Utility Configuration: Facing North

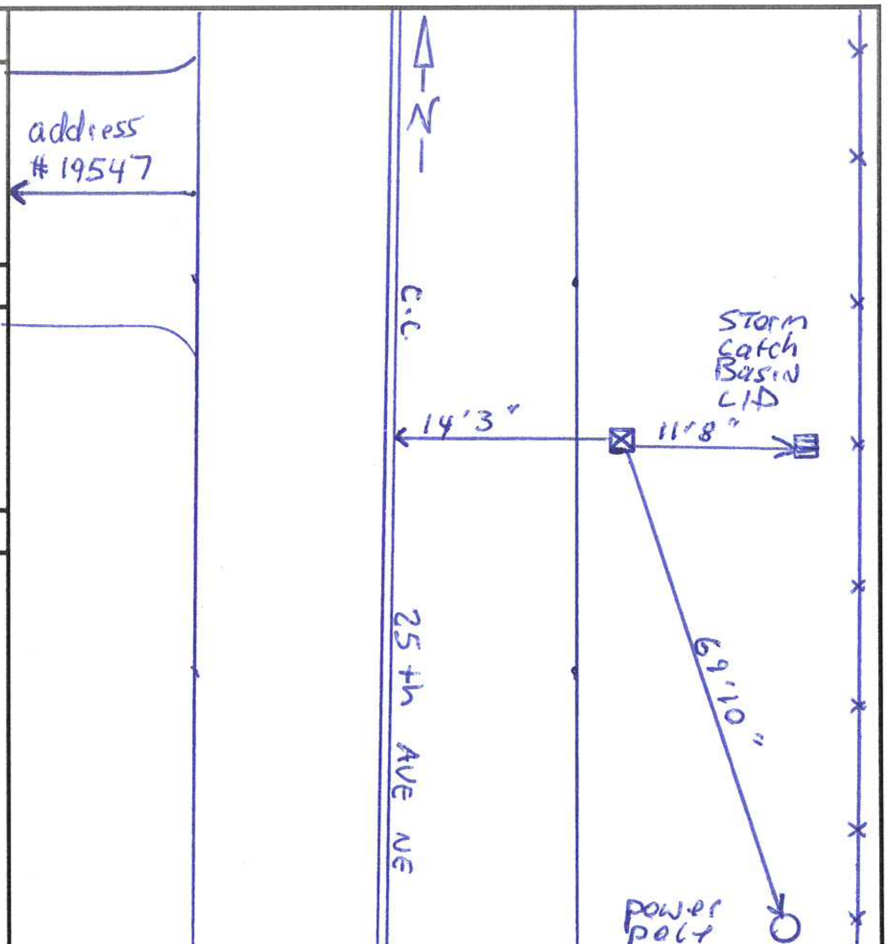
H20
6" Steel

Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline.

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

Applied Professional Services, Inc.

TEST HOLE DATA SHEET

APS Job # 4149 Date: 6-23-16

Pothole#: 5	Overlay Thickness — inches.	CTL? Utility type: COM (gas,water, etc.)
Utility Size: 2" inches	Utility Material: PVC	Soil Cond. Rocky

Overlay layers: Soft

Pipe Direction (circle one)

- E & W
- N & S (circled)
- SW & NE
- SE & NW

Top of utility from grade: 26" inches.

Bottom of utility from grade: 28" inches.

Width of Structure if necessary: ______ inches.

Additional utilities found in same location: E & W N & S SW & NE SE & NW

Test hole#______

Utility Type:______ Top:______ Bot:______ Size:______ Ut Material:______ Overlay Thick:______

Utility Configuration: Facing North

O← 2" PVC

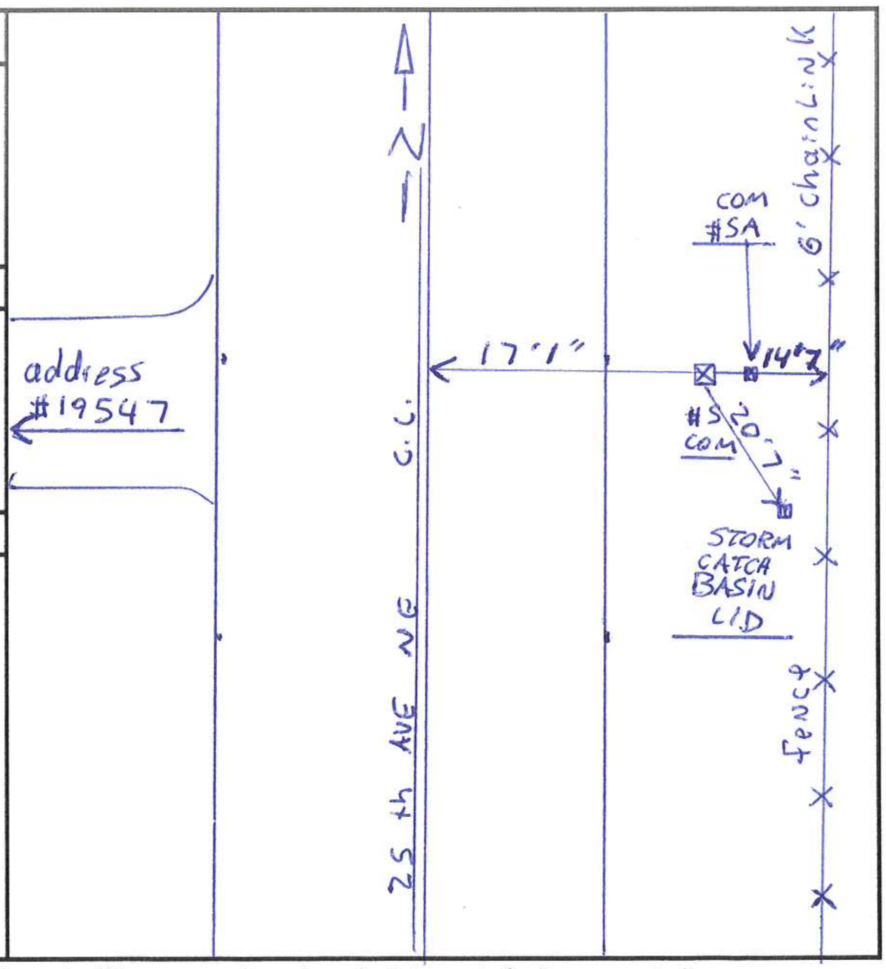
Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

Found at pothole Location



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline.

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

APS

Applied
Professional
Services, Inc.

TEST HOLE DATA SHEET

APS Job # 4149 Date: 6-23-16

Pothole#: 5A Overlay Thickness — inches. Utility type: COM (gas,water, etc.)

Overlay layers:

DIRT

Utility Size: (2) x 4" inches Utility Material: P.V.C. Soil Cond. Rocky

Pipe Direction (circle one)
E & W
N & S
SW & NE
SE & NW

Top of utility from grade: 34.5" inches.

Bottom of utility from grade: 38.5" inches.

Width of Structure if necessary: ______ inches.

Additional utilities found in same location: E & W N & S SW & NE SE & NW

Test hole#______

Utility Type:______ Top:______ Bot:______ Size:______ Ut Material:______ Overlay Thick:______

Utility Configuration: Facing North

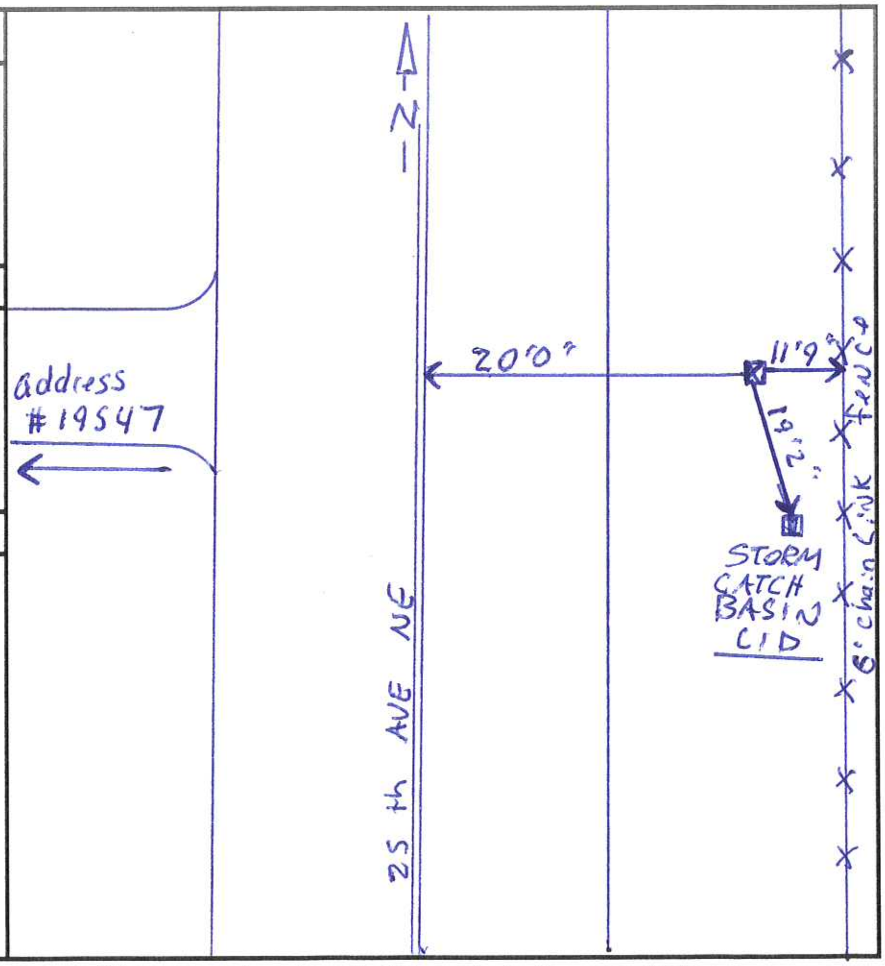
COM
OO (2)x4" PVC

Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline.

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

APS

Applied Professional Services, Inc.

TEST HOLE DATA SHEET

APS Job # 4149 Date: 6-23-16

Overlay layers: Soft

Pothole#: 6 Overlay Thickness — inches. Utility type: COM (gas,water, etc.)

Utility Size: (2) x 4" inches Utility Material: PVC Soil Cond. Rocky + wet

Pipe Direction (circle one)

- E & W
- N & S (circled)
- SW & NE
- SE & NW

Top of utility from grade: 35.5 inches.

Bottom of utility from grade: 40" inches.

Width of Structure if necessary: ______ inches.

Additional utilities found in same location: E & W N & S SW & NE SE & NW

Test hole# ______

Utility Type: ______ Top: ______ Bot: ______ Size: ______ Ut Material: ______ Overlay Thick: ______

Utility Configuration: Facing North

Top: 36" Top: 35.5"

COM (2) x 4" PVC

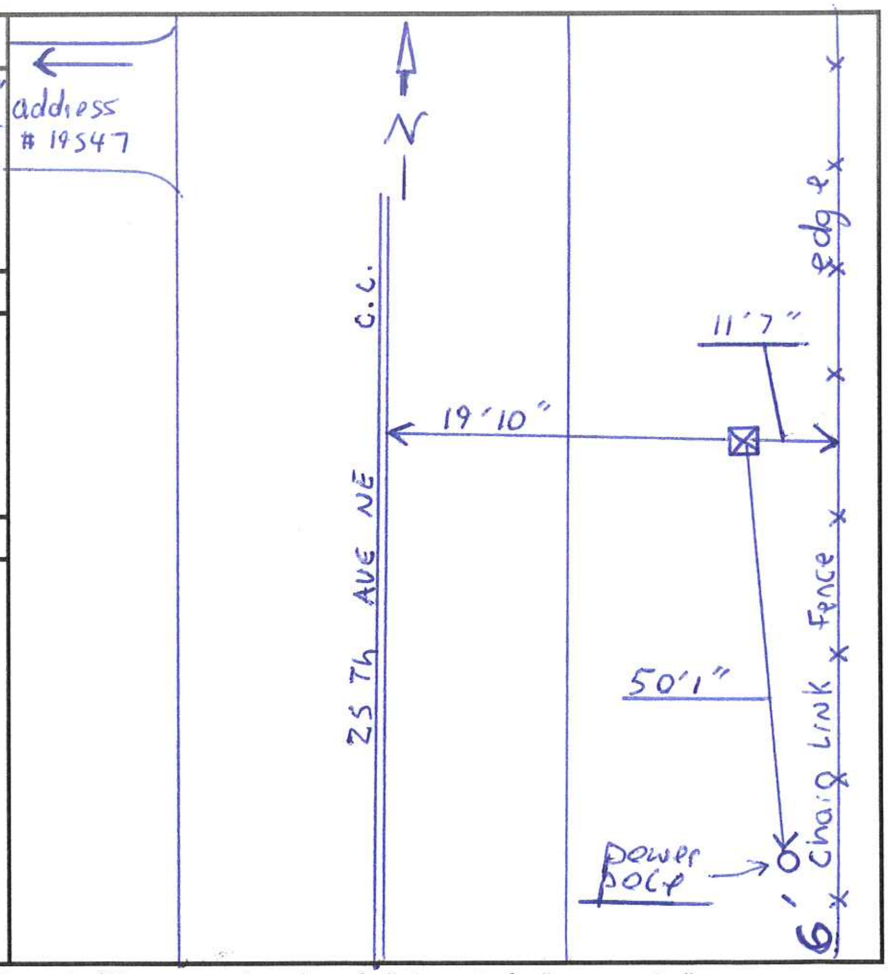
Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

Dug at One Call Locates to 5' deep by 3' wide but did not find COM. Found about 3' to the West.



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline.

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

Applied Professional Services, Inc.

APS Job # 4149 Date: 6-23-16

Pothole#: 7 (2) Overlay Thickness — inches. Utility type: COM (gas,water, etc.)

Utility Size: (2) x4" inches Utility Material: PVC Soil Cond. Rocky

Overlay layers:

Soft

Pipe Direction (circle one)

E & W
N & S
SW & NE
SE & NW

Top of utility from grade: 30" inches.

Bottom of utility from grade: 35" inches.

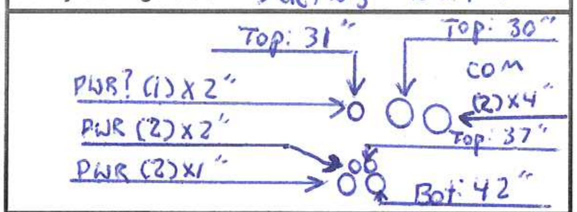
Width of Structure if necessary: ______ inches.

Additional utilities found in same location: (1)x2" (2)x2" E & W N & S SW & NE SE & NW

Test hole# 7A

Utility Type: Power Top: 37" Bot: 42" Size: (2)x1" Ut Material: PVC Overlay Thick: —

Utility Configuration: Facing North

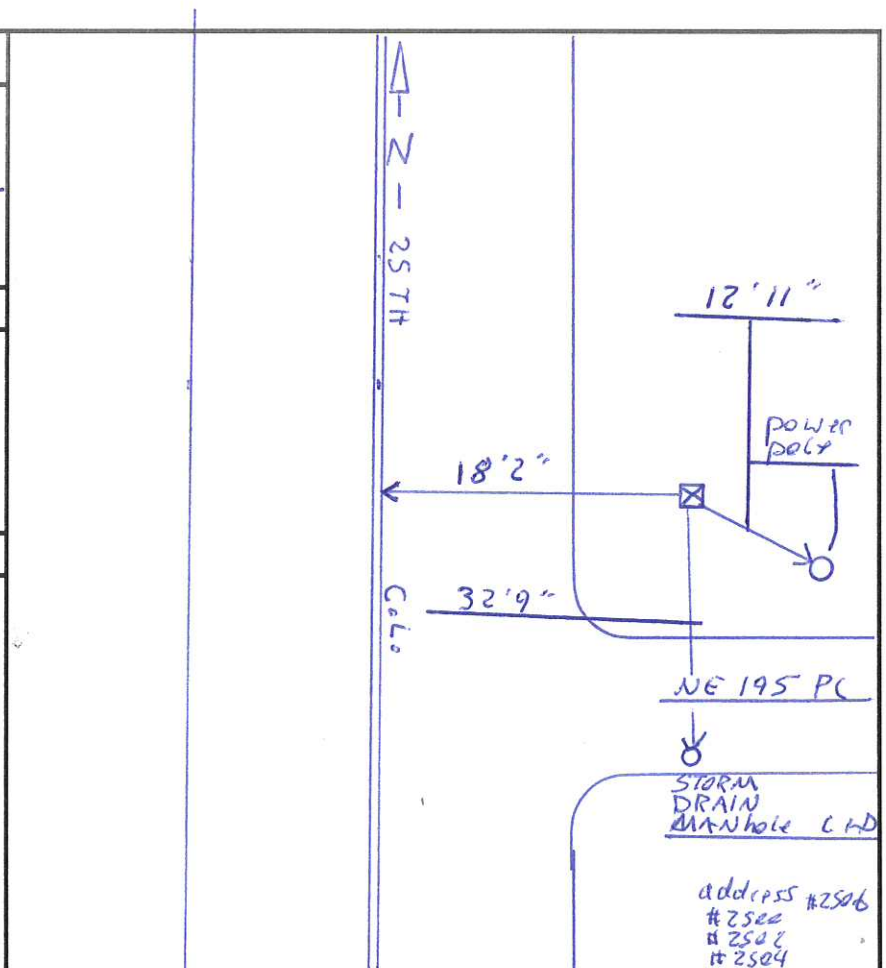


Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline.

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

Job #: 4149 Date: 6-22-16

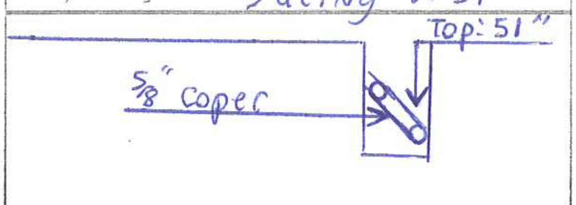
Overlay layers:	Pothole#: 8	Overlay Thickness: 6" inches	Utility type: Water (gas, water, etc)
asphalt | 6"	Utility Size: 5/8" inches	Utility Material: Coper	Soil Cond: Rocky, Loose Sand+Wet
Dirt	Pipe Direction (circle one): E & W (circled), N & S, SW & NE, SE & NW	Top of utility from grade: 51" inches	
		Bottom of utility from grade: 51 5/8" inches	
		Width of Structure if necessary: ______ inches	

Additional utilities found in same location:	E & W	N & S	SW & NE	SE & NW

Test hole#: ____________

Utility Type: ________ Top: ______ Bott: ______ Size: ______ Ut Material: ______ Overlay Thick: ______

Utility Configuration: Facing West



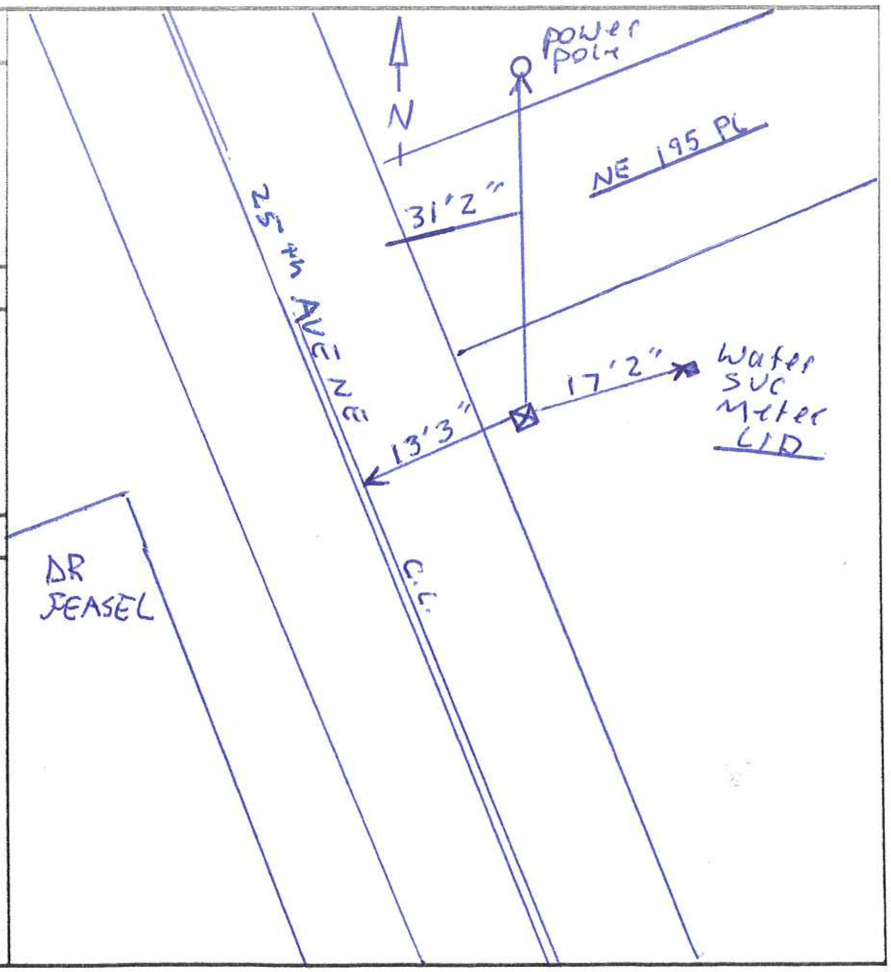
Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

Found water svc that dives down to main.



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

APS # 4149 Date 6-22-16

Pothole# 9 Overlay Thickness — inches Utility type COM/PWR (gas, water, etc)

Utility Size (4) x 4" (1) x 2" inches Utility Material PVC Soil Cond Rocky sand + wet

Overlay layers:

Soft

Pipe Direction (circle one)

E & W

N & S

SW & NE (circled)

SE & NW

Top of utility from grade 55" inches

Bottom of utility from grade 59" inches

Width of Structure if necessary ______ inches

Additional utilities found in same location: E & W N & S SW & NE SE & NW (circled)

Test hole# 9A

Utility Type STORM Top 23.5" Bot 71.5" Size 48" Ut Material Steel CMP Overlay Thick —

Utility Configuration: Facing NE

#9A STORM > Seen (4) x 4"

Seen (1) x 2" PVC

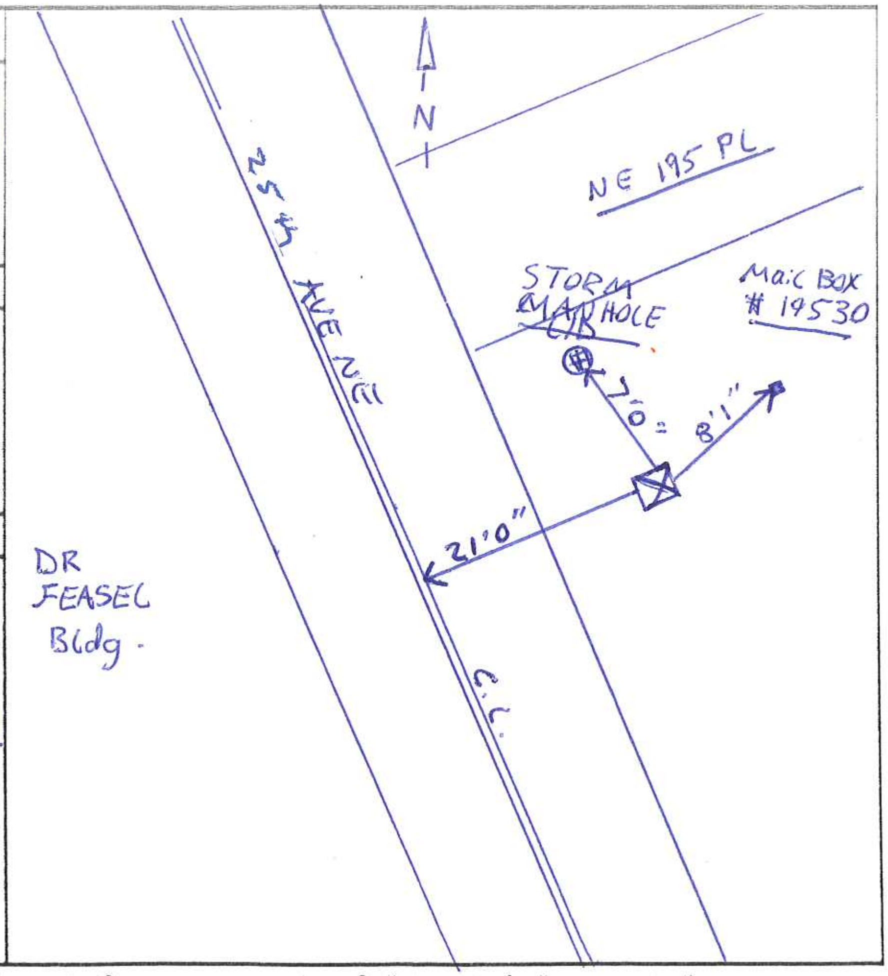
Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

Ground kept underming because of loose soil and very wet. Might be more underneath PWR/COM conduits. Ground started to get very wet and muddy.



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

APS Job #: 4149 Date: 6-22-10

Pothole#: 10 Overlay Thickness: 5" inches Utility type: COM (gas, water, etc.)

Utility Size: (2)x4" inches Utility Material: PVC Soil Cond: Rocky

Overlay layers:	
asphalt	5"
Dirt	

Pipe Direction (circle one): E & W, N & S, SW & NE, SE & NW

Top of utility from grade: 30" inches

Bottom of utility from grade: 37" inches

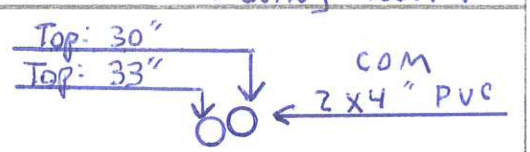
Width of Structure if necessary: ______ inches

Additional utilities found in same location: E & W N & S SW & NE SE & NW

Test hole#: ______

Utility Type: ______ Top: ______ Bot: ______ Size: ______ Ut Material: ______ Overlay Thick: ______

Utility Configuration: Facing North

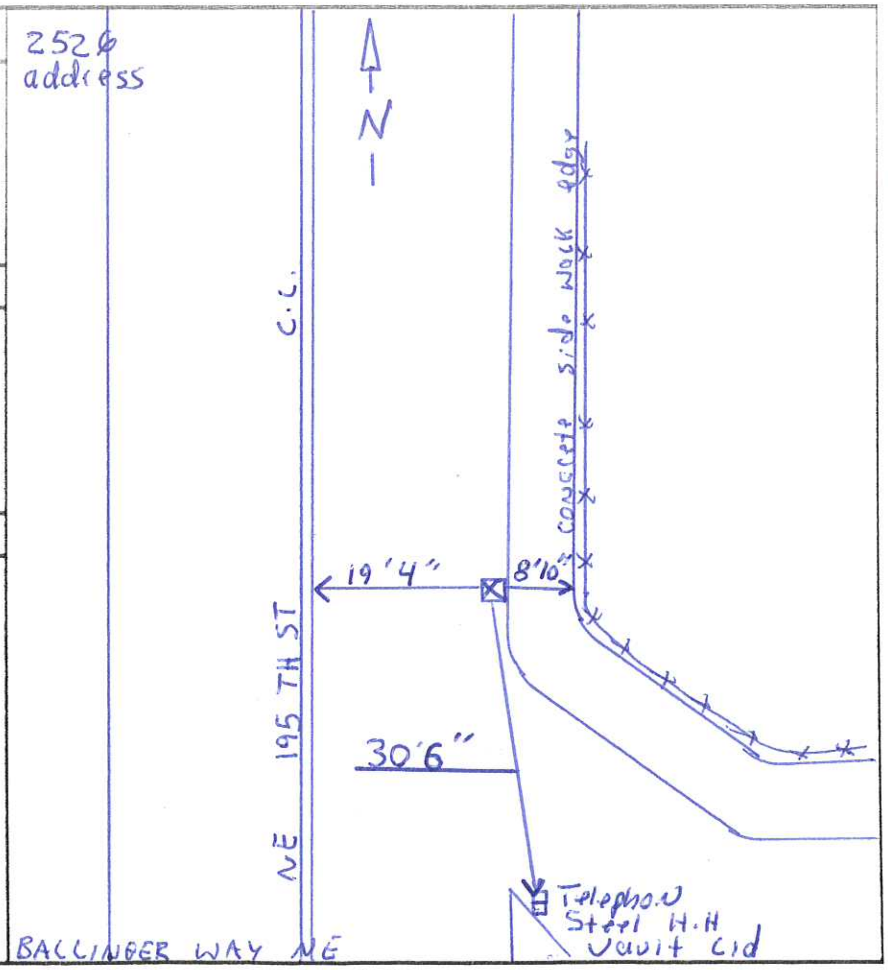


Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:



Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

TEST HOLE DATA SHEET

Job # 4149 Date 6-22-16

Pothole# 11 Overlay Thickness 4" inches Utility type COM
(gas water etc)

Utility Size (2) x 4" inches Utility Material PVC Soil Cond Rocky + Sand

Overlay layers:
asphalt | 4"
Dirt

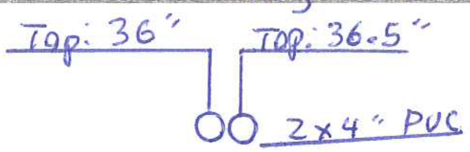
Pipe Direction (circle one)
E & W
N & S
SW & NE
SE & NW (circled)

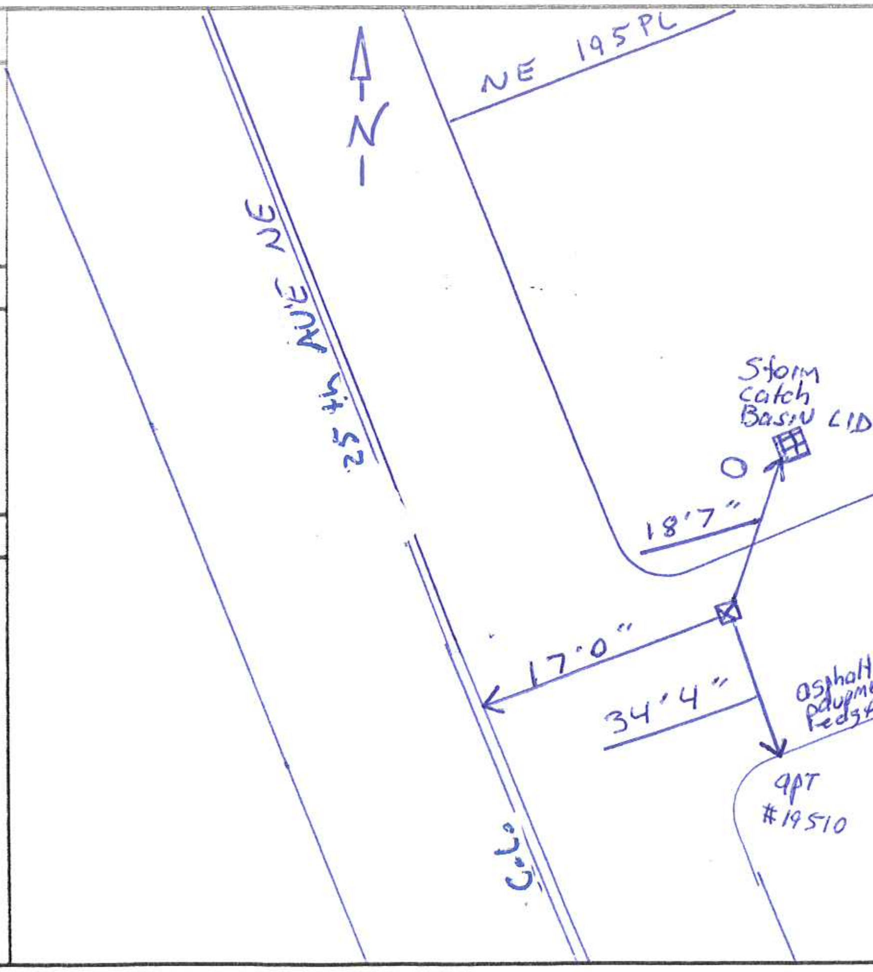
Top of utility from grade 36" inches
Bottom of utility from grade 40.5" inches
Width of Structure if necessary ________ inches

Additional utilities found in same location:	E & W	N & S	SW & NE	SE & NW
Test hole# 11 A	Did not find			

Utility Type Side Sewer Top ____ Bott ____ Size ____ Ut Material ____ Overlay Thick ____

Utility Configuration: Facing NW





Vacuum Crew:

Lead: Rob

Helper: Kyle

Notes:

pothole #11A / Sewer
Dug down to 5'6" deep and ran into ground water. Could not vac water out fast enough. probed to 11' deep by about 2' wide but did not find sewer.

Sketch to include street name(s), North arrow, distance to (3) permanent markers & distance to fogline or centerline

Be sure to include a description of each permanent marker

Any known building address, or side street address in the vicinity should be included

90 45 0 90 Feet

N W E S

City of Shoreline
25th Avenue SE Conveyance Improvements
Potholes.

Appendix I
Geotechnical Investigations

Appendix I.1
Draft Geotechnical Report

Note that the preparation of the draft geotechnical investigation report describes the project site conditions in general as well as providing input on the most of the initial seven potential alternatives. In particular 6 and 7 were not included at the time. It is also noted that the designations of the alternatives changed from an alphabetic system to numeric system, and there has since been some modifications to the location and extent of alternatives. The original scope of the geotechnical investigations was to prepare draft report that covered the range of geotechnical issues that may inform alternative development. A final geotechnical report will be prepared in later phases of the project development and focus on the preferred alternative once it is selected.

The following provide a simple cross reference of the alternative designations within the geotechnical report and the updated alternative numbering.

Geotechnical Report	***Updated Alternative Number***
Option A (Maximum Feasibility)	Alternatives 1 and 2
Option B (Maximum Habitat)	Alternative 3 (NMF or School Annex)
Option C (Lowest Cost)	Alternative 4
Option D (High Flow Bypass)	Alternative 5

Draft Preliminary Geotechnical Engineering Report

25th Avenue NE Flood Reduction
Shoreline, Washington

September 6, 2016
Terracon Project No. 81165045

Prepared for:

Louis Berger, Inc.
Seattle, Washington

Prepared by:

Terracon Consultants, Inc.
Mountlake Terrace, Washington

September 6, 2016

Louis Berger, Inc.
520 Pike Street, Suite 1005
Seattle, WA 98101

Attn: Mr. Mike Giseburt, P.E.
P: [206] 453-1549
E: mgiseburt@louisberger.com

Re: Draft Preliminary Geotechnical Engineering Report
25th Avenue NE Flood Reduction
Shoreline, Washington
Terracon Project Number: 81165045

Dear Mr. Giseburt:

Terracon Consultants, Inc. (Terracon) has completed the Phase I preliminary geotechnical engineering services for the above referenced project. This study was performed in general accordance with our proposal number P81165045 dated March 2, 2016 and a Services Task Order between Louis Berger, Inc. (Louis Berger) and Terracon dated May 16, 2016. This report presents the findings of the subsurface and hydrologic exploration and provides preliminary geotechnical recommendations concerning the alternatives under consideration for proposed stormwater improvements. Once the approach and configuration of the proposed stormwater improvements is selected, it is intended that Terracon develop a geotechnical design report to address specific design and construction considerations related to the selected alternative.

We appreciate the opportunity to be of service to you on this project. If you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Tori Hesedahl, E.I.T.
Geotechnical Engineer

Dennis R. Stettler, P.E.
Senior Consultant

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EXECUTIVE SUMMARY

Terracon has performed preliminary geotechnical engineering services to support the evaluation and selection of preferred alternatives for the 25th Avenue NE Flood Reduction project in Shoreline, Washington. As part of these services we conducted geotechnical explorations which consisted of four borings to a maximum depth below existing site grade (bgs) of about 31 ½ feet. We also searched for existing subsurface information in publicly available resources and our own records.

Based on the information obtained from our subsurface exploration and research of existing information, construction of the proposed project alternatives appears to be geotechnically feasible. The following geotechnical considerations were identified:

- Underlying soil conditions typically consist of transitional beds of medium dense to very dense Sand and Gravel with varying fines (silt and clay) content. Soil interpreted to be alluvium consisting of very loose silty Sand extends to a depth of up to about 13 feet below ground surface in most of the borings. Fill overlies the alluvium or transitional beds and typically consists of very loose to medium dense silty Sand with gravel. The fill disclosed in the four borings advanced for this project extended to a depth of about 3.5 to 5 feet below the ground surface, but could be variable along the alignment based on past grading activities and the location of utility trench backfill.

- Oil and diesel range hydrocarbons were detected between 3 and 3 ¼ feet in boring B-4 and in some of the explorations completed on the adjacent Shoreline North Maintenance Facility site as a part of a separate City of Shoreline project. While the sample tested from boring B-4 was below Washington State Model Toxics Control Act (MTCA) cleanup levels, excavation could uncover areas with higher concentrations.

- Groundwater was observed within 2 feet below ground surface (bgs) in most of our explorations with depth to groundwater being near 7 feet bgs at higher ground elevations near NE 195th Street . Shallow groundwater will likely present constructability issues related to trenching for culvert installation and for daylight stream sections.

- Groundwater samples from two of the monitoring wells installed as a part of this project were analyzed for total petroleum hydrocarbons, volatile organic compounds, and metals. All of the test results were below the method reporting limits except for arsenic which was detected at a level slightly above the MTCA cleanup level. The arsenic finding was consistent with test results often indicative of background levels of arsenic in the Puget Sound area.

- A number of buried utilities run along the existing culvert on the east side of 25th Avenue NE. In the consideration of alternatives the design team appears to have largely avoided conflict with these utilities by either running the alignment down the west side of 25th Avenue NE, or into the school district property on the east side of 25th Avenue NE.

- Replacing the culvert crossing at NE 195th Street will be complicated by a 66-inch water transmission pipe that runs along the south side of NE 195th Street. The pipeline will likely need to be temporarily underpinned and supported across the culvert excavation by a pile-supported frame.

- Stream channel regrading is proposed to accommodate the new stream gradient which is necessitated, in part, by clearance below the existing 66-inch water main. Proposed lowering of the stream channel would result in subvertical to vertical banks of up to about 4 feet of exposed height (1 foot existing sediment buildup plus up to 3 feet deepening) at the toe of steep slopes (such as north of NE 195th Street and at the toe of a distressed gabion basket retaining wall south of NE 195th Street. New stream channel walls will likely be required and need to be designed to support surcharge from the slope and roadway above, and for scour.

- Open channel stream bank slopes should be sloped no steeper than 2H:1V and will require protection from erosion.

- Potentially liquefieable soils were identified in borings B-4 and H-1-16.

- Close monitoring of the construction operations discussed herein will be critical in achieving the project design. We therefore recommend that the Terracon be retained to monitor this portion of the work.

This summary should be used in conjunction with the entire report for preliminary design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

DRAFT PRELIMINARY GEOTECHNICAL ENGINEERING REPORT
25th Avenue NE Flood Reduction
Shoreline, Washington
Terracon Project No. 81165045
September 6, 2016

1.0 INTRODUCTION

Terracon Consultants, Inc. (Terracon) is pleased to present the results of our preliminary geotechnical engineering services for the proposed stormwater conveyance improvements. The project alignment runs along 25th Avenue NE between Brugger's Bog Park in Shoreline, then crosses beneath NE 195th Street and follows along the south side of Ballinger Way for a few hundred feet within the city of Lake Forest Park. Logs of the site explorations along with a site location map and exploration plan are included in Appendix A of this report.

The purpose of these services is to provide subsurface information and preliminary geotechnical engineering recommendations to support evaluation and selection of project alternatives. Geotechnical conditions were considered relative to:

- subsurface soil conditions
- earthwork
- existing retaining walls
- groundwater conditions
- existing slopes
- support of stormwater conveyance pipeline

This information and preliminary recommendations are intended to support preliminary design and alternative selection for the project. Once the project alignment, preliminary grading concepts, and channel/culvert configuration are finalized, this preliminary report should be revised and updated to address the specific details of the planned stormwater conveyance improvements.

2.0 PROJECT INFORMATION

2.1 Project Description

Significant flooding is a recurrent issue along Ballinger Creek from approximately the City of Shoreline corporate limits at NE 195th Street, north to the crossing with 25th Avenue NE, and into Brugger's Bog Park, including portions of the proposed Shoreline North Maintenance Facility (SNMF). This problem was previously studied and the basin plan concluded that the approximate 550-foot-long pipe system crossing 25th Avenue NE and extending south has inadequate capacity. In addition, it concluded that the 74-foot-long culvert crossing of NE 195th Street, located just downstream of the 25th Avenue NE pipe system, is also undersized, and contributes to the upstream flooding.

The objective of this project is to perform preliminary design, permitting and final design for the replacements of both the 25th Avenue NE pipe system and the NE 195th Street culvert in order to improve the level of flood protection in this area. The schedule for the project is important because the City is in the process of redeveloping the SNMF and the two projects need to be coordinated.

Four alternative designs for the stretch between Brugger's Bog Park and NE 195th Street are proposed for further study in meeting summary minutes from the August 2, 2016 meeting between design team members from Herrera, Louis Berger, and the City of Shoreline.

- **Option A - Maximum Feasibility –** Daylight the stream within the right-of-way on the west side of 25th Avenue NE along the SNMF frontage, then
  - Culvert across 25th at an angle, daylight between south side of 195th Place NE and driveway to 2518 NE 195th Street, new culvert under driveway, or
  - One long culvert under 25th Avenue NE with outlet at existing location south of driveway to 2518 NE 195th Street
- **Option B - Maximum Habitat/Fish Passage Benefit –** Daylight creek on east side of 25th Avenue NE on Aldercrest Annex property and within 25th Avenue NE ROW south of 195th Place, use fish passable culverts at all roadway/driveway crossings
- **Option C - Lowest Cost –** Closed conduit under west side of 25th Avenue NE, cross near existing open channel south of driveway to 2518 NE 195th Street
- **Option D - High Flow Bypass Replacement –** Replace existing high flow bypass and move outlet to downstream side of NE 195th Street culvert.

Alternative designs to carry the stream under NE 195th Street were also identified in the meeting minutes.

- Fish Passable Culvert
  - Standard dimension box culvert. or
  - Minimum thickness/clearance culvert
- Maintain existing culvert for normal flow and rely on High Flow Bypass Replacement option above to carry storm event flows under NE 195th Street.

Should any of the above information be inconsistent with the proposed project, please let us know so we may make any necessary modifications to this report.

2.2 Site Location and Description

The project is located in the cities of Shoreline and Lake Forest Park, Washington. The alignment under consideration begins as an open channel in Brugger's Bog Park. At the southeast corner of the park the stream enters a pair of parallel culverts which continue south along either side of 25th Avenue NE. The outfall of the culverts is on the east side of 25th Avenue NE, approximately opposite the southeast corner of the Shoreline North Maintenance Facility. An open channel continues south from the outfall along the east side of 25th Avenue NE, crosses under NE 195th Street through a culvert, then continues along the north side of Ballinger Way. The project ends several hundred feet downstream.

Item	Description
Location	25th Avenue NE in the City of Shoreline, Washington, from Brugger's Bog Park to NE 195th Street and along Ballinger Way in Lake Forest Park, Washington
Existing conveyance	Parallel buried culverts on either side of 25th Avenue NE from the southeast corner of Brugger's Bog Park to the south end of the future Shoreline North Maintenance Facility, open channel from there to NE 195th Street, culvert under NE 195th Street, and open channel along Ballinger Way
Current ground cover	Variable along alignment – includes gravel surfacing, roadway pavements, trees and brush
Existing topography	Relatively flat along the northern portion of 25th Avenue NE; as 25th Avenue NE approaches Ballinger Way it slopes up to match grade with Ballinger Way forming an approximately 1H:1V sloped bank down to the open channel; along Ballinger Way the south stream bank is formed by a distressed gabion basket wall with exposed height of about 8 feet and 2.5H:1V backslope above.

3.0 SUBSURFACE CONDITIONS

3.1 Geology

The Geologic map of the Edmonds East and part of the Edmonds West quadrangles, Washington (Minard, J.P. 1983) shows the surficial geology for the site is mapped as Qtb – Transitional Beds. This unit is Fraser-age to Pre-Fraser. These glacial and non-glacial deposits are highly variable in composition but consist mostly of gray clay, silt, and fine sand. Gravels, cobbles, and boulders may also be present.

3.2 Typical Profile

Based on the results of borings B-1, B-2, and B-3, subsurface conditions along the project alignment from the southeast corner of Brugger's Bog Park to about 195th Place NE can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	3.5 to 5	Possible Fill consisting of silty SAND with gravel	Very Loose to Medium Dense
2[1]	Greater than 21.5	Transitional beds consisting of interbedded SAND and GRAVEL with varying fines content	Medium Dense to Very Dense

1. Each of the borings B-1, B-2, and B-3 were terminated at its planned depth of approximately 20 feet within this stratum.

Based on the results of boring B-4 and Washington State Department of Transportation (WSDOT) boring H-1-16, subsurface conditions along the project alignment south from about 195th Place NE can be generalized as follows:

Stratum	Approximate Depth to Bottom of Stratum (feet)	Material Description	Consistency/ Density
1	3.3 to 4.5	Roadway Fill consisting of silty SAND in B-4 and well graded GRAVEL in H-1-16	Medium Dense to Dense
2[2]	13	Alluvium consisting of silty SAND with gravel and organics	Very Loose
3[1]	Greater than 59.5	Transitional Beds consisting of interbedded SAND and GRAVEL with varying fines content and sandy SILT	Medium Dense to Very Dense

1. Borings B-4 and H-1-16 were terminated at their planned depth of approximately 30 and 60 feet, respectively, within this stratum.
2. This stratum was not observed in boring B-4.

In boring B-4 we noted olfactory detection of hydrocarbons from soil between 3 and 3 ¼ feet bgs. Subsequent lab testing results detected oil and diesel range hydrocarbons at a concentration below Model Toxics Control Act clean up levels. Some soil samples from explorations on the adjacent Shoreline North Maintenance Facility also noted hydrocarbon odors or detection in laboratory test results.

Conditions encountered at each boring location are indicated on the individual boring logs. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in situ, the transition between materials may be gradual. Details for each of the borings can be found on the boring logs in Appendix A of this report.

3.3 Groundwater

Groundwater was observed in each of our explorations. Standpipe piezometer type wells were installed in borings B-1 through B-3. The well in boring B-1 was not sounded on 7/25/2016 during our site visit to perform slug testing. The table below summarizes groundwater observations. Groundwater levels can be expected to vary seasonally and from year to year depending on precipitation, site utilization, and other on- and off-site factors.

Boring	While Drilling (feet)		7/11/2016 (feet)		7/25/2016 (feet)	
	Depth	Elevation	Depth	Elevation	Depth	Elevation
B-1	7.5	210	1.6	216	---	---
B-2	5	210	1.8	213	2.0	213
B-3	5	208	2.8	210	2.9	210
B-4	7.5	210	---	---	---	---
WSDOT H-1-16	7	208.6	---	---	---	---

Slug tests were performed in wells installed in borings B-2 and B-3. Hydraulic conductivity estimates calculated from the slug test monitoring data ranged from about 11 to 26 feet per day. Average hydraulic conductivity is estimated to be 19 and 13 feet per day in wells installed in borings B-2 and B-3, respectively. A description of our slug test and analysis procedures along with our results are included in Appendix D.

Terracon collected groundwater samples from wells installed in borings B-2 and B-3 on July 27, 2016 and submitted them for analytical testing. All total petroleum hydrocarbon (TPH) and volatile organic compounds (VOC) results were below the laboratory method reporting limits (MRLs). Arsenic was detected in the samples, but no other metals. The groundwater sample collected from boring B-2 has a reported arsenic concentration of 5.3 micrograms per liter (µg/L, or parts per billion [ppb]), which is just above the Washington State Model Toxics Control Act (MTCA) Method A cleanup level of 5 µg/L, which is protective of groundwater as a potable drinking water source. This low arsenic detection in the groundwater sample is likely due to background levels of arsenic in the glacially-derived sediment, and does not appear to be an indication of the presence of a release of contaminants to the environment, based on the lack of other contaminants detected in the sample.

4.0 PRELIMINARY RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the results of the subsurface exploration, laboratory testing, and our analyses, it is our opinion that the proposed stormwater conveyance improvement alternatives are geotechnically feasible. Geotechnical considerations for this project include:

- undocumented fill – environmental impacts
- groundwater and dewatering
- existing utilities
- steep slopes and existing retaining walls
- liquefaction

4.1.1 Undocumented Fill

Oil and diesel range hydrocarbons were detected in a sample from boring B-4. While the sample tested was below MTCA cleanup levels, excavation could uncover areas with higher concentrations.

4.1.2 Groundwater

Shallow groundwater will likely present constructability issues related to trenching for culvert installation and for daylight sections. Intensive dewatering effort will likely be required depending on depth and location of cut.

4.1.3 Existing Utilities

A number of buried utilities run along the existing culvert on the east side of 25th Avenue NE. The design team appears to have largely avoided conflict with these utilities in their consideration of alternatives by either running the alignment down the west side of 25th Avenue NE, or into the school district property on the east side of 25th Avenue NE.

Seattle Public Utilities owns a 66-inch water transmission pipe that runs along NE 195th Street. Construction of a culvert crossing of NE 195th Street will be complicated by the location of this pipe. Box culvert replacements will have to be designed such that the stream bed is lowered by 2 to 3 feet. The pipeline will likely need to be temporarily supported across the culvert excavation during construction.

4.1.4 Steep Slope North of NE 195th Street

The west bank of the existing open channel slopes up 10 to 12 feet from the creek to 25th Avenue NE at about a 1H:1V slope. Some boulders in the stream bed appear to have tumbled down from the slope above. Proposed channel regrading and lowering would cut subvertical to vertical banks of up to about 4 feet of exposed height (1 foot of existing sediment accumulation plus 3 feet deepening) at the toe of this slope. Given the existing constrained stream channel and available right-of-way, a new stream channel wall on the west side of the stream channel will be required and need to be designed to support surcharge from the slope and roadway above. Scour will be another major design consideration that compounds the concerns with the cut at the toe of the surcharged slope.

4.1.5 Existing Retaining Wall South of NE 195th Street

WSDOT owns a gabion basket retaining wall that forms the NE 195th Street culvert outfall headwall and the south bank of the stream channel downstream of NE 195th Street. This wall extends from the corner of NE 195th Street and Ballinger Way and continues along Ballinger Way past the south end of the project alignment. Exposed height appears to be about 8 feet with a 2.5H:1V backslope above based on a review of topographic contours and observations in the field.

The headwall for the existing culvert has completely failed and is planned for replacement by WSDOT in the next few months. The wall is in fair to poor condition along Ballinger Way. The gabion wire baskets at the base of the wall in the zone of water inundation have corroded completely through and the formerly contained spalls have spilled out. The walls appears to be leaning out from the slope in some areas due to the loss of support and the walls could be subject to failure. Proposed regrading of the stream channel would cut subvertical to vertical banks of up to about 4 feet of exposed height (1 foot existing sediment accumulation plus up to 3 feet deepening) at the toe of this wall which could cause the wall to completely fail without mitigation.

Coordinating wall replacement or rehabilitation efforts with culvert replacement and stream channel regrading has the potential advantage of addressing existing wall stability and deepened stream channel issues in one system. However, since WSDOT owns the gabion basket wall, coordination and cost sharing issues in a timely manner could be problematic.

To deepen the channel while leaving the existing gabion basket wall in place would require permanent shoring to prevent undermining the gabion wall.

4.1.6 Liquefaction

The term liquefaction refers to a phenomenon by which saturated soils develop high pore water pressures during seismic shaking and, as a result, lose their strength characteristics. This phenomenon generally occurs in areas of high seismicity, where groundwater is relatively shallow and where loose granular soils (mainly sands) or non-plastic fine-grained soils (mainly silts) are present. Ground water was encountered within about 1.5 to 7.5 feet of the ground surface in our exploratory borings. Considering depth to groundwater and varying composition and density of soil encountered in our boring, our opinion is that risk of occurrence of liquefaction is moderate.

4.2 Earthwork

Based on the subsurface conditions encountered in our exploration, we expect that all of the on-site soils within the limits of construction can be removed with conventional excavation equipment. Cobbles and boulders were not observed in our exploration but are often found in transitional beds. The contractor should be prepared to deal with cobbles and boulders. Recommendations for site preparation, structural fill, and permanent slopes are presented below.

4.2.1 Site Preparation

Prior to equipment arriving onsite, clearing and grading limits should be established and marked. Silt fences should be constructed along the downslope side of all areas planned for clearing and grading. Preparation for site grading and construction should begin with procedures intended to control surface water runoff. Diversion of the existing stream will be necessary for excavation and construction in the existing channel. The sandy site soils are moderately susceptible to erosion by flowing water.

Stripping efforts should include removal of vegetation, organic materials, and any deleterious debris from the project alignment. It appears that up to about 0.5 feet of stripping will be necessary in areas with light vegetation. Greater depths of stripping and grubbing may be necessary in areas with thick vegetation and tree roots. These materials are not suitable for reuse as structural fill. Site disturbance beyond the work area should be limited to reduce the potential for erosion and off-site sediment transport.

Areas that are stripped or excavated to the design subgrade elevation, or that are to receive structural fill, should be systematically probed to evaluate the subgrade. Any soft, loose, or otherwise unsuitable areas identified during probing should be recompacted if practical or removed and replaced with structural fill. We recommend that probing of the subgrade be observed by a representative of our firm to assess the adequacy of the subgrade conditions and identify areas needing remedial work.

4.2.2 Reuse of Site Soils

Onsite granular soils are suitable for reuse as structural fill or trench backfill on the basis of gradation. However, the fines content of near-surface onsite granular soil make this material highly moisture sensitive. The high groundwater level and in situ moisture content may make this material unsuitable for reuse as structural fill without drying back. This material is unsuitable for use during periods of wet weather.

Fine-grained soil was observed in boring B-4 and H-1-16. This material is not suitable for reuse as structural fill or trench backfill but may be reused in landscaped areas.

4.3 Dewatering

We anticipate that, with careful construction sequencing, shallow excavations less than approximately 2 feet below water table may be dewatered with sumps and pumps. Examples of sequencing construction to manage groundwater include, but are not limited to, starting at the low end of excavation and opening only limited areas so that seepage remains within the removal capacity of the equipment on hand. These considerations may apply to portions of the alignment where the stream may be daylighted.

For deeper excavations a more intensive dewatering effort will be required. While dewatering design is the responsibility of the contractor, we expect that a system of vacuum well points for dewatering less than 15 feet below top of the extraction well, or pumping extraction wells for deeper pumping depths, will be suitable for dewatering trenches to install pipe culvert or box culverts. The trench should be dewatered prior to and during construction to a depth of at least 2 feet below the trench bottom. Disposal of water pumped from the trench should be in accordance with City, County, and State requirements.

Terracon estimates that flow rates may be expected to be in the range of about 250 gallons per minute to about 60 gallons per minute. Dewatering flow rate estimates are based on a number of assumptions and idealizations, including dewatered length limited to 100 feet at a time and depth to about 10 feet. Hydrogeological conditions are greatly simplified from existing conditions for the purpose of estimation. The flow rate estimates are average values over time. Instantaneous flow rates may be significantly higher, particularly at start of pumping a new section. Actual flow rates observed at a particular time and location during construction could vary significantly from the estimates provided due to:

- spatial variability in hydraulic conductivity,
- groundwater elevations at the time of dewatering (including seasonal variability),
- the depth of drawdown required at a particular location,
- the stage of dewatering (higher rates to initially drawdown the groundwater; lower rates to maintain a steady state condition once drawdown has occurred),
- the length of trench dewatered at one time,
- dewatering system design,
- construction sequencing, and/or other factors.

It should also be noted that a factor of safety or other specific conservative assumptions were not included in the model input parameters. Therefore, use of the flow rate estimates from the model should be used carefully and with full consideration of how actual conditions could vary from the model assumptions.

At commencement of dewatering any given section, flow rates are expected to be highest and would decrease as the dewatering system draws the water table down. Dewatering rates would tend toward the lower end of the estimated range for shallower excavations for stream daylighting.

4.4 Box Culverts

Box culverts are proposed in several configurations as part of Options A, B, and C. Foundations should bear on either relatively undisturbed medium dense to very dense sand and gravel of the transitional beds, or structural fill extending down to the transitional beds. Based on the preliminary profile provided by Louis Berger, it appears that thalweg will be within about 2 to 5 feet with the contact with the transitional beds. Given that minimum embedment of foundations of 2 feet and that foundations may be deeper for scour considerations we anticipate minimal overexcavation would be required for box culvert foundations.

Headwalls of box culverts should extend below scour depth. For preliminary design we recommend assuming that headwalls should extend at least 2 feet below the culvert footing depth.

4.5 Pipe Culverts

Based on the preliminary profile provided by Louis Berger, it appears that thalweg will be within about 2 to 5 feet of the contact with the transitional beds. The medium dense to very dense sand and gravel transitional bed soils or medium dense granular alluvial soils will provide adequate support to the 72-inch diameter corrugated metal pipe (CMP) culvert proposed in Options C and D. Localized soft areas at the bottom of the trench excavation may need to be overexcavated and replaced with structural fill. The CMP should be bedded in a well-graded granular material with particles no larger than 1 ½-inches in diameter and fines content less than 10 percent.

4.6 Support of Tolt Pipeline

We expect that the pipeline will not be able to span the 15 to 20 foot wide excavation required to install a 10 foot wide culvert. Smaller pipelines are sometimes supported from above by spanning the excavation with structural steel placed on grade and tying the pipeline to the steel. The size of this pipe may require bracing the pipeline on a pile-supported frame. Based on the information from WSDOT boring H-1-16, driving piles with impact or vibratory hammers or drilling soldier piles appears feasible.

The design team expects minimum clearance between the pipe invert and the top of the culvert. Standard culvert designs typically require 2 or more feet of soil cover to distribute heavy loads from above. Depending on culvert design and configuration, pipeline bracing may need to be permanent to keep load off of the culvert.

4.7 Open Channel Slopes

Open channel cut slopes should be no steeper than 2H:1V and would require surface protection from erosion. Cut slopes covered by a geotextile and rock facing sized to prevent erosion and scour could be used to protect the cut slopes. Synthetic slope protection systems are also available such as cellular confinement (or geocells) with the cells filled with granular material and seeded with grasses to provide a greener alternate slope protection concept.

4.8 Channel Wall Alternatives

Permanent stream channel walls and temporary shoring for stream regrading will need to be designed to support surcharge from the slopes and potentially the roadway above. Scour will be another major design consideration that compounds the concerns with the cut at the toe of the surcharged slope since it means effectively designing for a higher retained height at toe of slope. These considerations limit feasible wall system alternatives where surcharges exist along 25th Avenue NE and Ballinger Way .

4.8.1 Soldier Pile and Lagging

A soldier pile wall with lagging would be capable of supporting the surcharges. Equipment access could be a challenge to constructing this system at this location. Driving piles with a vibratory hammer appears to be feasible based on the soils observed in boring B-4 and H-1-16. Given space constraints for equipment and the desirability of not generating spoils, driven piles offer an advantage over drilled soldier piles. However, ground vibrations from installation by driven methods could be of concern for nearby residential structures. Permanent soldier piles would require corrosion protection (hot dip galvanizing is typical) or sacrificial thickness if left exposed to the elements. Lagging should be installed to at least 2 feet below the anticipated scour depth.

Lagging/facing options include:

- Pressure-treated wood lagging is often used for permanent walls without other facing for its ease of installation and relative price. However, this alternative may not be the most appropriate considering the alternate wetting and drying conditions at the stream channel and potential environmental concerns for use of pressure-treated products in an aquatic environment.
- Concrete lagging might be a lower maintenance alternative to pressure-treated wood. The exposed side can be formed and dyed to give an attractive appearance. Installation can be difficult, however. Concrete lagging is typically precast and sizing in the field is not possible. Pile installation tolerances may need to be tightened or a wider flange on the piles may be needed to ensure adequate bearing area of the lagging on the pile flanges. Of the facing options presented this could be the most expensive to construct.
- Temporary wood (untreated) lagging with a permanent concrete facing has some of the advantages of both pressure treated wood and concrete lagging. The facing can be precast concrete panels or shotcrete sculpted and dyed to give a more natural appearance. With adequate shotcrete cover over the piles, corrosion protection or sacrificial thickness may not be required. Initial installation of lagging is still relatively simple but requires the additional step of adding permanent facing.

Placing shotcrete in the stream channel may pose permitting and/or constructability challenges.

4.8.2 Gravity

A gravity wall constructed with ecology blocks or cast-in-place concrete is another alternative capable of supporting the surcharges. Ecology blocks are available with many facing patterns and can be dyed for asthetics. We anticipate that this wall system will have to extend about 4 feet below the proposed channel bottom to account for scour depth and to maintain minimum embedment depth. This means that a cut of 6 to 8 feet at the toe of slope will be required. Our opinion is that stand-up times in the wet silty sand soil observed in boring B-4 would be too short to allow an open cut of even a modest length for construction. We expect that some form of temporary shoring such as sheet piles or soldier pile and lagging would be required to construct a gravity wall.

4.8.3 Sheet Piles

Driving sheets with impact or a vibratory hammer appears to be feasible though driving could be difficult through the silty gravel observed between elevation 196.5 and 192 feet in boring B-4. Sheet piles could be used for temporary shoring or for a permanent wall though the aesthetics may not be as pleasing as other alternatives. As with exposed soldier piles for permanent applications, corrosion protection or sacrificial steel should be provided for the portion of the piles above seasonal low groundwater.

4.8.4 Rockery

We understand that a rockery has been considered initially by the design team. Rockeries are suitable for protection of cut slopes of limited height in otherwise stable ground and are not considered to be effective as engineered retaining structres. In our opinion, rockeries are not suitable for retaining slopes with the soil conditions present at borings B-4 and H-1-16. Armoring the east bank of the stream channel where the backslope is relatively level and of limited height with a rockery (or slope armored with rock) appears feasible geotechnically. It is our opinion that a rockery is not appropriate along the relatively high and steep west bank along 25th Avenue NE north of NE 195th Street or the south bank along Ballinger Way where the existing height and steepness of slope or the presence of a failing gabion wall requires a more positive form of slope retention.

4.9 Recommendations for Final Design

After the preferred alternative is selected, Terracon will refine and expand upon the preliminary recommendations presented in this report and make them specific to the preferred alternative. These refinements may include, depending on the alternative selected:

- Slope stability modeling of the proposed final stream configuration at 25th Avenue NE and Ballinger Way

- One additional boring downstream of NE 195th Street
- Specific material and compaction requirements for support and backfill of buried structures
- Shoring and/or retaining wall recommendations specific to the selected system
- Underpinning and protection of the SPU water pipe
- Plan review for consistency with our geotechnical recommendations.

5.0 GENERAL COMMENTS

This report has been prepared to provide preliminary geotechnical engineering to support evaluation of project alternatives. Once an alternative is selected and the project moves toward final design, it is intended that Terracon replace this preliminary report with a design phase geotechnical engineering report that addresses the specific geotechnical design and construction elements associated with the selected project alternative.

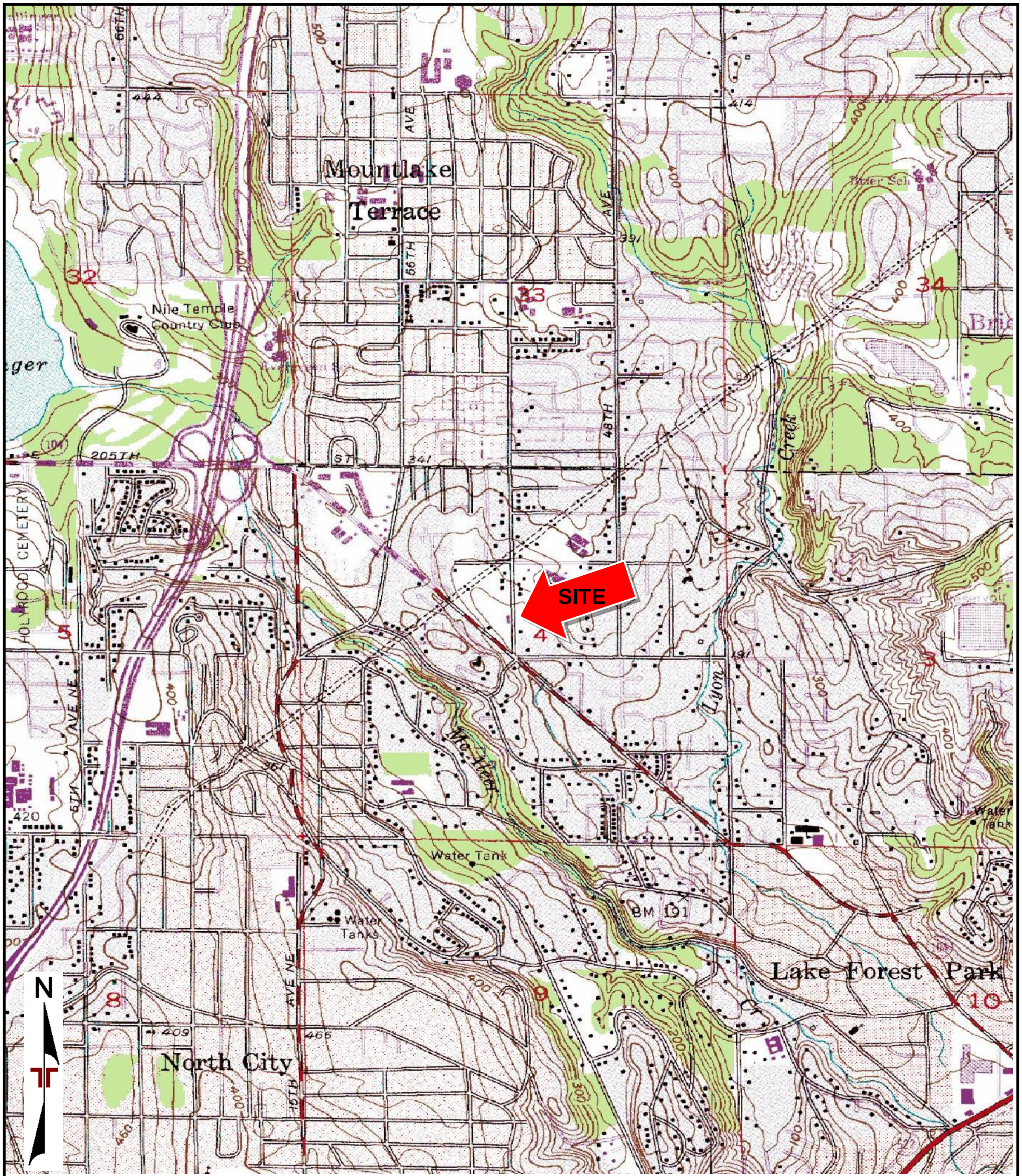
At the conclustion of design, Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The preliminary analyses and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between borings, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions other than the limited soil and groundwater testing as discussed in this report. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of Louis Berger for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

APPENDIX A
FIELD EXPLORATION

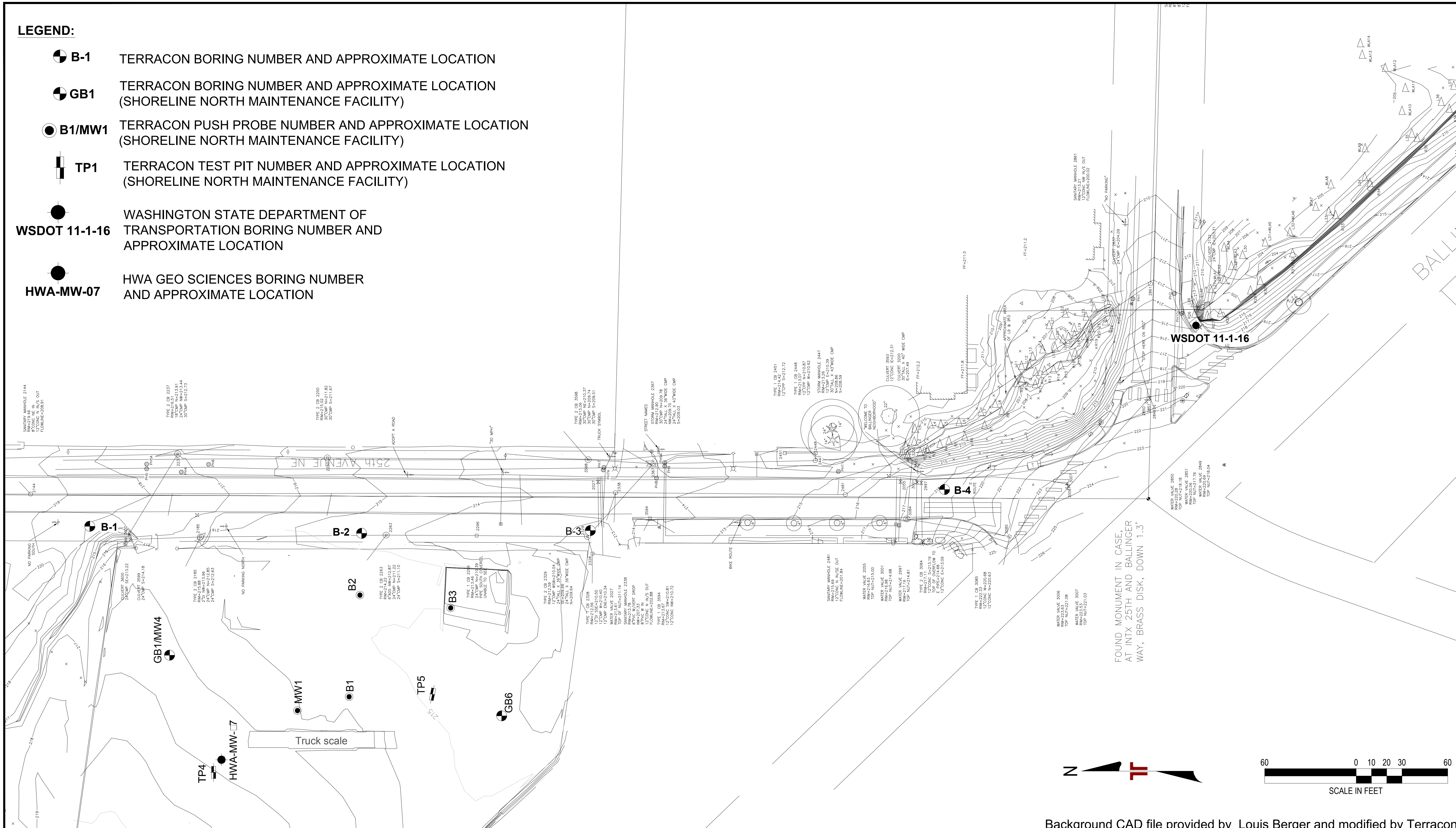


TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: EDMONDS EAST, WA (1/1/1981) and SEATTLE NORTH, WA (1/1/1983).

Project Manager: TLH	Project No. 81165045	Terracon	SITE LOCATION	Exhibit
Drawn by: AMP	Scale: 1"=2,000'	21905 64th Ave W Ste 100	25th Ave NE Flood Reduction Project	A-1
Checked by: TLH	File Name: Exhibit 1	Mountlake Terrace, WA 98043-2251	25th Ave NE	
Approved by: TLH	Date: July 2016		Shoreline, King County, Washington	

LEGEND:

Symbol	Description
B-1	TERRACON BORING NUMBER AND APPROXIMATE LOCATION
GB1	TERRACON BORING NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)
B1/MW1	TERRACON PUSH PROBE NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)
TP1	TERRACON TEST PIT NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)
WSDOT 11-1-16	WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BORING NUMBER AND APPROXIMATE LOCATION
HWA-MW-07	HWA GEO SCIENCES BORING NUMBER AND APPROXIMATE LOCATION



Background CAD file provided by Louis Berger and modified by Terracon.

Project Mngr: TLH	Project No. 81165045	Terracon Consulting Engineers and Scientists 21905 64th Avenue W, Ste 100 Mountlake Terrace, WA 98043 PH. (425) 771-3304 FAX. (425) 771-3549	**SITE AND EXPLORATION PLAN** 25th Ave NE Flood Reduction Project 25th Ave NE Shoreline, King County, Washington
Drawn By: AMP	Scale: AS SHOWN		
Checked By: TLH	File No. Exhibit A-2		EXHIBIT A-2
Approved By: DRS	Date: July 2016		

Field Exploration Description

The proposed boring locations were laid out in the field by a Terracon representative using a scaled site plan provided by Louis Berger, Inc. and a tape measure. Ground surface elevations indicated on the boring logs were interpolated from the topographic contours on the site plan. The locations and elevations of the borings should be considered accurate only to the degree implied by the means and methods used to define them.

The borings were drilled with a truck-mounted rotary drill rig using hollow-stem augers to advance the boreholes. Samples of the soil encountered in the borings were obtained using the split-barrel sampling procedures.

In the split-barrel sampling procedure, the number of blows required to advance a standard 2-inch O.D. split-barrel sampler the last 12 inches of the typical total 18-inch penetration by means of a 140-pound hammer with a free fall of 30 inches, is the standard penetration resistance value (SPT-N). This value is used to estimate the in situ relative density of cohesionless soils and consistency of cohesive soils.

An automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A significantly greater efficiency is achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. This higher efficiency has an appreciable effect on the SPT-N value. The effect of the automatic hammer's efficiency has been considered in the interpretation and analysis of the subsurface information for this report.

The samples were tagged for identification, sealed to reduce moisture loss, and taken to our laboratory for further examination, testing, and classification. Information provided on the boring logs attached to this report includes soil descriptions, consistency evaluations, boring depths, sampling intervals, and groundwater conditions. The borings were backfilled with bentonite chips prior to the drill crew leaving the site.

Standpipe piezometers were installed in borings B-1, B-2, and B-3. Each of these wells was screened from approximately 10 feet below ground surface (bgs) to 20 feet bgs with 2-inch nominal diameter by 0.020-inch slotted PVC pipe. The filter pack consisted of #10-20 Colorado Sand.

A field log of each boring was prepared by a Terracon geotechnical engineer. These logs included visual classifications of the materials encountered during drilling as well as the engineer’s interpretation of the subsurface conditions between samples. Final boring logs included with this report represent the engineer's interpretation of the field logs and include modifications based on laboratory observation and tests of the samples.

BORING LOG NO. B-1

PROJECT: 25th Avenue NE Flood Reduction

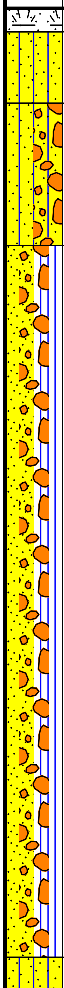
CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION: See Exhibit A-2

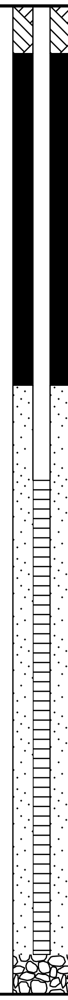
Latitude: 47.772063° Longitude: -122.302964°

Approximate Surface Elev: 219 (Ft.) +/-



DEPTH	Material Description	ELEVATION (Ft.)
0.5	**SOD**	218.5+/-
2.0	**SILTY SAND (SM)**, olive gray, moist	217+/-
5.0	**SILTY SAND (SM)**, with gravel, brown, very loose, moist, with rootlets	214+/-
20.0	**POORLY GRADED SAND WITH SILT (SP-SM)**, gravelly, gray, medium dense, wet; trace gravel; gravelly, very dense; with gravel, dense; very dense	199+/-
20.8	**SILTY SAND**, very dense, wet	198+/-
	Boring Terminated at 20.83 Feet	

INSTALLATION DETAILS



WATER LEVEL OBSERVATIONS: water level symbols shown at approx. 1.6 ft and 7.5 ft depth.

DEPTH (Ft.)	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
2.5–4	X	2	2-1-1 N=2	S-1	0.2		
5–6.5	X	11	6-9-15 N=24	S-2	0.3	15	8
7.5–9	X	12	8-9-15 N=24	S-3	0.4		
10–11.5	X	12	12-49-35 N=84	S-4	0.4		
12.5–14	X	6	7-14-16 N=30	S-5	0.6		
15–16.5	X	15	16-21-30 N=51	S-6	0.5		
20–20.83	X	14	39-50/4" N=50/4"	S-7	0.4		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:
Well Tag BJW 176

WATER LEVEL OBSERVATIONS

- *While drilling*
- *1.6' bgs on 7/11/2016*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/5/2016	Boring Completed: 7/5/2016
Drill Rig: D-120 truck	Driller: Holocene
Project No.: 81165045	Exhibit: A-4

BORING LOG NO. B-2

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION: See Exhibit A-2

Latitude: 47.771543° Longitude: -122.302944°

Approximate Surface Elev: 215 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
0.5	**FILL - , CRUSHED ROCK SURFACING**	214.5+/-									
	SILTY SAND (SM), with gravel, olive gray, medium dense, moist			▽							
					X	7	6-10-11 N=21	S-1	1.0		
4.0		211+/-									
	SILTY SAND (SM), olive gray, medium dense, wet		5	▽							
					X	10	6-10-15 N=25	S-2	0.5		
7.5		207.5+/-									
	SILTY GRAVEL (GM), sandy, gray, very dense, wet				X	9	27-30-29 N=59	S-3	0.6	8	14
			10		X	12	17-30-27 N=57	S-4	1.2		
12.5		202.5+/-									
	SILTY SAND (SM), gravelly, gray, dense, wet				X	12	14-21-27 N=48	S-5	0.5		
	medium dense		15		X	10	14-12-12 N=24	S-6	1.0		
	very dense		20		X	12	21-30-33 N=63	S-7	0.7		
21.5		193.5+/-									
	Boring Terminated at 21.5 Feet										

INSTALLATION DETAILS

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:
Well Tag BJW 175

WATER LEVEL OBSERVATIONS

▽ *While drilling*
▽ *1.8' bgs on 7/11/2016*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/5/2016	Boring Completed: 7/5/2016
Drill Rig: DR009	Driller: Holocene
Project No.: 81165045	Exhibit: A-5

BORING LOG NO. B-3

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

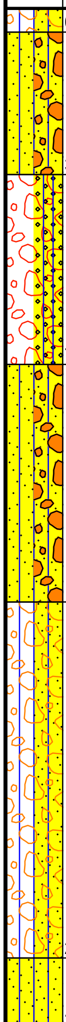
SITE:
Shoreline, Washington

LOCATION: See Exhibit A-2

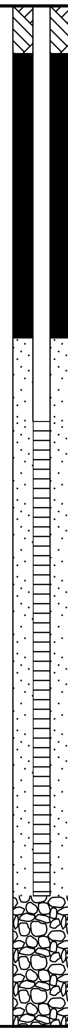
Latitude: 47.77112° Longitude: -122.302913°

Approximate Surface Elev: 213 (Ft.) +/-

GRAPHIC LOG



INSTALLATION DETAILS



DEPTH	Material Description	ELEVATION (Ft.)
0.5	**FILL - , CRUSHED ROCK SURFACING**	212.5+/-
3.5	**SILTY SAND (SM)**, trace gravel, olive gray, medium dense, moist	209.5+/-
7.5	**WELL GRADED GRAVEL WITH SILT (GW-GM)**, sandy, gray, medium dense, wet gravelly, wood fragments	205.5+/-
12.5	**SILTY SAND (SM)**, gravelly, gray, very dense, wet dense	200.5+/-
20.0	**SILTY GRAVEL (GM)**, sandy, gray, very dense, wet	193+/-
21.5	**SILTY SAND (SM)**, with gravel, gray, very dense, wet	191.5+/-

Boring Terminated at 21.5 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
2.5–4	∇	X	6	5-8-6 N=14	S-1	0.3		
5–6.5	∇	X	6	5-7-7 N=14	S-2	0.3	14	7
7.5–9		X	14	26-36-23 N=59	S-3	0.3	12	19
10–11.5		X	13	8-17-22 N=39	S-4	0.2		
12.5–14		X	6	22-50 N= N=50/6"	S-5	0.2		
15–16.5		X	6	28-50 N= N=50/3"	S-6	0.4		
20–21.5		X	12	23-29-31 N=60	S-7	0.4		

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:
Well Tag BJW 174

WATER LEVEL OBSERVATIONS

∇ *While drilling*
∇ *2.8' bgs on 7/11/2016*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/5/2016	Boring Completed: 7/5/2016
Drill Rig: DR009	Driller: Holocene
Project No.: 81165045	Exhibit: A-6

BORING LOG NO. B-4

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger
Seattle, Washington

SITE:
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.770511° Longitude: -122.302816°

Approximate Surface Elev: 222 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)
0.5	**FILL - ASPHALT CONCRETE**, 6"	221.5+/-
1.0	**FILL - AGGREGATE BASE COURSE**, 6"	221+/-
2.5	**FILL - SILTY SAND (SM)**, with gravel, olive gray, loose to medium dense, moist	219.5+/-
3.0	**FILL - LEAN CLAY (CL)**, sandy, gray, very soft to soft, moist	219+/-
3.3	**FILL - SILTY SAND (SM)**, gravelly, black, dense, oily feel, hydrocarbon odor	219+/-
8.3	**LEAN CLAY (CL)**, sandy, gray, stiff, moist No recovery	214+/-
10.0	**POORLY GRADED SAND (SP-SM)**, with silt, red brown, loose, moist	212+/-
	SILTY SAND (SM), gray, very loose, wet medium dense	

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
		X	10	2-1-29 N=30	S-1	11.3		
5		X	0	4-5-5 N=10	S-2	0.3		
	▽	X	9	3-2-2 N=4	S-3	0.8		
10		X	5	1-1-1 N=2	S-4	0.2		
		X	5	6-9-13 N=22	S-5			
15		X	9	8-6-5 N=11	S-6			
20		X	12	11-18-25 N=43	S-7			
25								

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS
▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/6/2016	Boring Completed: 7/6/2016
Drill Rig: DR009	Driller: Holocene
Project No.: 81165045	Exhibit: A-7

BORING LOG NO. B-4

PROJECT: 25th Avenue NE Flood Reduction

CLIENT: Louis Berger Seattle, Washington

SITE: Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.770511° Longitude: -122.302816°

Approximate Surface Elev: 222 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE ID	PID (ppm)	WATER CONTENT (%)	PERCENT FINES
25.5	**SILTY GRAVEL (GM)**, with sand, gray, very dense, wet, broken gravels	196.5+/-			X	13	13-32-30 N=62	S-8			
30.0	**SILTY SAND (SM)**, gray, medium dense, wet, driller added water at 30' bgs, driller notes heave at 30'	192+/-	30		X	8	5-5-6 N=11	S-9			
31.5	***Boring Terminated at 31.5 Feet***	190.5+/-									

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
HSA 4 1/4" ID, 8" OD

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

While drilling

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 7/6/2016	Boring Completed: 7/6/2016
Drill Rig: DR009	Driller: Holocene
Project No.: 81165045	Exhibit: A-7

WELL LOG NO. GB1/MW-4

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771851° Longitude: -122.303263°

Approximate Surface Elev: 217.5 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)
0.2	**ASPHALT 1-2"**	217.5+/-
1.0	**SILTY SAND (SM)**, with gravel, dark brown, moist	216.5+/-
7.0	**SAND (SP-SM)**, with silt, trace gravel, dark gray, medium dense, wet; grades to dense	210.5+/-
9.5	**SAND (SP-SM)**, with silt and gravel, dark gray, dense, wet	208+/-
20.5	**GRAVEL (GP)**, with sand, trace silt, very dense, wet	197+/-
21.5	**SANDY SILT (ML)**, with gravel, gray, hard, wet	196+/-

Boring Terminated at 21.5 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.5	▽							
2.5–4		X	6	5-11-10 N=21	S-1	16		11
5–6.5		X	12	11-16-16 N=32	S-2			
7.5–9		X	12	16-19-20 N=39	S-3			
10–11		X	6	20-50/6" N=50/6"	S-4			
12.5–14		X	12	19-25-21 N=46	S-5			
15–15.5		X	6	50/6" N=50/6"	S-6			
20–21.5		X	12	30-50/6" N=50/6"	S-7			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
8" Hollow Stem Auger

Abandonment Method:
2" Monitoring Well

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Well Started: 1/20/2016	Well Completed: 1/20/2016
Drill Rig: B-59	Driller: Holt Services, Inc.
Project No.: 81155070	Exhibit: A-8

BORING LOG NO. GB6

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771262° Longitude: -122.303336°

Approximate Surface Elev: 217 (Ft.) +/-

DEPTH	Material Description	ELEVATION (Ft.)
0.2	**ASPHALT 1-2"**	217+/-
1.0	**SILTY SAND (SM)**, with gravel, dark brown, moist	216+/-
4.5	**SILTY SAND (SM)**, with gravel, gray, loose, moist grades to wet	212.5+/-
9.5	**SILTY SAND (SM)**, with gravel, gray, dense, wet grades to very dense	207.5+/-
14.0	**GRAVELLY SAND (SP)**, trace silt, gray, very dense, wet	203+/-

Boring Terminated at 14 Feet

DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	▽	X	9	4-2-4 N=6	S-1	15		21
5		X	9	15-16-20 N=36	S-2			
		X	9	17-22-44 N=66	S-3			
10		X	18	8-17-24 N=41	S-4			
		X	18	13-47-50 N=97	S-5			

Stratification lines are approximate. In-situ, the transition may be gradual.

Hammer Type: Automatic SPT Hammer

Advancement Method:
8" Hollow Stem Auger

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were measured in the field using an engineer's level and grade rod.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 1/21/2016	Boring Completed: 1/21/2016
Drill Rig: B-59	Driller: Holt Services, Inc.
Project No.: 81155070	Exhibit: A-9

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 81155070 BORING LOGS.GPJ TERRACON2015.GDT 8/11/16

TEST PIT LOG NO. TP4

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771831° Longitude: -122.303584°

Approximate Surface Elev: 218 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	RECOVERY (In.)	FIELD TEST RESULTS	SAMPLE NUMBER	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
0.2	**FILL - ASPHALT CONCRETE**, 2 1/2"	218+/-									
0.5	**FILL - AGGREGATE BASE COURSE**, black, medium dense to dense, 3 1/2" oily feel, strong hydrocarbon odor	217.5+/-			Grab			S-1			
3.0	**FILL - SILTY SAND (SM)**, trace gravel, gray to red brown, very loose to loose, moist, trace organics and woody fragments tree roots	215+/-									
5.5	**PEAT (PT)**, brown, very soft to soft groundwater seepage observed pit wall at 5'	212.5+/-	5	▽	Grab			S-2	243	NP	
					Grab			S-3			
6.5	**POORLY GRADED GRAVEL WITH SILT (GP-GM)**, sandy, gray, medium dense to dense, wet, minor caving below 5.5'	211.5+/-									
8.0	**SILTY SAND (SM)**, olive gray, medium dense to dense, wet	210+/-			Grab			S-4			

Test Pit Terminated at 8 Feet

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Backhoe with 36" bucket

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While digging*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Test Pit Started: 6/27/2016	Test Pit Completed: 6/27/2016
Excavator: Cat 420F IT backhoe	Operator: City of Shoreline
Project No.: 81155070	Exhibit: A-10

TEST PIT LOG NO. TP5

PROJECT: Shoreline North Maintenance Facility

CLIENT: TCF Architecture
Tacoma, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit A-2

Latitude: 47.771698° Longitude: -122.303424°

Approximate Surface Elev: 215 (Ft.) +/-

DEPTH	DESCRIPTION	ELEVATION (Ft.)
0.3	**FILL - ASPHALT CONCRETE**, 3"	215+/-
0.5	**FILL - AGGREGATE BASE COURSE**, black, medium dense to dense, 3" oily feel, strong hydrocarbon odor	214.5+/-
3.5	**FILL - SILTY SAND (SM)**, with gravel, trace cobbles, gray to red brown, very loose to loose, moist, trace organics and woody fragments	211.5+/-
4.0	tree roots	211+/-
5.0	**PEAT (PT)**, brown, very soft to soft	210+/-
6.0	**POORLY GRADED GRAVEL WITH SILT (GP-GM)**, sandy, fine gravel, gray, medium dense to dense, wet, trace woody fragments, groundwater seepage from 4'	209+/-
	SILTY SAND (SM), olive gray, medium dense to dense, wet	
8.5	**POORLY GRADED GRAVEL WITH SILT (GP-GM)**, sandy, coarse gravel, gray, medium dense to dense, wet,	206.5+/-

Test Pit Terminated at 8.5 Feet

SAMPLE NUMBER	WATER LEVEL OBSERVATIONS	WATER CONTENT (%)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
S-1				
S-2				
S-3	▽	80	NP	
S-4				
S-5				

Columns: DEPTH (Ft.) (5), WATER LEVEL OBSERVATIONS, SAMPLE TYPE, RECOVERY (In.), FIELD TEST RESULTS, SAMPLE NUMBER, WATER CONTENT (%), ATTERBERG LIMITS LL-PL-PI, PERCENT FINES

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Backhoe with 36" bucket

Abandonment Method:
Backfilled with soil cuttings upon completion.

See Exhibit A-3 for description of field procedures.
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix C for explanation of symbols and abbreviations.
Elevations were interpolated from a topographic site plan.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While digging*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Test Pit Started: 6/27/2016	Test Pit Completed: 6/27/2016
Excavator: Cat 420F IT backhoe	Operator: City of Shoreline
Project No.: 81155070	Exhibit: A-11

WELL LOG NO. B1

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

INSTALLATION DETAILS

Well Completion:

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
0.2	**ASPHALT 1-2"**							
0.5	**SILTY SAND (SM)**, with gravel, brown/dark brown							
	SAND (SP), gray, moist, hydrocarbon odor					<1		
	grades to saturated			▽	■	48.7		B1-3'
4.0								
4.5	**SILT (ML)**, with organics, dark brown, moist							
5.0	**SAND (SP)**, with gravel, gray, wet		5			3.8		
	SILT (ML), with organics, dark brown, moist							
6.5	**GRAVELLY SAND (SP)**, gray, wet							
8.0						<1		
8.5	**CLAYEY SILT (CL-ML)**, tan, moist							
	GRAVELLY SAND (SP), gray, wet		10					
						<1		
13.0	**SANDY SILT (SM)**, tan, wet							
14.0	***Boring Refusal at 14 Feet***							

3/4" Slotted PVC pipe packed in sand

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:
- Temporary well removed after groundwater sample collection.

WATER LEVEL OBSERVATIONS
▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Well Started: 1/11/2016	Well Completed: 1/11/2016
Drill Rig: AMS Power Probe	Driller: Holt Services, Inc.
Project No.: 81157201	Exhibit: A-12

WELL LOG NO. B2

PROJECT: Shoreline North Maintenance Facility - LSI

**CLIENT: TCF Architecture
Seattle, Washington**

**SITE: 19547 25th Avenue NE
Shoreline, Washington**

LOCATION See Exhibit 2

INSTALLATION DETAILS

Well Completion:

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
0.2	**ASPHALT 1-2"**								
	SILTY SAND (SM), with gravel, brown/dark brown, moist						<1		
	grades to gray						<1		
5.5			3/4" Slotted PVC pipe packed in sand	5					
	SILTY SAND (SM), with organics, gray, wet						<1		
7.0									
7.5	**SILT (ML)**, gray, moist				▽				
	GRAVELLY SAND (SP), gray, wet					■	<1		B2-7.5'
				10			<1		
13.0									
	GRAVEL (GP), with sand, gray, wet								
15.0				15					
	Boring Terminated at 15 Feet								

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:
- Temporary well removed after groundwater sample collection.

WATER LEVEL OBSERVATIONS
▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Well Started: 1/11/2016	Well Completed: 1/11/2016
Drill Rig: AMS Power Probe	Driller: Holt Services, Inc.
Project No.: 81157201	Exhibit: A-13

WELL LOG NO. B3

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

INSTALLATION DETAILS

Well Completion:

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	INSTALLATION DETAILS	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
0.3	**3-4" Concrete**								
	GRAVEL (GP), with sand, gray, wet				▽	■	<1		B3-1'
							<1		
5.0	**GRAVEL (GP)**, gray, wet		3/4" Slotted PVC pipe packed in sand	5		■	<1		B3-2'
6.0	**SAND (SP)**, with gravel, gray-brown, wet								
8.0	**SAND (SP)**, black						<1		
10.0	**GRAVELLY SAND (GP)**, gray, wet			10			<1		
	grades to brown								
15.0	***Boring Terminated at 15 Feet***			15					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:
- Temporary well removed after groundwater sample collection.

WATER LEVEL OBSERVATIONS
▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Well Started: 1/11/2016	Well Completed: 1/11/2016
Drill Rig: AMS Power Probe	Driller: Holt Services, Inc.
Project No.: 81157201	Exhibit: A-14

BORING LOG NO. MW1

PROJECT: Shoreline North Maintenance Facility - LSI

CLIENT: TCF Architecture
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	ELEVATION (Ft.)	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SPT N-VALUE	SAMPLE NUMBER
0.2	**ASPHALT 1-2"**							
	SAND (SP), brown-gray, moist					<1		
				▽				
4.0	grades to wet				■	<1		MW1-3.5
4.5	**SILT (ML)**, with organics, dark brown, moist							
	SAND (SP), gray, wet		5			<1		
7.0	grades to brown							
	SILT (ML), light brown with orange mottling, wet							
8.0	**SILTY SAND (SM)**, with gravel, gray, wet					<1		
11.0			10					
	Refusal at 11 Feet							

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push

Abandonment Method:
Borings backfilled with bentonite chips upon completion

See Appendices for description of field procedures.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While Drilling*

Terracon
21905 64th Ave. W, Suite 100
Mountlake Terrace, Washington

Boring Started: 1/11/2016	Boring Completed: 1/11/2016
Drill Rig: AMS Power Probe	Driller: Holt Services, Inc.
Project No.: 81157201	Exhibit: A-15

APPENDIX B
LABORATORY TESTING

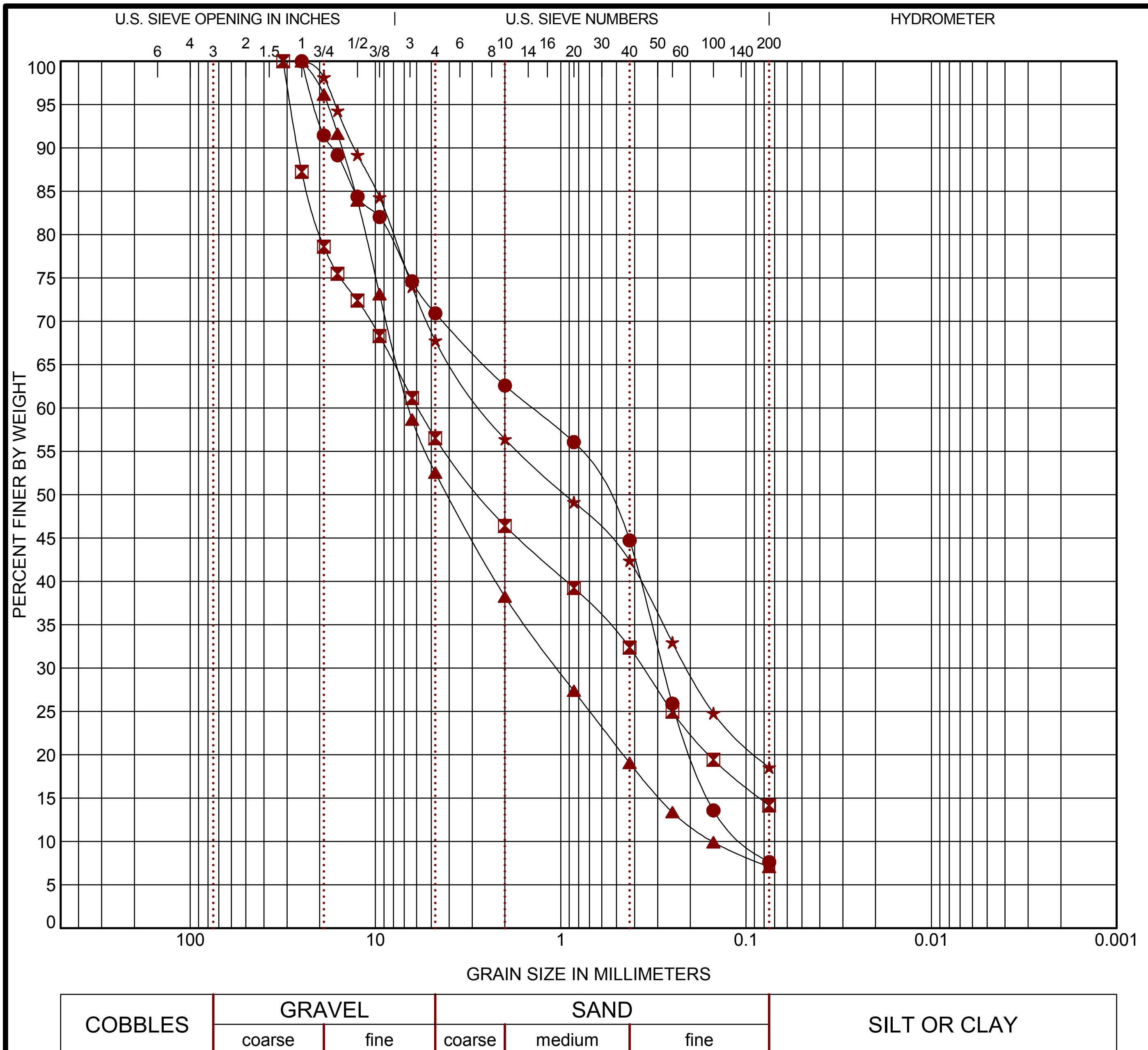
Laboratory Testing Description

Soil samples were tested in the laboratory to measure their natural water content. The test results are provided on the boring logs included in Appendix A.

Descriptive classifications of the soils indicated on the boring logs are in accordance with the enclosed General Notes and the Unified Soil Classification System. Also shown are estimated Unified Soil Classification Symbols. A brief description of this classification system is attached to this report. All classification was by visual manual procedures. Selected samples were further classified using the results of grain size distribution testing. Grain size distribution plots are included in this appendix. Fines content results are also provided on the boring logs.

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B-1	5 - 6.5	POORLY GRADED SAND WITH SILT AND GRAVEL SP-SM				0.56	14.41
⊠	B-2	7.5 - 9	SILTY GRAVEL WITH SAND GM					
▲	B-3	5 - 6.5	WELL GRADED GRAVEL WITH SILT AND SAND GW-GM				1.09	43.38
★	B-3	7.5 - 9	SILTY SAND WITH GRAVEL SM					

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
●	B-1	5 - 6.5	25	1.425	0.281	0.099	29.1	63.3	7.6
⊠	B-2	7.5 - 9	31.5	5.907	0.359		43.5	42.4	14.1
▲	B-3	5 - 6.5	25	6.591	1.046	0.152	47.5	45.5	7.1
★	B-3	7.5 - 9	25	2.63	0.208		32.2	49.2	18.5

PROJECT: 25th Avenue NE Flood Reduction

SITE: Shoreline, Washington

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

PROJECT NUMBER: 81165045

CLIENT: Louis Berger
Seattle, Washington

EXHIBIT: B-2

August 2, 2016

Mr. Mike Noll
Terracon
21905 - 64th Ave W, Suite 100
Mountlake Terrace, WA 98043

Dear Mr. Noll,

On July 27th, 2 samples were received by our laboratory and assigned our laboratory project number EV16070152. The project was identified as your 81165045. The sample identification and requested analyses are outlined on the attached chain of custody record.

No abnormalities or nonconformances were observed during the analyses of the project samples.

Please do not hesitate to call me if you have any questions or if I can be of further assistance.

Sincerely,

ALS Laboratory Group

Rick Bagan
Laboratory Director

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-01
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 12:51:00 PM
CLIENT SAMPLE ID	B-2-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	50	1	UG/L	07/29/2016	PAB
TPH-Diesel Range	NWTPH-DX	U	130	1	UG/L	07/28/2016	EBS
TPH-Oil Range	NWTPH-DX	U	250	1	UG/L	07/28/2016	EBS
Dichlorodifluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Vinyl Chloride	EPA-8260	U	0.20	1	UG/L	07/29/2016	DLC
Bromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Tetrachloride	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichlorofluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Disulfide	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Acetone	EPA-8260	U	25	1	UG/L	07/29/2016	DLC
1,1-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Methylene Chloride	EPA-8260	U	5.0	1	UG/L	07/29/2016	DLC
Acrylonitrile	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Methyl T-Butyl Ether	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Butanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Dibromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromodichloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Methyl-2-Pentanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Toluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Hexanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,3-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-01
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 12:51:00 PM
CLIENT SAMPLE ID	B-2-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Tetrachloroethylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Dibromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromoethane	EPA-8260	U	0.010	1	UG/L	07/29/2016	DLC
Chlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Ethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
m,p-Xylene	EPA-8260	U	4.0	1	UG/L	07/29/2016	DLC
Styrene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
o-Xylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromoform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Isopropylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Propyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
T-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
S-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
P-Isopropyltoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,4-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Butylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Hexachlorobutadiene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Naphthalene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Mercury	EPA-245.1	U	0.20	1	UG/L	07/28/2016	RAL
Arsenic	EPA-200.8	**5.3**	1.0	1	UG/L	07/28/2016	RAL
Cadmium	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL
Chromium	EPA-200.8	U	2.0	1	UG/L	07/28/2016	RAL
Lead	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	8/2/2016
		ALS JOB#:	EV16070152
		ALS SAMPLE#:	EV16070152-01
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 12:51:00 PM
CLIENT SAMPLE ID	B-2-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**83.5**	07/29/2016	PAB
C25	NWTPH-DX	**92.1**	07/28/2016	EBS
1,2-Dichloroethane-d4	EPA-8260	**97.5**	07/29/2016	DLC
Toluene-d8	EPA-8260	**101**	07/29/2016	DLC
4-Bromofluorobenzene	EPA-8260	**88.9**	07/29/2016	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-02
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 1:33:00 PM
CLIENT SAMPLE ID	B-3-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	50	1	UG/L	07/29/2016	PAB
TPH-Diesel Range	NWTPH-DX	U	130	1	UG/L	07/28/2016	EBS
TPH-Oil Range	NWTPH-DX	U	250	1	UG/L	07/28/2016	EBS
Dichlorodifluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Vinyl Chloride	EPA-8260	U	0.20	1	UG/L	07/29/2016	DLC
Bromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Tetrachloride	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichlorofluoromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Carbon Disulfide	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Acetone	EPA-8260	U	25	1	UG/L	07/29/2016	DLC
1,1-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Methylene Chloride	EPA-8260	U	5.0	1	UG/L	07/29/2016	DLC
Acrylonitrile	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Methyl T-Butyl Ether	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Butanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Chloroform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trichloroethene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Dibromomethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromodichloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Methyl-2-Pentanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
Toluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2-Trichloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Hexanone	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,3-Dichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Tetrachloroethylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC

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ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-02
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 1:33:00 PM
CLIENT SAMPLE ID	B-3-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromoethane	EPA-8260	U	0.010	1	UG/L	07/29/2016	DLC
Chlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Ethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
m,p-Xylene	EPA-8260	U	4.0	1	UG/L	07/29/2016	DLC
Styrene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
o-Xylene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromoform	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Isopropylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichloropropane	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Bromobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Propyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
2-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
4-Chlorotoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
T-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
S-Butyl Benzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
P-Isopropyltoluene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,3-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,4-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
N-Butylbenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	10	1	UG/L	07/29/2016	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Hexachlorobutadiene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Naphthalene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	2.0	1	UG/L	07/29/2016	DLC
Mercury	EPA-245.1	U	0.20	1	UG/L	07/28/2016	RAL
Arsenic	EPA-200.8	**1.7**	1.0	1	UG/L	07/28/2016	RAL
Cadmium	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL
Chromium	EPA-200.8	U	2.0	1	UG/L	07/28/2016	RAL
Lead	EPA-200.8	U	1.0	1	UG/L	07/28/2016	RAL

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**83.5**	07/29/2016	PAB

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	8/2/2016 EV16070152 EV16070152-02
CLIENT CONTACT:	Mike Noll	DATE RECEIVED:	07/27/2016
CLIENT PROJECT:	81165045	COLLECTION DATE:	7/27/2016 1:33:00 PM
CLIENT SAMPLE ID	B-3-W	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
C25	NWTPH-DX	**100**	07/28/2016	EBS
1,2-Dichloroethane-d4	EPA-8260	**99.4**	07/29/2016	DLC
Toluene-d8	EPA-8260	**97.2**	07/29/2016	DLC
4-Bromofluorobenzene	EPA-8260	**94.0**	07/29/2016	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

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ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	8/2/2016
		ALS SDG#:	EV16070152
		WDOE ACCREDITATION:	C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MBG-072616W - Batch 106613 - Water by NWTPH-GX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	UG/L	50	07/26/2016	PAB

U - Analyte analyzed for but not detected at level above reporting limit.

MB-072216W - Batch 106552 - Water by NWTPH-DX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Diesel Range	NWTPH-DX	U	UG/L	130	07/22/2016	EBS
TPH-Oil Range	NWTPH-DX	U	UG/L	250	07/22/2016	EBS

U - Analyte analyzed for but not detected at level above reporting limit.

MB-072816W2 - Batch 106694 - Water by EPA-8260

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Dichlorodifluoromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Chloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Vinyl Chloride	EPA-8260	U	UG/L	0.20	07/28/2016	DLC
Bromomethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Chloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Carbon Tetrachloride	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trichlorofluoromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Carbon Disulfide	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Acetone	EPA-8260	U	UG/L	25	07/28/2016	DLC
1,1-Dichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Methylene Chloride	EPA-8260	U	UG/L	5.0	07/28/2016	DLC
Acrylonitrile	EPA-8260	U	UG/L	10	07/28/2016	DLC
Methyl T-Butyl Ether	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1-Dichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2-Butanone	EPA-8260	U	UG/L	10	07/28/2016	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2,2-Dichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromochloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Chloroform	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,1-Trichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1-Dichloropropene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trichloroethene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC

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Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	8/2/2016 EV16070152 C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MB-072816W2 - Batch 106694 - Water by EPA-8260

1,2-Dichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Dibromomethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromodichloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
4-Methyl-2-Pentanone	EPA-8260	U	UG/L	10	07/28/2016	DLC
Toluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,2-Trichloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2-Hexanone	EPA-8260	U	UG/L	10	07/28/2016	DLC
1,3-Dichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Tetrachloroethylene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Dibromochloromethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dibromoethane	EPA-8260	U	UG/L	0.010	07/28/2016	DLC
Chlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Ethylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
m,p-Xylene	EPA-8260	U	UG/L	4.0	07/28/2016	DLC
Styrene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
o-Xylene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromoform	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Isopropylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2,3-Trichloropropane	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Bromobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
N-Propyl Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
2-Chlorotoluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
4-Chlorotoluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
T-Butyl Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
S-Butyl Benzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
P-Isopropyltoluene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,3-Dichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,4-Dichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
N-Butylbenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	UG/L	10	07/28/2016	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Hexachlorobutadiene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
Naphthalene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	UG/L	2.0	07/28/2016	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	8/2/2016 EV16070152 C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MB-072816W2 - Batch 106694 - Water by EPA-8260

U - Analyte analyzed for but not detected at level above reporting limit.

MBLK-279076 - Batch R279076 - Water by EPA-245.1

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Mercury	EPA-245.1	U	UG/L	0.20	07/28/2016	RAL

U - Analyte analyzed for but not detected at level above reporting limit.

MB-072816W - Batch 106635 - Water by EPA-200.8

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Arsenic	EPA-200.8	U	UG/L	1.0	07/28/2016	RAL
Cadmium	EPA-200.8	U	UG/L	1.0	07/28/2016	RAL
Chromium	EPA-200.8	U	UG/L	2.0	07/28/2016	RAL
Lead	EPA-200.8	U	UG/L	1.0	07/28/2016	RAL

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	8/2/2016 EV16070152 C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY CONTROL SAMPLE RESULTS

ALS Test Batch ID: 106613 - Water by NWTPH-GX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range - BS	NWTPH-GX	**87.6**			66.5	122.7	07/26/2016	PAB
TPH-Volatile Range - BSD	NWTPH-GX	**89.8**	**2**		66.5	122.7	07/26/2016	PAB

ALS Test Batch ID: 106552 - Water by NWTPH-DX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Diesel Range - BS	NWTPH-DX	**87.4**			67	125.2	07/25/2016	EBS
TPH-Diesel Range - BSD	NWTPH-DX	**92.5**	**6**		67	125.2	07/25/2016	EBS

ALS Test Batch ID: 106694 - Water by EPA-8260

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
1,1-Dichloroethene - BS	EPA-8260	**107**			72.5	136	07/28/2016	DLC
1,1-Dichloroethene - BSD	EPA-8260	**118**	**10**		72.5	136	07/28/2016	DLC
Benzene - BS	EPA-8260	**102**			74.7	143	07/28/2016	DLC
Benzene - BSD	EPA-8260	**118**	**15**		74.7	143	07/28/2016	DLC
Trichloroethene - BS	EPA-8260	**103**			74.4	141	07/28/2016	DLC
Trichloroethene - BSD	EPA-8260	**119**	**14**		74.4	141	07/28/2016	DLC
Toluene - BS	EPA-8260	**90.1**			71.7	139	07/28/2016	DLC
Toluene - BSD	EPA-8260	**102**	**13**		71.7	139	07/28/2016	DLC
Chlorobenzene - BS	EPA-8260	**93.6**			73	131	07/28/2016	DLC
Chlorobenzene - BSD	EPA-8260	**108**	**14**		73	131	07/28/2016	DLC

ALS Test Batch ID: R279076 - Water by EPA-245.1

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
Mercury - BS	EPA-245.1	**100**			80.6	118	07/28/2016	RAL
Mercury - BSD	EPA-245.1	**106**	**6**		80.6	118	07/28/2016	RAL

ALS Test Batch ID: 106635 - Water by EPA-200.8

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
Arsenic - BS	EPA-200.8	**93.5**			89.1	110	07/28/2016	RAL
Arsenic - BSD	EPA-200.8	**94.5**	**1**		89.1	110	07/28/2016	RAL
Cadmium - BS	EPA-200.8	**95.9**			89.4	109	07/28/2016	RAL
Cadmium - BSD	EPA-200.8	**98.4**	**3**		89.4	109	07/28/2016	RAL
Chromium - BS	EPA-200.8	**95.8**			86.2	107	07/28/2016	RAL
Chromium - BSD	EPA-200.8	**97.4**	**2**		86.2	107	07/28/2016	RAL
Lead - BS	EPA-200.8	**96.9**			87.5	107	07/28/2016	RAL

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	8/2/2016 EV16070152 C601
CLIENT CONTACT:	Mike Noll		
CLIENT PROJECT:	81165045		

LABORATORY CONTROL SAMPLE RESULTS

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
Lead - BSD	EPA-200.8	**97.8**	**1**		87.5	107	07/28/2016	RAL

APPROVED BY

Laboratory Director

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

Exhibit C-3

ALS Environmental
8620 Holly Drive, Suite 100
Everett, WA 98208
Phone (425) 356-2600
Fax (425) 356-2626
http://www.alsglobal.com

Chain Of Custody/ Laboratory Analysis Request

ALS Job# (Laboratory Use Only): EV16070152

Date 7/27/16 Page 1 Of 1

PROJECT ID: ~~81155045~~ 81165045
REPORT TO COMPANY: Terracon
PROJECT MANAGER: Mike Noll
ADDRESS: 21905 64th Ave W Ste 100
Mountlake Terrace, WA 98043
PHONE: 425-771-3304 FAX:
P.O. #: E-MAIL: mdnoll@terracon.com
INVOICE TO COMPANY: Same
ATTENTION:
ADDRESS:

ANALYSIS REQUESTED / OTHER (Specify)

	SAMPLE I.D.	DATE	TIME	TYPE	LAB#	NWTPH-HCID	NWTPH-DX	NWTPH-GX	BTEX by EPA 8021 ☐ BTEX by EPA 8260 ☐	MTBE by EPA 8021 ☐ MTBE by EPA 8260 ☐	Halogenated Volatiles by EPA 8260	Volatile Organic Compounds by EPA 8260	EDB / EDC by EPA 8260 SIM (water)	EDB / EDC by EPA 8260 (soil)	Semivolatile Organic Compounds by EPA 8270	Polycyclic Aromatic Hydrocarbons (PAH) by EPA 8270 SIM	PCB by EPA 8082 ☐ Pesticides by EPA 8081 ☐	Metals-MTCA-5 ☒ RCRA-8 ☐ Pri Pol ☐ TAL ☐	Metals Other (Specify)	TCLP-Metals ☐ VOA ☐ Semi-Vol ☐ Pest ☐ Herbs ☐	~~Total Metals~~ SKL							NUMBER OF CONTAINERS	RECEIVED IN GOOD CONDITION?
1.	B-2-W	7/27/16	12:51	GW	1		X	X				X						X			~~X~~							7	
2.	B-3-W	7/27/16	13:33	GW	2		X	X				X						X			~~X~~							7	
3.																													
4.																													
5.																													
6.																													
7.																													
8.																													
9.																													
10.																													

SPECIAL INSTRUCTIONS

SIGNATURES (Name, Company, Date, Time):
1. Relinquished By: [signature] Terracon 7/27/16 2:50pm
Received By: [signature] ALS 7/27/16 2:50
2. Relinquished By:
Received By:

TURNAROUND REQUESTED in Business Days*
Organic, Metals & Inorganic Analysis: 10 (Standard) ☐ 5 ☒ 3 ☐ 2 ☐ 1 ☐ SAME DAY ☐
Fuels & Hydrocarbon Analysis: 5 (Standard) ☒ 3 ☐ 1 ☐ SAME DAY ☐
OTHER:
Specify: Per national account

Exhibit C-3

*Turnaround request less than standard may incur Rush Charges

APPENDIX C
SUPPORTING DOCUMENTS

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING	WATER LEVEL	FIELD TESTS
Standard Penetration Test	Water Initially Encountered Water Level After a Specified Period of Time Water Level After a Specified Period of Time Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.	**N** Standard Penetration Test Resistance (Blows/Ft.) **(HP)** Hand Penetrometer **(T)** Torvane **(DCP)** Dynamic Cone Penetrometer **(PID)** Photo-Ionization Detector **(OVA)** Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Standard Penetration or N-Value Blows/Ft.**	**Descriptive Term (Consistency)**	**Unconfined Compressive Strength Qu, (psf)**	**Standard Penetration or N-Value Blows/Ft.**
Very Loose	0 - 3	Very Soft	less than 500	0 - 1
Loose	4 - 9	Soft	500 to 1,000	2 - 4
Medium Dense	10 - 29	Medium Stiff	1,000 to 2,000	4 - 8
Dense	30 - 50	Stiff	2,000 to 4,000	8 - 15
Very Dense	> 50	Very Stiff	4,000 to 8,000	15 - 30
		Hard	> 8,000	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

Exhibit: C-1

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]				Soil Classification	
				Group Symbol	Group Name [B]
Coarse Grained Soils: More than 50% retained on No. 200 sieve	**Gravels:** More than 50% of coarse fraction retained on No. 4 sieve	**Clean Gravels:** Less than 5% fines [C]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [E]	GW	Well-graded gravel [F]
			$Cu < 4$ and/or $1 > Cc > 3$ [E]	GP	Poorly graded gravel [F]
		Gravels with Fines: More than 12% fines [C]	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel [F,G,H]
	Sands: 50% or more of coarse fraction passes No. 4 sieve	**Clean Sands:** Less than 5% fines [D]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [E]	SW	Well-graded sand [I]
			$Cu < 6$ and/or $1 > Cc > 3$ [E]	SP	Poorly graded sand [I]
		Sands with Fines: More than 12% fines [D]	Fines classify as ML or MH	SM	Silty sand [G,H,I]
			Fines classify as CL or CH	SC	Clayey sand [G,H,I]
Fine-Grained Soils: 50% or more passes the No. 200 sieve	**Silts and Clays:** Liquid limit less than 50	**Inorganic:**	PI > 7 and plots on or above "A" line [J]	CL	Lean clay [K,L,M]
			PI < 4 or plots below "A" line [J]	ML	Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [K,L,M,N]
					Organic silt [K,L,M,O]
	Silts and Clays: Liquid limit 50 or more	**Inorganic:**	PI plots on or above "A" line	CH	Fat clay [K,L,M]
			PI plots below "A" line	MH	Elastic Silt [K,L,M]
		Organic:	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [K,L,M,P]
					Organic silt [K,L,M,Q]
Highly organic soils:	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add "sandy" to group name.

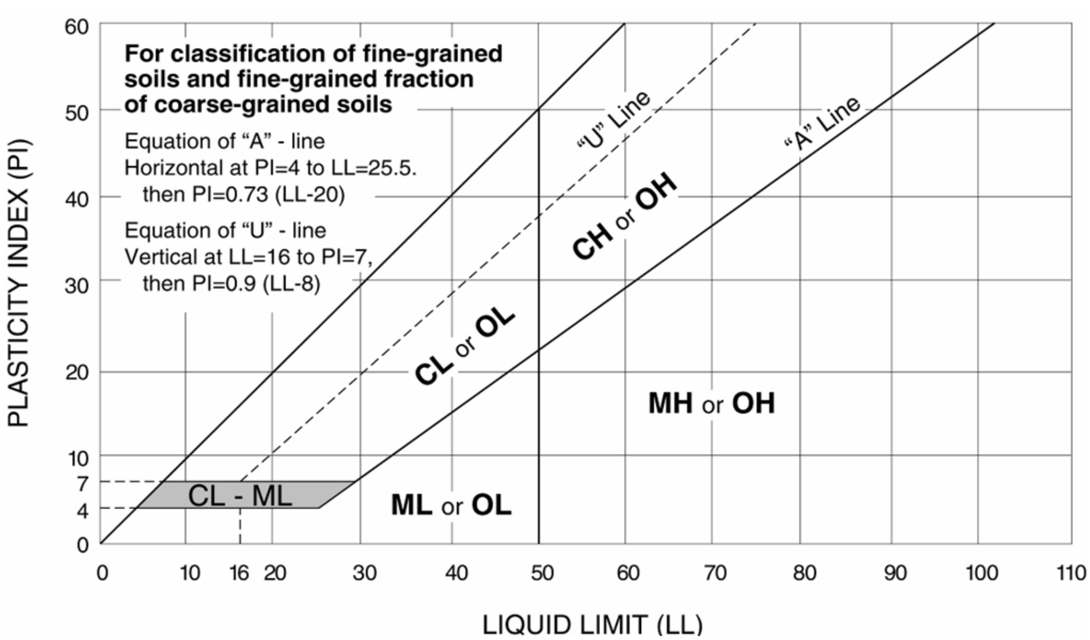
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI ≥ 4 and plots on or above "A" line.

[O] PI < 4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.



APPENDIX D
SLUG TESTING

Slug Test Description

Terracon performed field slug tests in two monitoring wells (B-2 and B-3) in order to calculate the estimated hydraulic conductivity of the aquifer. Each slug test was performed in general accordance with applicable guidelines (USGS, 2010). Before slug testing commenced, an Instrumentation Northwest P2X transducer was suspended approximately 1 foot from the bottom of the well. A 5-foot long slug fabricated from 1-inch nominal diameter schedule 40 PVC pipe was then quickly submerged in the well until reaching near-steady state conditions (i.e. slug-in or falling-head test). Upon reaching near-steady state conditions, the slug was quickly elevated above the water column and removed from the well (i.e. slug-out or rising-head test). The water level recovery was recorded using the pressure transducer and was monitored until sufficient recovery had been observed (approximately 95%). Typically, three slug-out tests were performed at each well. Slug test data was downloaded from the pressure transducers and saved to a handheld Model Demand field computer.

Raw data was extracted from the transducers using Aqua4Plus software. Prior to conducting analysis, slug test data was processed to yield displacement (feet) and elapsed time (second) for each test. This was calculated from the difference of the pre-test water level from the maximum (or minimum) water elevation and by verifying the accuracy of the timestamp prior to commencing the tests.

Aquifer parameters and well construction details were obtained based on information from the boring well development logs. Among the required input parameters is an estimate of the depth to the next confining unit. According to regional geologic information and boring log HWA-MW-7 advanced at the adjacent Shoreline North Maintenance Facility for the Brightwater Outfall, the confining was estimated to be approximately 237 feet below ground surface (bgs) throughout the project area.

Hydraulic conductivity was subsequently estimated using Aqtesolv Pro software and the Bouwer and Rice solution (Bouwer, H. and R.C. Rice, 1976). This method is widely used and suitable for wells screened in unconfined aquifers that partially or fully penetrate the aquifer. It can also be used if the well screen is only partially submerged.

A summary of hydraulic conductivity (K) values obtained from the slug tests is presented on Table D-1 and the Aqtesolv Slug Test Summary Sheets are provided in this appendix.

References:

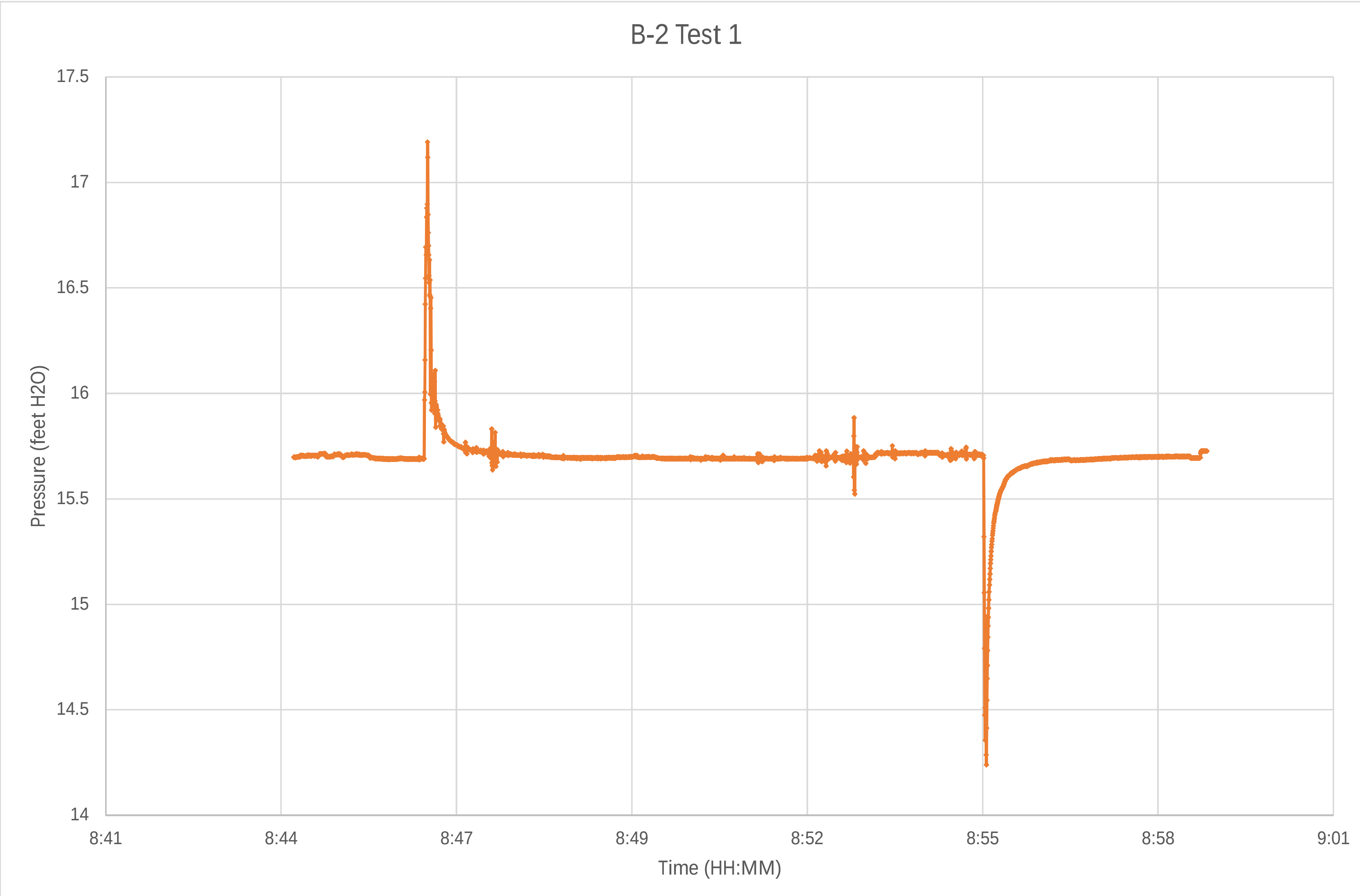
United States Geological Survey (USGS), 2010, *GWPD 17—Conducting an Instantaneous Change in Head (Slug) Test with a Mechanical Slug and Submersible Pressure Transducer*.

Bouwer, Herman, and Rice, R.C., 1976, *A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells*: Water Resources Research, v. 12, no. 3, p. 423–428.

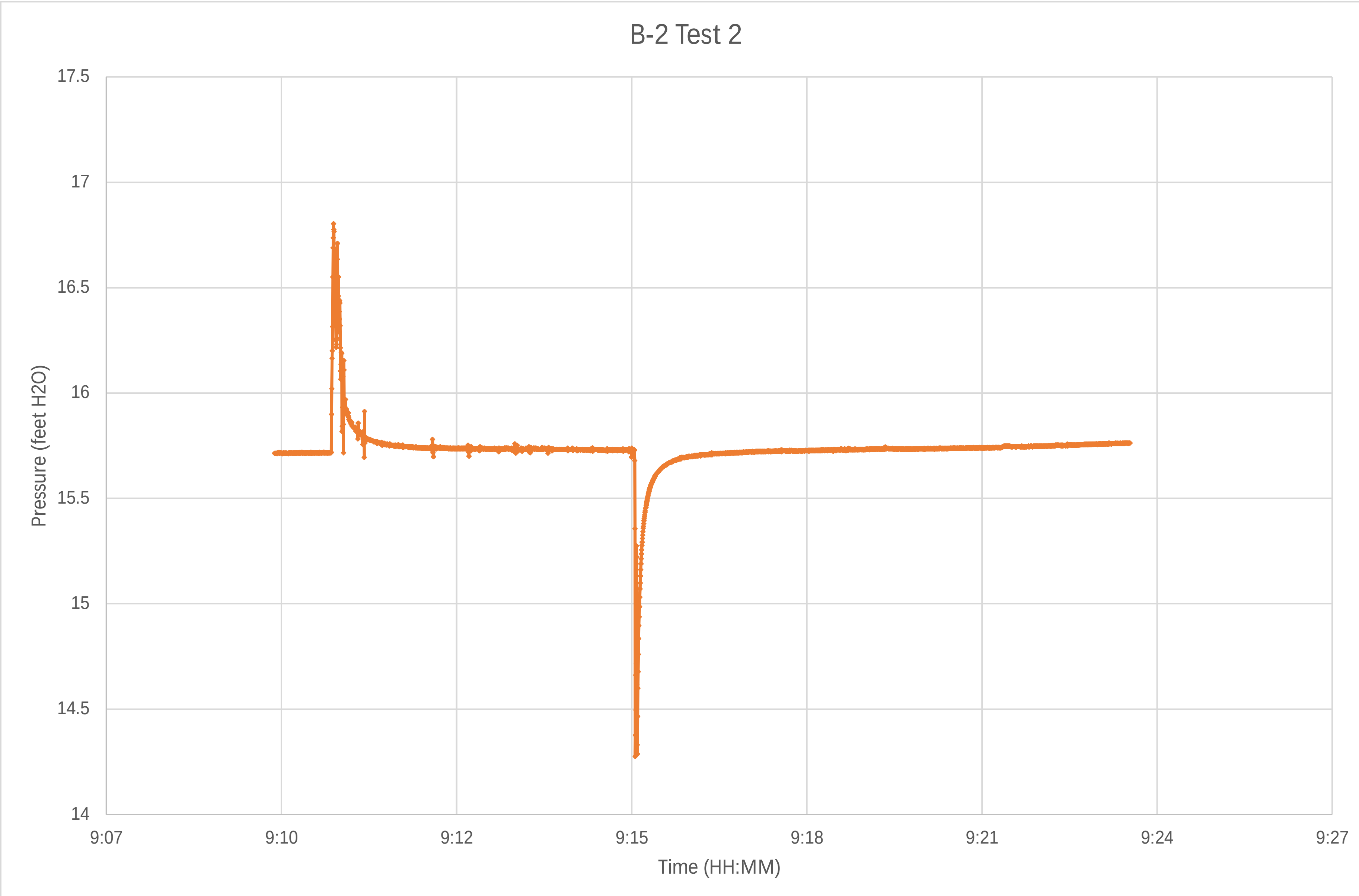
Hydraulic Conductivity Summary

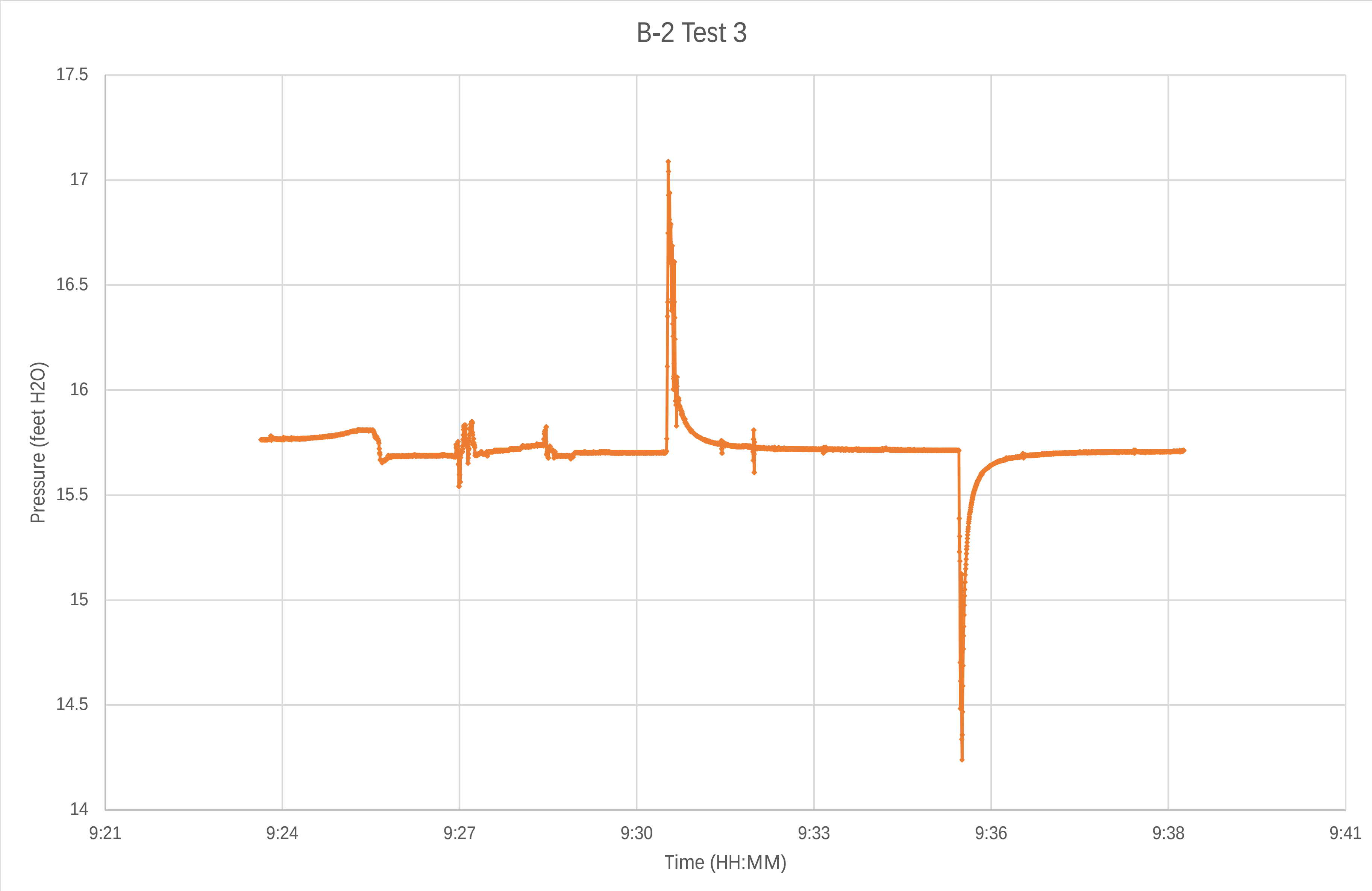
Well ID	Date Slug Test Completed	Type (Falling Head or Rising Head)	DTB (ft bgs)	Static DTW (ft bgs)	Well Casing Diameter (inches)	Borehole Diameter (inches)	Depth to Bottom Confining Layer (ft bgs)	Lithology in screened interval	Aqtesolv Input: Initial Displacement H_0(ft)	Static Water Column Height H (ft)	Sat Thickness Aquifer b (ft)	Depth to top of well screen d (ft)	Length of Screen (ft)	Casing Radius r(c) (ft)	Downhole Equip. Radius (ft)	Well Radius (including filter pack) (ft)	Aqtesolv Output: K (ft/d)	Arith. Mean K (ft/d)
B2	7/25/2016	FH	19.5	1.97	2	8	237	Silty Gravel / Silty Sand	1.50	17.53	235.03	7.53	10	0.083	0.010	0.333	17.91	18.69
	7/25/2016	RH							1.47								18.22	
	7/25/2016	FH							1.09								10.75	
	7/25/2016	RH							1.44								26.37	
	7/25/2016	FH							1.39								12.73	
	7/25/2016	RH							1.47								26.15	
B3	7/25/2016	FH	18.75	2.85	2	8	237	Silty Gravel / Silty Sand	1.38	15.90	234.15	5.90	10	0.083	0.010	0.333	12.58	12.94
	7/25/2016	RH							1.63								13.76	
	7/25/2016	FH							1.99								12.87	
	7/25/2016	RH							1.64								12.03	
	7/25/2016	FH							1.72								11.54	
	7/25/2016	RH							1.59								14.83	

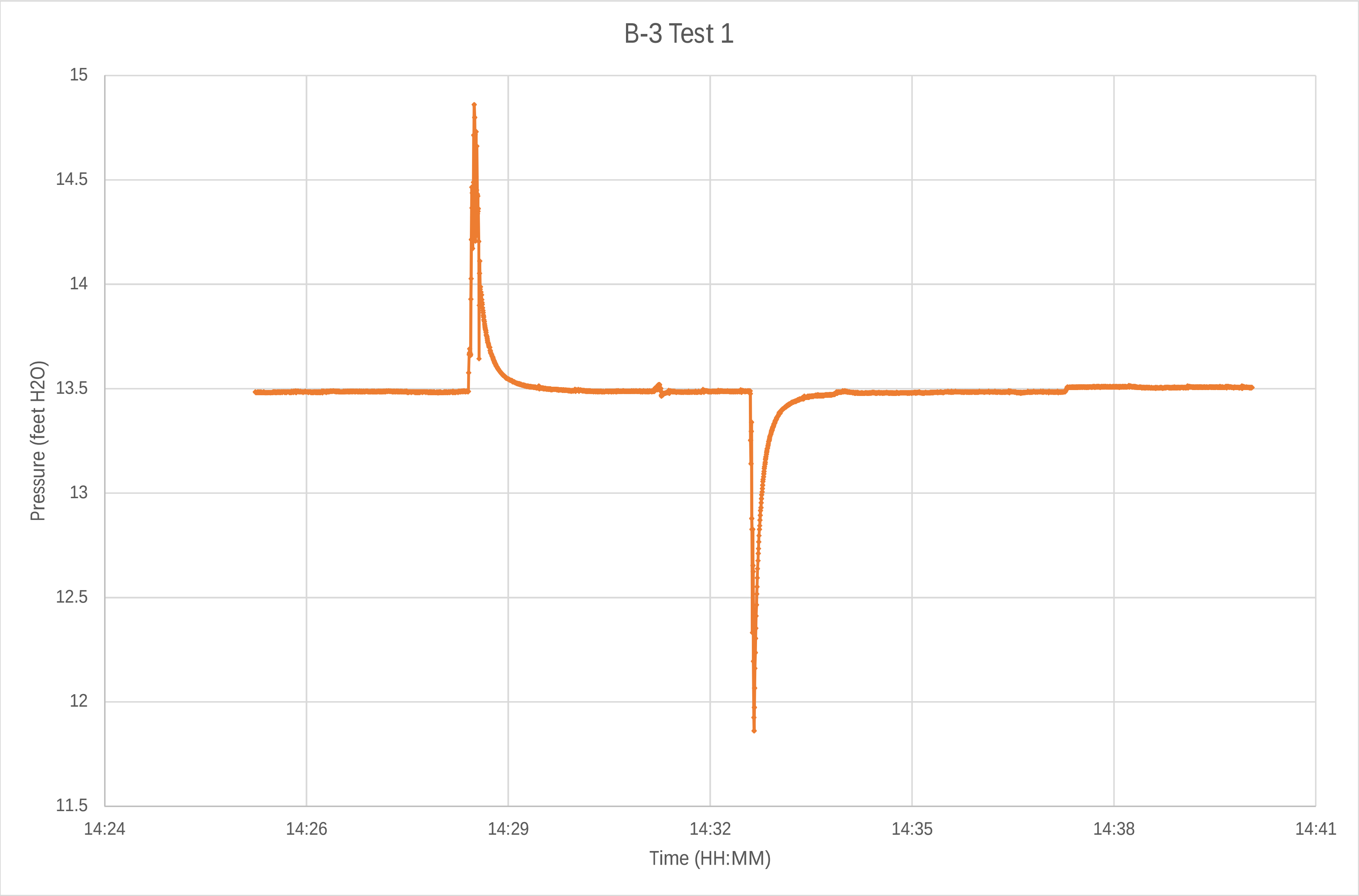
Notes:
DTB - Depth to bottom
DTW - Depth to water
K - hydraulic conductivity
Isotropic conditions were assumed in all directions (Kv/Kh = 1).
No well/borehole skin was assumed. Wells were assumed properly developed.
All three wells have fully submerged well screens (no correction necessary).
Depth to bottom confining unit based on boring log for MW-4 (fat clay at 237 ft). At MW-3, clay is at 202 ft, at MW-5 at 196 ft.
Maximum calculated displacement assuming a 5 foot long 1-inch nominal diameter Schedule 40 PVC (1.315-inch OD) slug and a 2-inch ID PVC well casing is 2.16 feet.

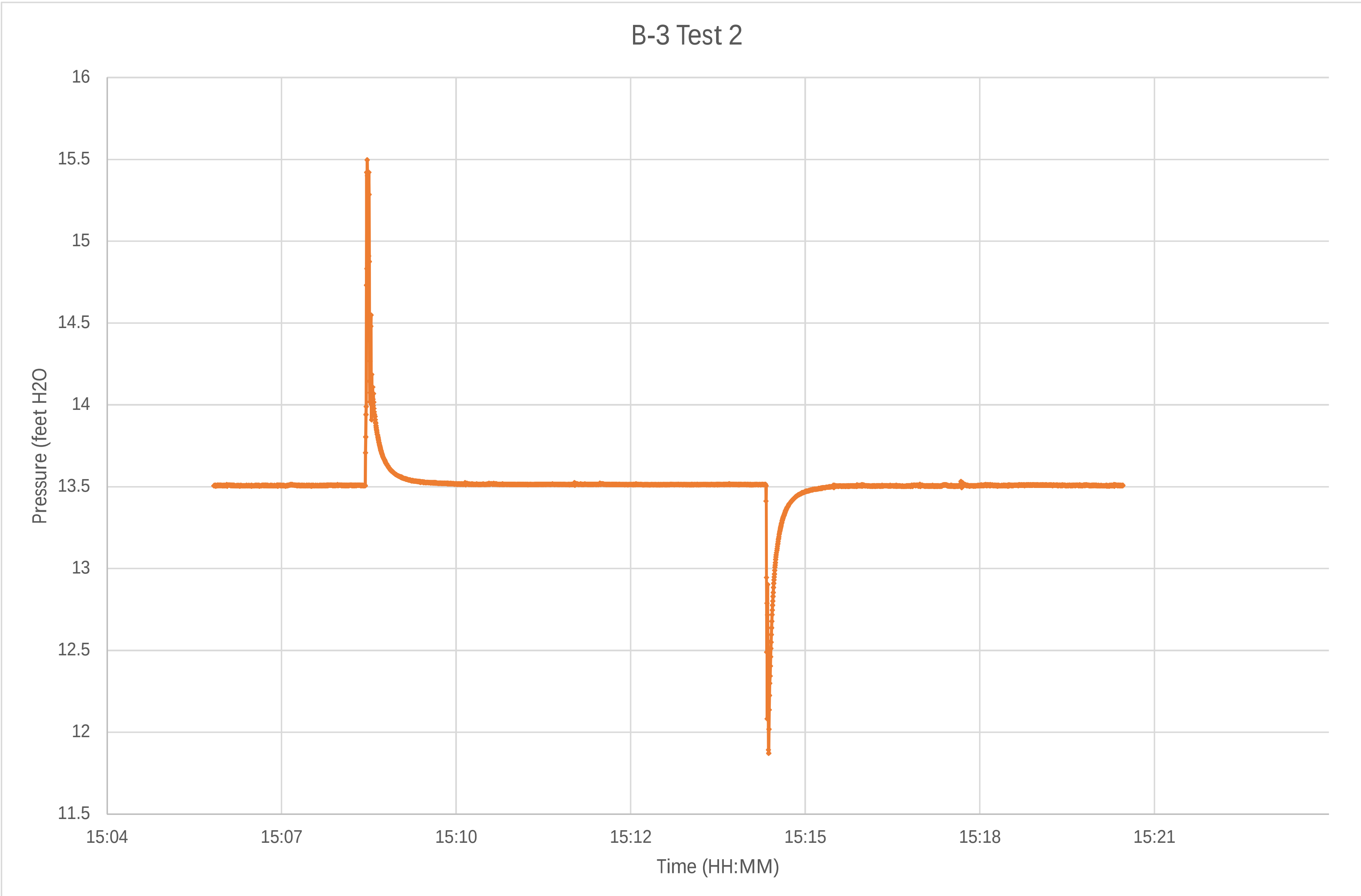


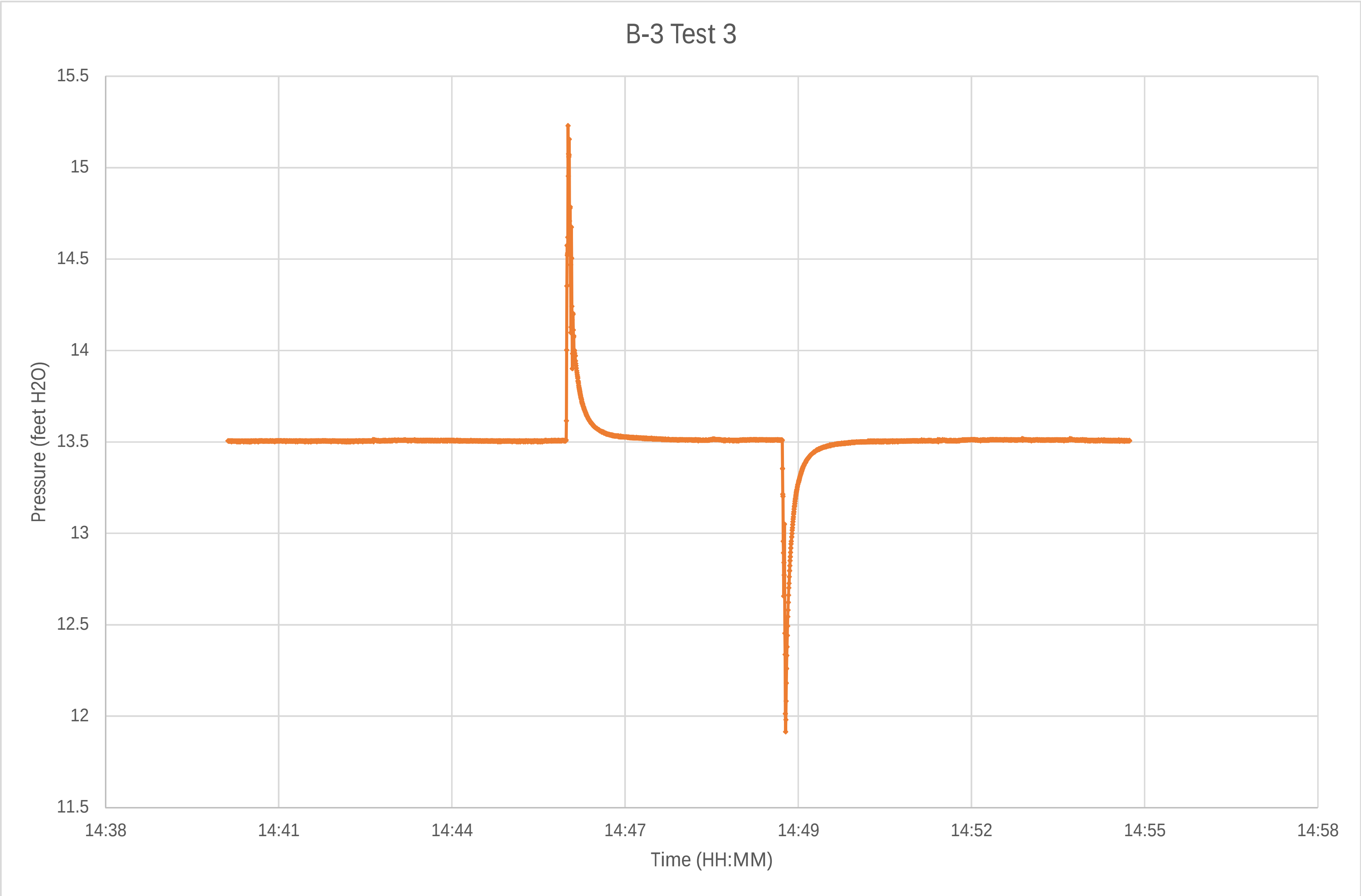
B-2 Test 1
17.5
17
16.5
16
15.5
15
14.5
14
Pressure (feet H2O)
8:41
8:44
8:47
8:49
8:52
8:55
8:58
9:01
Time (HH:MM)


B-2 Test 2
17.5
17
16.5
16
15.5
15
14.5
14
Pressure (feet H2O)
9:07
9:10
9:12
9:15
9:18
9:21
9:24
9:27
Time (HH:MM)


B-2 Test 3
17.5
17
16.5
16
15.5
15
14.5
14
Pressure (feet H2O)
9:21
9:24
9:27
9:30
9:33
9:36
9:38
9:41
Time (HH:MM)


B-3 Test 1
15
14.5
14
13.5
13
12.5
12
11.5
Pressure (feet H2O)
14:24
14:26
14:29
14:32
14:35
14:38
14:41
Time (HH:MM)


B-3 Test 2
Pressure (feet H2O
16
15.5
15
14.5
14
13.5
13
12.5
12
11.5
15:04
15:07
15:10
15:12
15:15
15:18
15:21
Time (HH:MM)


B-3 Test 3
15.5
15
14.5
14
13.5
13
12.5
12
11.5
Pressure (feet H2O)
14:38
14:41
14:44
14:47
14:49
14:52
14:55
14:58
Time (HH:MM)

APPENDIX E
BORINGS BY OTHERS

Washington State
Department of Transportation

Boring and Test Pit Legend

Sampler Symbols

	Standard Penetration Test
	Non-Standard Sized Penetration Test
	Shelby Tube
	Piston Sample
	Washington Undisturbed
	Vane Shear Test
	Core
	Becker Hammer
	Bag Sample

Well Symbols

	Cement Surface Seal
	Piezometer Pipe in Granular Bentonite Seal
	Piezometer Pipe in Sand
	Well Screen in Sand
	Granular Bentonite Seal
	Inclinometer Casing or PVC Pipe in Cement Bentonite Grout
	Sand
	Vibe Wire in Grout
	Miscellaneous, noted on boring log

Laboratory Testing Codes

AL	Atterberg Limits
CD	Consolidated Drained Triaxial
CN	Consolidation Test
CSS	Cyclic Simple Shear
CU	Consolidated Undrained Triaxial
DG	Degradation
DN	Density
DS	Direct Shear Test
DSS	Direct Simple Shear
GS	Grain Size Distribution
HT	Hydrometer Test
LA	LA Abrasion
LOI	Loss on Ignition
MC	Moisture Content
PT	Point Load Compressive Test
RM	Resilient Modulus
RS	Ring Shear Test
SG	Specific Gravity
SL	Slake Test
UC	Unconfined Compression Test
UU	Unconsolidated Undrained Triaxial

Soil Density Modifiers

Gravel, Sand & Non-plastic Silt		Elastic Silts and Clay	
SPT Blows/ft	Density	SPT Blows/ft	Consistency
0-4	Very Loose	0-1	Very Soft
5-10	Loose	2-4	Soft
11-24	Medium Dense	5-8	Medium Stiff
25-50	Dense	9-15	Stiff
>50	Very Dense	16-30	Very Stiff
(REF)	Refusal	31-60	Hard
		>60	Very Hard

Angularity of Gravel & Cobbles

Angular	Coarse particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Coarse grained particles are similar to angular but have rounded edges.
Subrounded	Coarse grained particles have nearly plane sides but have well rounded corners and edges.
Rounded	Coarse grained particles have smoothly curved sides and no edges.

Soil Moisture Modifiers

Dry	Absence of moisture; dusty, dry to touch
Moist	Damp but no visible water
Wet	Visible free water

Soil Structure

Stratified	Alternating layers of varying material or color at least 6mm thick; note thickness and inclination.
Laminated	Alternating layers of varying material or color less than 6mm thick; note thickness and inclination.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing.
Slickensided	Fracture planes appear polished or glossy, sometimes striated.
Blocky	Cohesive soil that can be broken down into smaller angular lumps which resist further breakdown.
Disrupted	Soil structure is broken and mixed. Infers that material has moved substantially - landslide debris.
Homogeneous	Same color and appearance throughout.

HCl Reaction

No HCl Reaction	No visible reaction.
Weak HCl Reaction	Some reaction with bubbles forming slowly.
Strong HCl Reaction	Violent reaction with bubbles forming immediately.

Degree of Vesicularity of Pyroclastic Rocks

Slightly Vesicular	5 to 10 percent of total
Moderately Vesicular	10 to 25 percent of total
Highly Vesicular	25 to 50 percent of total
Scoriaceous	Greater than 50 percent of total

Boring and Test Pit Legend

Grain Size

Fine Grained	< 0.04 in	Few crystal boundaries/grains are distinguishable in the field or with hand lens.
Medium Grained	0.04 to 0.2 in	Most crystal boundaries/grains are distinguishable with the aid of a hand lens.
Coarse Grained	> 0.2 in	Most crystal boundaries/grains are distinguishable with the naked eye.

Weathered State

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration in major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as core stones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as discontinuous framework or as core stone.	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric is destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

Relative Rock Strength

Grade	Description	Field Identification	Uniaxial Compressive Strength approx
R1	Very Weak	Specimen crumbles under sharp blow from point of geological hammer, and can be cut with a pocket knife.	0.15 to 3.6 ksi
R2	Moderately Weak	Shallow cuts or scrapes can be made in a specimen with a pocket knife. Geological hammer point indents deeply with firm blow.	3.6 to 7.3 ksi
R3	Moderately Strong	Specimen cannot be scraped or cut with a pocket knife, shallow indentation can be made under firm blows from a hammer.	7.3 to 15 ksi
R4	Strong	Specimen breaks with one firm blow from the hammer end of a geological hammer.	15 to 29 ksi
R5	Very Strong	Specimen requires many blows of a geological hammer to break intact sample.	Greater than 29 ksi

Discontinuities

Spacing	
Very Widely	Greater than 10 ft
Widely	3 ft to 10 ft
Moderately	1 ft to 3 ft
Closely	2 inches to 12 inches
Very Closely	Less than 2 inches

RQD (%)

$$\frac{100(\text{length of core in pieces} > 100\text{mm})}{\text{Length of core run}}$$

Condition	
Excellent	Very rough surfaces, no separation, hard discontinuity wall
Good	Slightly rough surfaces, separation less than 0.05 in, hard discontinuity wall.
Fair	Slightly rough surfaces, separation greater than 0.05 in, soft discontinuity wall.
Poor	Slickensided surfaces, or soft gouge less than 0.2 in thick, or open discontinuities 0.05 to 0.2 in.
Very Poor	Soft gouge greater than 0.2 in thick, or open discontinuities greater than 0.2 in.

Fracture Frequency (FF) is the average number of fractures per 1 ft of core. This does not include mechanical breaks caused by drilling or handling.

Datum:
NAD 83/91 HARN = North American Datum of 1983/1991 High Accuracy Reference Network
NAVD88 = North American Vertical Datum of 1988
SPN (ft) = State Plane North (ft)
SPS (ft) = State Plane South (ft)

Exhibit E-1

Washington State
Department of Transportation

LOG OF TEST BORING

Start Card SE-57728 / AE-36443

HOLE No. H-1-16

Sheet 1 of 3

Job No. DMA-177 SR 104 Elevation 215.4 ft

Project SR104 Gabion Rock Wall Emergency Repair

Driller Fetterly, Jamie Lic# 2507

Component

Inspector Harvey, Thomas #2599

Start March 14, 2016 Completion March 14, 2016 Well ID#

Equipment CME 55 (9C7-1)

Station A-Line 10+38.86 Offset 4.1 feet right Hole Dia (inches) 4

Historical SPT Efficiency 87.3%

Northing 284337.206 Easting 1279195.088 Collected by

Method Mud Rotary

Lat 47.7700478 Long -122.3023422 Datum NAD 83/91 HARN, NAVD88, SPN (ft) Drill Fluid Bentonite

Legend: SPT Efficiency; ◆ Field SPT (N); Moisture Content; RQD (scale 20 40 60 80)

Depth (ft)	Elevation (ft)	Blows/6" (N) and/or RQD FF	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater
	215.0					
		8 9 11 (20)	D-1		Well graded GRAVEL, sub-rounded, medium dense, gray, wet, homogeneous. HCl not tested. Recovered: 0.2 ft Retained: 0.2 ft	
					ESU 1	
5	210.0				ESU 2	03-14-2016
		2 1 2 (3)	D-2		No Recovery. HCl not tested.	
		1 0 1 (1)	D-3		Silty SAND with gravel with organic, sub-rounded, very loose, brown, wet, homogeneous, laminated. HCl not tested. Recovered: 0.4 ft Retained: 0.4 ft	
10	205.0					
		1 1 2 (3)	D-4		Silty SAND with gravel with organic, sub-rounded, very loose, dark brown, wet, homogeneous. HCl not tested. Recovered: 0.6 ft Retained: 0.6 ft	
					ESU 2	
		6 12 11 (23)	D-5		ESU 3 SILT with sand withwell grade sand /gravel/organic, medium dense, gray, wet, stratified. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
15	200.0					
		9 15 16 (31)	D-6		Poorly graded SAND trace gravel, dense, gray, wet, homogeneous. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
		7 14 21 (35)	D-7		Silty SAND trace silt, dense, gray, wet, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft	
20						

Exhibit E-2

Washington State Department of Transportation

LOG OF TEST BORING

Job No. DMA-177 SR 104 Elevation 215.4 ft

HOLE No. H-1-16

Sheet 2 of 3

Project SR104 Gabion Rock Wall Emergency Repair

Driller Fetterly, Jamie

Legend: SPT Efficiency; Field SPT (N); Moisture Content; RQD — scale 20 40 60 80

Depth (ft): 25, 30, 35, 40, 45

Elevation (ft): 195, 190, 185, 180, 175

Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
15 16 18 (34)		D-8		SILT with sand, dense, gray, moist, stratified, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
11 12 12 (24)		D-9		SILT with sand, medium dense, gray, wet, stratified, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
7 9 12 (21)		D-10		Sandy SILT trace gravel, medium dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
6 11 13 (24)		D-11		Sandy SILT, medium dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
7 12 15 (27)		D-12		Sandy SILT with gravel, sub-rounded, dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		

Exhibit E-2

Washington State
Department of Transportation

LOG OF TEST BORING

Job No. DMA-177 SR 104 Elevation 215.4 ft HOLE No. H-1-16

Sheet 3 of 3

Project SR104 Gabion Rock Wall Emergency Repair Driller Fetterly, Jamie

Depth (ft)	Elevation (ft)	Profile	SPT Efficiency / Field SPT (N) / Moisture Content / RQD (20 40 60 80)	Blows/6" (N) and/or RQD FF	Sample Type	Sample No. (Tube No.)	Lab Tests	Description of Material	Groundwater	Instrument
	170									
				7 10 15 (25)		D-13		Sandy SILT, dense, gray, moist, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
50	165									
				10 14 18 (32)		D-14		Sandy SILT, dense, gray, wet, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
55	160									
				8 13 16 (29)		D-15		SILT trace sand, dense, gray, wet, homogeneous, laminated. HCl not tested. Recovered: 1.5 ft Retained: 1.5 ft		
60	155									
65	150									
70										

The implied accuracy of the borehole location information displayed on this boring log is typically sub-meter in (X,Y) when collected by the HQ Geotech Office and sub-centimeter in (X,Y,Z) when collected by the Region Survey Crew.

End of test hole boring at 59.5 ft below ground elevation.
This is a summary Log of Test Boring.
Soil/Rock descriptions are derived from visual field identifications and laboratory test data.
Note: REF = SPT Refusal

Bail/Recharge test:
Hole Diameter: 4
Depth of boring during bail test: 59.5'
Depth of casing during bail test: 54'
Bailed bore hole water level to 7.9'
Recharge after 5 minutes :6.8'

could not bail past7.9

Exhibit E-2

Project: CSI Brightwater Project Location: King and Snohomish Counties Contract Number: E83004E	Log of Boring MW-7 Sheet 1 of 5

Date(s) Drilled	12/10/01 - 12/12/01	Geotechnical Consultant	HWA GeoSciences Inc.	Logged By	BKH	Checked By	MLR/SEG
Drilling Method/ Rig Type	Becker Hammer/ Truck	Drilling Contractor	Layne Christensen Company	Total Depth of Borehole	266.5 feet		
Drill Bit Size/Type	Dual Wall Reverse Circ.	Hammer Weight/Drop (lbs/in.)	300#, 30"	Ground Surface Elevation/Datum	213 feet / NAVD88		
Location	Bruger Bog K.C. Public Works Facility	Coordinates	N. 47.77175 W. 122.30361	Elevation Source	Plan		

Elevation, feet	Depth, feet	SAMPLES Type	Number	Blows / 6 in. (N)	Recovery, %	Graphic Log	USCS	MATERIAL DESCRIPTION	Piezometer Schematic	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
	0						SP-SM	Medium dense, olive gray, slightly silty, gravelly, fine to coarse SAND, wet. (ALLUVIUM, Qal)				3/28/2002 0.4 ft 2/8/2002 0.93 ft
210	5											VWP-17.9 feet Artesian Head, 3/28/2002
	10		S-1	6 - 8 - 5 (13)	100					M	16.5	
200								Abundant wood pieces present in cuttings.				
	15											
							SP	Dense, grayish brown, fine gravelly, fine to coarse SAND, wet. (GLACIAL FLUVIAL, Qva)				
	20		S-2	6 - 20 - 39 (59)	100					M SA	12.2	
190	25											
							ML	Hard, gray, slightly fine sandy, SILT, moist. (GLACIOLACUSTRINE, Qvgl)				
	30		S-3	14 - 37 - 35 (72)	100					M SA	22.4	
180	35											
	40		S-4	4 - 5 - 7 (12)	100			At 39 feet, silt becomes stiff and interbedded thin, fine sand seams are present.		M SA HA	28.3	
170	45											
	50			3 - 7 - 10						M	29.9	

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HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.1

Project: CSI Brightwater	Log of Boring MW- 7
Project Location: King and Snohomish Counties	Sheet 2 of 5
Contract Number: E83004E	

Elevation, feet	Depth, feet	SAMPLES: Type / Number	Blows / 6 in. (N)	Recovery, %	USCS	MATERIAL DESCRIPTION	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
	50	S-5	(17)	100		At 49 feet, silt becomes very stiff and a one foot thick, water bearing sand seam is present.	SA		
160									
	55								
	60	S-6	6 - 9 - 15 (24)	100		Becomes wetter at 59 feet.	M SA	29.9	
150									
	65								
					ML	Very stiff, dark gray, slightly fine sandy SILT, moist.			
	70	S-7	4 - 9 - 13 (22)	100			M SA HA	23.4	
140									
	75								
					ML	Dense, dark gray, gravelly, sandy SILT, wet. Abundant water. Till-like.			
	80	S-8	9 - 16 - 19 (35)	100		(GLACIAL TILL, Qpgt)	M SA	17.2	
130									
	85								
					SM	Dense, gray, gravelly, very silty, fine SAND, wet. (GLACIAL FLUVIAL, Qpgf)			
	90	S-9a S-9b	23 - 25 - 7 (32)	150			M SA HA M SA	10.7 20.1	
120									
	95								
						Cuttings: Gray, slightly silty to silty, slightly fine gravelly, fine SAND, wet.			
						At 99 feet, 1 foot of heave present.			
	100	S-10	0 - 1 - 25 (26)	400			M SA	18.9	
110									
	105								

(Ver.1.1 Jan02RWSP-RWSP.GLB-RWSP.GDT) H:\GINTW\PROJECTS\9915349K.GPJ 5/1/02

HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.2

Project: CSI Brightwater	Log of Boring MW- 7
Project Location: King and Snohomish Counties	Sheet 3 of 5
Contract Number: E83004E	

Elevation, feet	Depth, feet	Sample Number	Blows / 6 in. (N)	Recovery, %	USCS	MATERIAL DESCRIPTION	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
		S-11		0		Fine gravel and coarse sand present in cuttings.			
	110				SP	8 feet of heave present at 110 feet. No sample driven. Cuttings are gray, very gravelly, fine to medium SAND, wet.	M SA	10.8	
-100									
	115					No water in cuttings.			
	120					5 feet of heave present at 120 feet.			
-90					SC	Medium dense, gray, clayey, gravelly, fine to medium SAND to slightly gravelly, very fine sandy CLAY, moist to wet. Till-like. Trace fine, rounded gravel and trace rounded coarse sand. (GLACIOMARINE DRIFT, Qpgm)			
	125	S-12		0			M	21.7	
	130	S-13	7 - 9 - 12 (21)	100			M SA HA	16.0	
-80									
	135				CL	Very stiff, gray with whitish banding, slightly fine to medium gravelly, CLAY, moist. Sub-angular gravel. (GLACIOLACUSTRINE, Qpgl)			
	140	S-14	5 - 9 - 14 (23)	100			M SA AL HA	21.6	
-70									
	145	S-15	7 - 10 - 14 (24)	100		At 145 feet, clay becomes highly plastic.	M SA AL	28.8	
					SM	Very dense, gray, very silty, fine to coarse gravelly, fine to medium SAND, moist. Sub-rounded to sub-angular gravel. (GLACIAL TILL, Qpgt)			
	150	S-16	110	83			M SA HA	8.9	
-60									
	155	S-17	104	83		At 155 feet, sand becomes fine to coarse.	M SA	9.1	
	160	S-18	99	83	GM	Very dense, gray, silty, gravelly SAND to silty, sandy GRAVEL, moist to wet. Sand is fine to coarse and gravel is fine to coarse and subrounded.	M	9.5	
-50					ML	Hard, gray, SILT, moist. Laminated. Low plasticity.			
	165	S-19	78	83			M	20.4	

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HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.3

Elevation, feet	Depth, feet	Sample Type / Number	Blows / 6 in. (N)	Recovery, %	USCS	MATERIAL DESCRIPTION	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
							SA		
	170	S-20	74	83	CL	Hard, dark gray with light gray bandings, slightly sandy, CLAY, moist. (GLACIOLACUSTRINE, Qpgl)	M SA AL HA	15.6	
40									
	175	S-21	92	83	CL	Hard, gray, CLAY interbedded with very dense, gray, slightly fine gravelly, fine to medium SAND, moist.	M	16.6	
	180	S-22	15 - 23 - 35 (58)	100	CH	Hard, dark gray with light gray banding and mottling, CLAY, moist. High plasticity.	M SA AL HA	16.9	
30									
	185	S-23	82	83	SC	Very dense, gray, fine to coarse gravelly, very clayey, fine to coarse SAND, moist. Occasional wood fragments and sub-rounded gravel present. (NONGLACIAL FLUVIAL, Qpnf)	M SA HA	11.3	
	190	S-24	78	83	SP-SM	Very dense, gray, slightly silty, gravelly, fine to coarse SAND, moist.	M SA	12.1	
20									
	195	S-25	19 - 30 - 51 (81)	100	CL	Hard, gray to dark gray with light gray mottling, fine to coarse gravelly, fine to coarse sandy, CLAY, moist. Till-like. (GLACIAOMARINE DRIFT, Qpgm)	M SA AL HA	12.2	
	200	S-26	11 - 18 - 27 (45)	100	CL	Very stiff to hard, gray to dark gray with light gray banding, CLAY, moist. (NONGLACIAL LACUSTRINE, Qpnl) Two 1-2 mm seams of fine sand present at 199 feet.			
10									
	205	S-27	10 - 18 - 32 (50)	100		At 205 feet, soil becomes slightly fine sandy CLAY with several thin light gray sandy seams.	M SA AL HA	18.8	
	210	S-28	8 - 19 - 40 (59)	100	CL	Hard, gray with light gray flecks, slightly fine to coarse gravelly, slightly fine to medium sandy, CLAY, moist.	M SA AL	14.5	
0									
	215	S-29	8 - 15 - 23 (38)	100	CL	Hard, gray, slightly fine sandy, CLAY, moist. Trace fine to coarse gravel.	M SA AL	19.3	
	220	S-30	8 - 16 - 19 (35)	100	CH	Hard, dark gray with light gray streaks, slightly fine gravelly, CLAY, moist. Highly plastic.	M SA	20.6	
-10						At 225 feet, clay becomes very stiff and contains light gray to white vertically oriented laminations.			
	225								

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Project: CSI Brightwater Project Location: King and Snohomish Counties Contract Number: E83004E	Log of Boring MW- 7 Sheet 5 of 5

Elevation, feet	Depth, feet	Type	Number	Blows / 6 in. (N)	Recovery, %	Graphic Log	USCS	MATERIAL DESCRIPTION	Piezometer Schematic	Lab Tests	Moisture Content, %	REMARKS AND OTHER TESTS
	225		S-31	6 - 11 - 13 (24)	100					M SA AL HA	31.8	
	230		S-32	5 - 5 - 11 (16)	100			At 229 feet, clay becomes highly fractured. Abundant white to light gray seams and randomly oriented laminations.		M SA	32.0	
-20												
	235		S-33	8 - 9 - 14 (23)	100					M SA AL HA	29.7	
							CL	Very stiff, dark gray with white laminations, CLAY, moist.				
	240		S-34	5 - 9 - 11 (20)	100					M SA AL HA	26.5	
-30												
	245		S-35	5 - 7 - 14 (21)	100		CH	Very stiff, dark gray with white laminations, CLAY, moist. Highly plastic.		M SA AL	31.3	
	250		S-36	6 - 9 - 12 (21)	100					M SA HA	32.1	
-40												
	255		S-37	6 - 8 - 10 (18)	100		CL	Very stiff, gray with ligh gray laminations, CLAY, moist.		M SA AL HA	26.7	
	260		S-38	5 - 7 - 11 (18)	100		CH	Very stiff, gray with light gray laminations, CLAY, moist. Highly plastic.		M SA	31.8	
-50												
	265		S-39	5 - 8 - 9 (17)	100			At 265 feet, no laminations noted.		M SA AL	33.3	
	270							Bottom of boring at 266.5 feet. 2" piezometer installed to 265 feet. Vibrating Wire Piezometer installed at 115 feet.				
-60												
	275											
	280											
-70												

(Ver.1.1 Jan02RWSP-RWSP.GLB-RWSP.GDT) H:\GINTW\PROJECTS\9815349K.GPJ 5/1/02

HWA GEOSCIENCES INC.

Exhibit E-3

Figure: A-8.5

Appendix I.2
Groundwater Monitoring Data

Memorandum

Date: August 7, 2017

To: Mike Giseburt, P.E.
Louis Berger, Inc.

From: Tori Hesedahl, P.E.

Subject: Groundwater Level Readings
25th Avenue NE Flood Reduction
Shoreline, Washington
Terracon Project No. 81165045

Terracon Consultants, Inc. (Terracon) presented findings from our Phase I preliminary geotechnical engineering services for the above referenced project in our report *Draft Preliminary Geotechnical Engineering Report, 25th Avenue NE Flood Reduction, Shoreline, Washington*, dated September 6, 2016. Subsurface and hydrologic exploration and services completed included the installation of 3 piezometers along the proposed alignment, on the west side of 25th Avenue NE. Piezometer locations are shown on the attached Site and Exploration Plan from our 2016 report. Groundwater level measurements were taken on several occasions in July 2016, and on 3 occasions in 2017. Data collected in 2016 and 2017 is presented in the table below.

	B-1	B-2	B-3
Ground Surface	**219.0**	**215.0**	**213.0**
5-Jul-2016 (At time of drilling)	211.50	210.00	208.00
11-Jul-2016	217.40	213.20	210.20
25-Jul-2016		213.00	210.10
27-Jul-2016		213.28	210.42
24-Feb-2017	217.97	214.22	211.02
2-May-2017	218.37	214.25	211.10
7-Jul-2017	217.73	212.99	210.00

Groundwater levels presented are elevations in feet. Ground surface elevations were inferred from a topographic site plan provided by Lous Berger.

LEGEND:

B-1 — TERRACON BORING NUMBER AND APPROXIMATE LOCATION

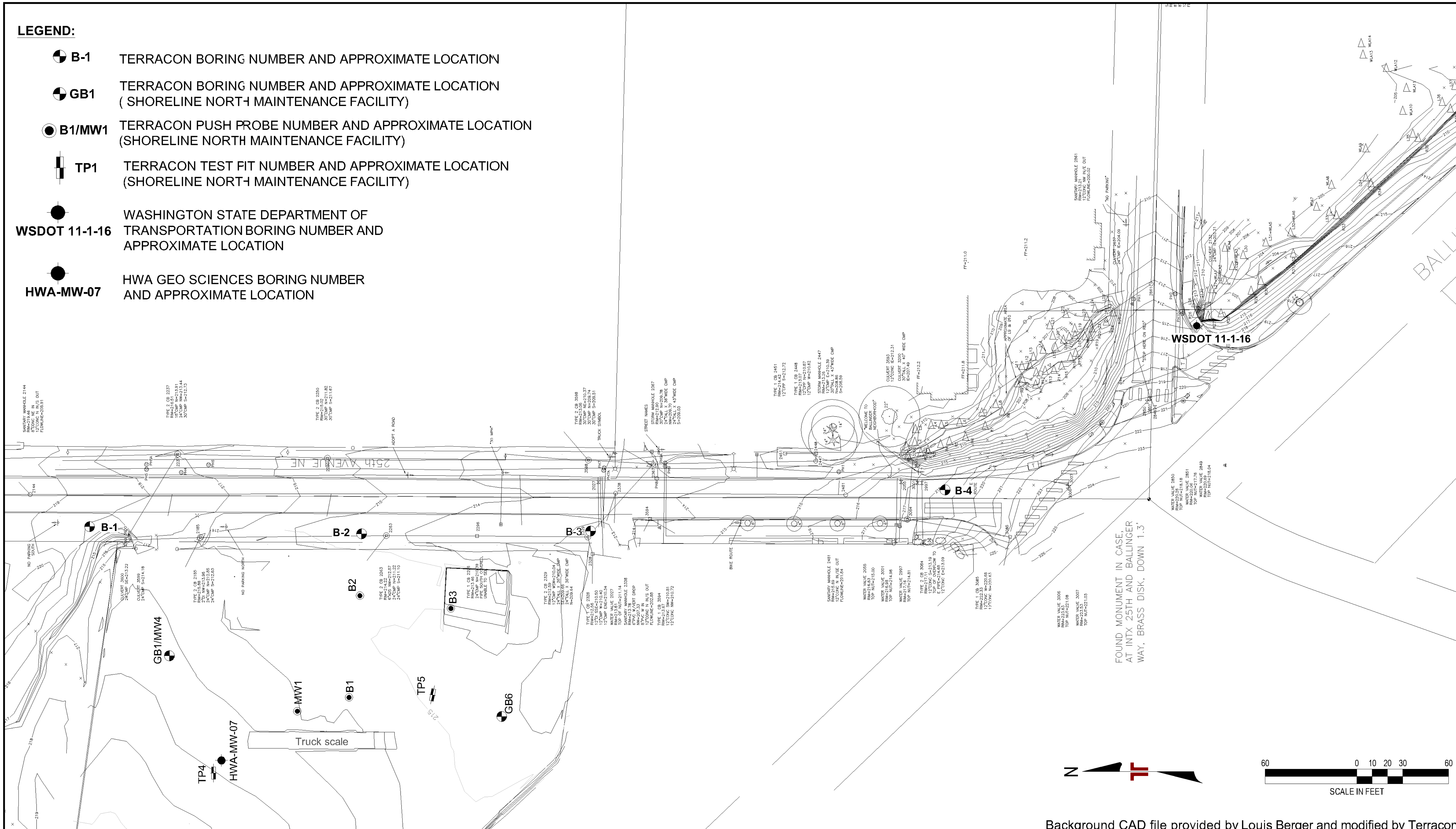
GB1 — TERRACON BORING NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)

B1/MW1 — TERRACON PUSH PROBE NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)

TP1 — TERRACON TEST PIT NUMBER AND APPROXIMATE LOCATION (SHORELINE NORTH MAINTENANCE FACILITY)

WSDOT 11-1-16 — WASHINGTON STATE DEPARTMENT OF TRANSPORTATION BORING NUMBER AND APPROXIMATE LOCATION

HWA-MW-07 — HWA GEO SCIENCES BORING NUMBER AND APPROXIMATE LOCATION



Background CAD file provided by Louis Berger and modified by Terracon.

Project Mngr: TLH	Project No. 81165045	Terracon Consulting Engineers and Scientists	**SITE AND EXPLORATION PLAN**
Drawn By: AMP	Scale: AS SHOWN	21905 64th Avenue W, Ste 100 Mountlake Terrace, WA 98043	25th Ave NE Flood Reduction Project
Checked By: TLH	File No. Exhibit A-2	PH. (425) 771-3304 FAX. (425) 771-3549	25th Ave NE
Approved By: TLH	Date: July 2016		Shoreline, King County, Washington

EXHIBIT A-2

Appendix I.3
Supplemental Geotechnical Investigations at North Maintenance Facility Site

Supplemental Environmental Limited Site Investigation

Proposed Constructed Wetland at
Proposed Shoreline North Maintenance Facility Site
19547 25th Avenue NE
Shoreline, Washington

August 7, 2017
Terracon Project No. 81165045

Prepared for:
Louis Berger U.S. Inc.
Seattle, Washington

Prepared by:
Terracon Consultants, Inc.
Mountlake Terrace, Washington

August 7, 2017

Louis Berger U.S. Inc.
520 Pike Street, Suite 1005
Seattle, Washington 98101

Attn: Michael Giseburt
Telephone: (206) 453-1549
E-mail: mgiseburt@louisberger.com

Re: Supplemental Environmental Limited Site Investigation
Proposed Constructed Wetland at Proposed Shoreline North Maintenance Facility Site
19547 25th Avenue NE
Shoreline, King County, Washington
Terracon Project No. 81165045

Dear Mr. Giseburt:

Terracon Consultants, Inc. (Terracon) is pleased to submit our report of Supplemental Environmental Limited Site Investigation (Supplemental Environmental LSI) activities completed at the site referenced above. The report presents data from recent field activities that included the completion of soil borings and the collection of soil samples for chemical analysis. Terracon conducted the Supplemental Environmental LSI in general accordance with our proposal (P81177327) dated June 1, 2017 and the Modification of Subcontract/Agreement between Louis Berger U.S. Inc. and Terracon dated June 12, 2017.

Please review and provide comments or authorization to finalize the Supplemental Environmental LSI report. Terracon appreciates this opportunity to provide environmental services to Louis Berger U.S. Inc. and the City of Shoreline. Should you have any questions or require additional information, please do not hesitate to contact our office.

Sincerely,
Terracon Consultants, Inc.

Carol Lybeer
Senior Project Manager

Michael D. Noll, L.G., L.Hg.
Senior Project Manager

Dennis R. Stettler. P.E.
Senior Geotechnical Consultant

Terracon

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Supplemental Environmental Limited Site Investigation

Proposed Constructed Wetland at Proposed Shoreline North Maintenance Facility Site
19547 25th Avenue NE
Shoreline, King County, Washington
Terracon Project No. 81165045
August 7, 2017

1.0 SITE DESCRIPTION

The site consists of an approximately 2.87-acre tract of land located at 19547 25th Avenue NE in Shoreline, King County, Washington, and is occupied by a City of Shoreline road maintenance facility, formerly the Brugger's Bog King County Maintenance Facility. The road maintenance facility has reportedly operated since the late 1950s. The site includes a covered vactor waste decant facility, a fleet vehicle fueling area, and a construction materials and equipment storage yard. Additional site improvements include an office/garage building, truck scale, and various outbuildings. The site is paved with asphalt and/or concrete, with some areas of gravel surfacing, and some landscaping and vegetation along the site borders. A Topographic Map showing the site location is included as Exhibit 1 and a Site Diagram is included as Exhibit 2 in Appendix A.

Terracon completed an Environmental Limited Site Investigation (Environmental LSI) at the site in January 2016 for TCF Architecture PLLC, and presented the results in a report dated February 24, 2016. As part of that investigation, five soil borings (B1 through B3, MW1, and GB1) were advanced in the northeast portion of the site and soil samples were collected for analysis. Gasoline- and diesel-range total petroleum hydrocarbon (TPH) were detected in the soil sample collected from boring B1 at 3 feet below the ground surface (bgs) at concentrations exceeding the Washington State Model Toxics Control Act (MTCA) Method A cleanup levels. Diesel- and oil-range TPH were detected in the soil samples collected from borings MW1 and GB1 at 3.5 and 2.5 feet bgs, respectively, but at concentrations below the MTCA Method A cleanup levels. A summary of Environmental LSI soil sample results from select borings are summarized in Table 1 in Appendix B.

As a part of planned improvements to drainage and flood reduction along 25th Avenue NE, one of the alternatives under consideration is to route Ballinger Creek through a constructed wetland to be constructed on the east side of the site. Louis Berger U.S. Inc. (Louis Berger) (Client) requested a proposal for a Supplemental Environmental LSI to further characterize shallow soils at the site in an area of the potential future constructed wetland. Please refer to Exhibit 2 for a depiction of site features.

2.0 SCOPE OF SERVICES

Terracon's scope of services included completion of the following tasks:

- Perform pre-mobilization activities including public and private underground utility clearances and preparation of a site specific health and safety plan;
- Advance 12 soil borings and collect soil samples from each boring;
- Complete laboratory analyses of soil samples; and
- Prepare this Supplemental Environmental LSI summary report.

The objective of this Supplemental Environmental LSI was to further characterize site soil for concentrations of total petroleum hydrocarbon (TPH) compounds and/or volatile organic compounds (VOCs) that may be excavated and potentially require off-site disposal, or may come into contact with surface water in a constructed wetland and/or day lighted stream. The scope of services was not intended to identify every chemical possibly associated with the site or surrounding facilities or to establish corrective action costs.

2.1 Standard of Care

Terracon's services were performed in a manner consistent with generally accepted practices of the profession undertaken in similar studies in the same geographical area during the same time. Terracon makes no warranties, either express or implied, regarding the findings, conclusions, or recommendations. Please note that Terracon does not warrant the work of laboratories, regulatory agencies, or other third parties supplying information used in the preparation of the report. These Supplemental Environmental LSI services were performed in accordance with the scope of services agreed with you, our client, as reflected in our proposal and were not restricted by ASTM E1903-11 *Standard Practice for Environmental Site Assessments: Phase II Environmental Site Assessment Process*.

2.2 Additional Scope Limitations

Findings, conclusions, and recommendations resulting from these services are based upon information derived from the on-site activities and other services performed under this scope of services; such information is subject to change over time. Certain indicators of the presence of hazardous substances, petroleum products, or other constituents may have been latent, inaccessible, unobservable, non-detectable, or not present during these services. We cannot represent that the site contains no hazardous substances, toxic materials, petroleum products, or other latent conditions beyond those identified during this Supplemental Environmental LSI. Subsurface conditions may vary from those encountered at specific borings or wells or during other surveys, tests, assessments, investigations, or exploratory services. The data, interpretations, findings, and our recommendations are based solely upon data obtained at the time and within the scope of these services.

2.3 Reliance

This report has been prepared for the exclusive use of Louis Berger U.S. Inc., and the City of Shoreline and any authorization for use or reliance by any other party (except a governmental entity having jurisdiction over the site) is prohibited without the express written authorization of Louis Berger U.S. Inc., the City of Shoreline, and Terracon. Any unauthorized distribution or reuse is at Louis Berger U.S. Inc.'s or the City of Shoreline's sole risk. Notwithstanding the foregoing, reliance by authorized parties will be subject to the terms, conditions, and limitations stated in the proposal, Supplemental Environmental LSI report, and the Modification of Subcontract/Agreement between Louis Berger U.S. Inc. and Terracon. The limitation of liability defined in the terms and conditions is the aggregate limit of Terracon's liability to Louis Berger U.S. Inc. and all relying parties unless otherwise agreed in writing.

3.0 FIELD INVESTIGATION

Terracon has a commitment to the safety of all its employees. As such, and in accordance with our *Incident and Injury Free®* safety goals, Terracon conducted the fieldwork under a site-specific health and safety plan developed for this project. Work was performed using the Occupational Health and Safety Administration (OSHA) Level D work attire consisting of hard hats, safety glasses, protective gloves, and protective boots. In an effort to locate underground utilities in the work area, Terracon contacted the Washington State Utility Notification Center to arrange for public underground utility clearance at the site. In addition, a private utility location service was subcontracted by Terracon to identify the locations and depths of the various utilities located near the proposed borings.

3.1 Geophysical Survey

On June 16, 2017, Terracon representative Kyle Bennett mobilized to the site with a subcontracted geophysical professional, C-N-I Locates Ltd., to perform a geophysical survey of selected portions of the site. The subcontractor utilized magnetometer survey methods to perform the survey. The purpose of the survey was to attempt to determine the location of possible utilities and/or anomalies near the proposed boring locations.

The geophysical survey consisted of scanning the areas of interest with an electromagnetic (EM) instrument. The geophysical survey was performed in the eastern portion of the property in the potential future constructed wetland area.

The geophysical survey did not reveal subsurface indications of utilities or anomalies near the proposed boring locations.

3.2 Soil Sampling

Field activities were performed throughout the potential future constructed wetland area. A total of 12 soil borings were advanced to approximately 10 feet below ground surface (bgs) using a direct-push technology (DPT) drill rig. Boring locations relative to site features are depicted on Exhibit 2 of Appendix A.

On June 16, 2017, Terracon field representative Kyle Bennett mobilized to the site to oversee the drilling of soil borings. The proposed scope of services stated that up to 10 soil borings or as many as could be completed in one day were to be advanced and sampled. Site conditions allowed for the advancement and sampling of 12 soil borings.

The borings were advanced by Holocene Drilling, a Washington State-licensed driller, using a limited-access, track-mounted DPT drill rig. The 12 borings, identified as soil borings WB1 through WB12, were advanced using a direct-push sampler equipped with disposable acetate sample sleeves. Throughout the drilling operation, soil samples were obtained continuously (to the extent practical) from five-foot long pushes driven into the ground using a 500-foot-pound, percussion hammer. The steel sampling tube was extracted from the hole and the liners were removed and split open. Non-disposable sampling equipment was cleaned using a non-phosphate soap wash and potable water rinse prior to the beginning of the project and before collecting each soil sample.

Terracon field-screened soil samples for organic vapors using a calibrated photoionization detector (PID). This device provides a direct reading in parts per million (ppm) isobutylene equivalents. Upon removal of the sampler from the borehole, Terracon put a portion of each sample in a sealable plastic bag. After a stabilization period, Terracon screened the headspace above the soil using the PID. In addition, select soils were field-screened by a sheen test by placing soil into a shallow bowl containing potable water and observing to see if a sheen was emitted on the top of the water's surface.

The boring logs in Appendix C include the field screening results for each soil boring. Soil samples were collected from the intervals with the highest PID readings or were collected from the capillary fringe (the interval immediately above the observed groundwater depth). Additional soil samples were collected at other depths for field screening purposes.

A total of 12 soil samples, one each from borings WB1 through WB12, were submitted for laboratory analysis. Additional soil samples were collected from each boring and placed on hold at the laboratory for possible analysis, depending on the results of the initial analyzed samples. Soil samples were extracted by hand using disposable gloves and placed directly into laboratory-supplied glassware.

Each sample container was labeled with the project number, date, time, boring number, and sample number. Sample containers were placed in a chilled cooler immediately after sampling, and subsequently transported to ALS Environmental (ALS) in Everett, Washington, a Washington State-accredited laboratory, under strict chain-of-custody procedures.

At the completion of field activities, the borings were decommissioned using bentonite chips hydrated with potable water immediately upon the conclusion of field work for this investigation and capped to approximately match the existing ground surface.

4.0 RESULTS OF THE FIELD INVESTIGATION

4.1 Geology/Hydrogeology

In general, Terracon encountered probable fill material consisting of sand and gravel below the pavement to depths ranging from 1.5 to 6 feet bgs. A 1- to 4-foot thick layer of dark brown sandy organic silt, indicative of a relic topsoil, was encountered below the fill to depths ranging from approximately 5 to 8.5 feet bgs. Gray silty sand with gravel and intermittent silty clay lenses was encountered below the relic topsoil, to boring termination depth (approximately 10 feet bgs). Shallow groundwater was encountered in the borings at depth ranging from approximately 1.5 feet bgs to 5.5 feet bgs. The boring logs attached in Appendix C detail the observed soil stratigraphy.

4.2 Field Screening

PID readings ranged from 0.1 ppm to 12.8 ppm in the soil samples collected from borings WB1 through WB12. A slight sheen was observed in soil samples collected from borings WB5 and WB6 at approximately 4 feet bgs. The sheen appeared to be due to organic-rich soil, and not from petroleum-related impacts. Sheens or other indications of possible chemical impacts were not observed in the remaining soil samples screened. The field screening results are summarized on the boring logs in Appendix C.

5.0 ANALYTICAL RESULTS

The selected soil samples were analyzed for gasoline-, diesel-, and oil-range TPH by Northwest Methods NWTPH-Gx/Dx and VOCs by EPA Method 8260. Soil samples analyzed for gasoline-range TPH and VOCs were collected using EPA Method 5035 sampling kits.

Reported soil concentrations were compared with the Washington Model Toxics Control Act (MTCA) Method A cleanup levels for unrestricted land use, as applicable, established under Chapter 70.105D Revised Code of Washington (RCW) and its implementing regulation, MTCA Chapter 173-340 Washington Administrative Code (WAC). Where a MTCA Method A cleanup level has not been established for a particular compound, the respective MTCA Method B cleanup level for cancer/non-cancer direct contact is applied for comparison.

In addition to the MTCA Method A or MTCA Method B cleanup levels, detected analyte concentrations were compared to Table 12.1 - Guidelines for Reuse of Petroleum-Contaminated Soil, found in the Washington State Department of Ecology (Ecology) *Guidance for Remediation of Petroleum Contaminated Soils, Toxics Cleanup Program, Publication No. 10-09-057 Revised June 2016*. The significance of these comparisons is discussed further below in Section 7.0.

The laboratory analytical report and chain-of-custody form are attached in Appendix D. The following sections describe the results of the testing.

5.1 Gasoline-, Diesel-, and Oil-Range TPH Analytical Results

Gasoline-range TPH was detected above the MTCA Method A cleanup level of 100 milligrams per kilogram (mg/kg) (when benzene is not present) in the soil sample collected from boring WB7 at 6 feet bgs, at a concentration of 150 mg/kg.

Based on the detection of gasoline-range TPH in the soil sample collected from boring WB7 at 6 feet bgs, the soil sample collected from boring WB7 at 9 feet bgs (which was placed on hold at the laboratory) was analyzed for TPH compounds. Gasoline-range TPH was not detected above the laboratory method reporting limit (MRL) of 3.0 mg/kg in the soil sample collected from boring WB7 at 9 feet bgs.

Gasoline-range TPH was detected above the laboratory MRL of 3.0 mg/kg but below the MTCA Method A cleanup level of 100 mg/kg in soil samples collected from borings WB4 at 1.5 feet bgs, WB8 at 1.5 feet bgs, WB9 at 1.5 feet bgs, and WB10 at 3 feet bgs.

Gasoline-range TPH was not detected above the laboratory MRL of 3.0 mg/kg in the remaining soil samples analyzed.

Diesel-range TPH was detected above the laboratory MRL of 25 mg/kg but below the MTCA Method A cleanup level of 2,000 mg/kg in soil samples collected from borings WB4 at 1.5 feet bgs, WB6 at 4 feet bgs, WB7 at 6 feet bgs, and WB10 at 3 feet bgs.

Diesel-range TPH was not detected above the laboratory MRL of 25 mg/kg in the remaining soil samples analyzed.

Oil-range TPH was detected above the laboratory MRL of 50 mg/kg but below the MTCA Method A cleanup level of 2,000 mg/kg in soil samples collected from borings WB2 at 4.5 feet bgs, WB4 at 1.5 feet bgs, WB6 at 4 feet bgs, WB7 at 6 feet bgs, WB8 at 1.5 feet bgs, WB9 at 1.5 feet bgs, and WB10 at 3 feet bgs.

Oil -range TPH was not detected above the laboratory MRL of 50 mg/kg in the remaining soil samples analyzed.

The soil analytical results are summarized in Table 1 of Appendix B.

5.2 VOC Analytical Results

Concentrations of three VOC analytes were detected in the soil samples analyzed. The three analytes that were detected above laboratory MRLs but below the applicable Method B cleanup levels were acetone, 2-butanone, and chlorobenzene.

Acetone was detected above the laboratory MRL of 0.050 mg/kg but below the MTCA Method B cleanup level of 72,000 mg/kg in soil samples collected from borings WB2 at 4.5 feet bgs, WB3 at 4 feet bgs, WB6 at 4 feet bgs, WB7 at 6 feet bgs, WB10 at 3 feet bgs, and WB12 at 3 feet bgs.

2-Butanone was detected above the laboratory MRL of 0.050 mg/kg but below the MTCA Method B cleanup level of 48,000 mg/kg in the soil sample collected from boring WB6 at 4 feet bgs.

Chlorobenzene was detected above the laboratory MRL of 0.010 mg/kg but below the MTCA Method B cleanup level of 1,600 mg/kg in the soil sample collected from boring WB10 at 3 feet bgs.

Additional VOC analytes were not detected above laboratory MRLs in the soil samples analyzed.

The soil sample analytical results are summarized in Table 1 of Appendix B.

6.0 INVESTIGATION DERIVED WASTE

One 20-gallon drum of drill cuttings was containerized during the field activities. The drum is currently staged onsite at the north perimeter along the existing row of 55-gallon drums. It is Terracon's understanding that the City of Shoreline will arrange for the disposal of the drum contents. Otherwise, Terracon can provide a cost estimate for a subcontractor to transport and dispose of the drums and contents at an off-site facility.

7.0 FINDINGS AND CONCLUSIONS

Based on the scope of services described in this report and subject to the limitations described herein, Terracon concludes the following.

Subsurface soils explored at select areas of the site did not contain concentrations of the analyzed compounds above their respective MTCA cleanup levels, with the exception of a concentration of gasoline-range TPH identified in soil sample WB7-6 collected at 6 feet bgs from the area between the garage/office building and the covered storage area. In addition, a soil sample collected from previous boring B1 at 3 feet bgs contained concentrations of gasoline- and diesel-range TPH exceeding the MTCA Method A cleanup levels.

As stated in Section 5.0 above, soil sample concentrations were also compared to the soil category criteria listed in Table 12.1 - Guidelines for Reuse of Petroleum-Contaminated Soil of Ecology's *Guidance for Remediation of Petroleum Contaminated Soils.* This table provides guidelines for the reuse of petroleum-contaminated soil based on contaminant concentrations. Category 1 soils do not contain contaminants at concentrations above specified laboratory MRLs. Category 2 soils contain one or more contaminants at concentrations above the laboratory MRLs, but below the MTCA cleanup levels. Category 3 and Category 4 soils contain one or more contaminants at higher concentrations, typically above the MTCA cleanup levels. A copy of Table 12.1 is included as Appendix E.

Based on the analytical results for soil samples collected from boring WB7 at 6 feet bgs and previous boring B1 at 3 feet bgs, these soils are Category 4 soils that should be properly disposed offsite at a licensed landfill or asphalt manufacturing plant. Results for soil samples collected from previous borings MW1 and GB1 at depths of 3.5 and 2.5 feet bgs, respectively indicate that soils in these areas are Category 3 soils that can be used for paving base material or road construction.

Results for soil samples collected from borings WB4, WB6, WB8, WB9, and WB10 at depths ranging from 1.5 to 3 feet bgs indicate that soils from these areas are Category 2 soils, which can be used as commercial fill above the groundwater table. As shown on Exhibit 2, the Category 2 soils are situated mainly in the southwestern portion of the potential future constructed wetland area. The remaining sample results indicate that soils in the potential future constructed wetland area are Category 1 soils, which can remain in place or, if excavated for the wetland, can be used onsite or offsite as clean fill.

Ecology's *Guidance for Remediation of Petroleum Contaminated Soils* provides guidance for the reuse of soil from petroleum-contaminated sites. According to Table 12.2, Category 2 soils should not be placed in or directly adjacent to wetlands or surface water where contact with water is possible. Therefore, if site soils are excavated that contain petroleum or VOC detections that exceed Category 1 criteria, the excavated soil should not be used as fill material in an area that will be in contact with groundwater or surface water. However, Ecology's *Guidance for Remediation of Petroleum Contaminated Soils* provides guidance on best management practices for reusing soil from petroleum-contaminated sites, and does not specifically address guidance for soil left in place at sites where a constructed wetland is anticipated. Based on Terracon's review of Ecology Wetland Mitigation Planning guidance documents, no specific soil cleanup levels have been established for constructed wetlands.

Terracon made a general inquiry to a wetland specialist at Ecology's Northwest Regional Office regarding a conceptual approach for a where petroleum impacts are known and construction of a wetland or day lighting a creek is being contemplated, and soil with residual impacts below MTCA cleanup levels may remain in place and potentially come into direct contact with surface water. The Ecology wetland specialist indicated that soil removal beyond the MTCA cleanup levels should not be necessary, but that Ecology staff in the Toxics Cleanup Program should also be consulted to verify this assumption.

Per the client's request, and with the approval of the City of Shoreline, Terracon provided site data to Ecology to obtain a more definitive answer to determine if soils at the site in the area of the proposed engineered wetland or potential day-lighted creek bed would require remedial cleanup to concentrations below the MTCA cleanup levels, and if so, what the appropriate criteria are for soil with petroleum concentrations left in-place. In discussions with an Ecology site manager in the Toxics Cleanup Program, Ecology apparently does currently not have established cleanup levels for TPH or VOCs in sediments or surface water. The Ecology site manager stated that the most appropriate cleanup standards for the site soil and groundwater would be MTCA Method A cleanup levels. The Ecology site manager stated that if soil grading or excavation do occur at the site, soil samples along the base and sidewalls of the excavation should be collected in accordance with Ecology guidance documents, and that soil concentrations left in place should be documented in order to establish the baseline concentrations that would potentially come into contact with re-directed surface water from the day-lighted creek.

If a wetland is constructed on the property, Terracon understands that soil in the proposed constructed wetland area would be excavated to depths of between 5 and 10 feet bgs. Soil samples collected in the area of the proposed potential wetland area are primarily located above 5 feet bgs, with the exception of WB7 at a depth of 6 feet bgs, which had gasoline-range TPH concentrations above the MTCA Method A cleanup level, and diesel- and oil-range TPH concentrations above the Category 1 and Category 2 criteria. Earthwork activities for wetland construction are likely to remove identified soil impacts that exceed MTCA Method A and Category 1 criteria.

If a wetland is not constructed on the property and the property is developed as a maintenance facility, environmental impacts that exceed MTCA cleanup levels should be addressed to achieve regulatory closure. Soil and groundwater results from the January 2016 Environmental LSI (Terracon report dated February 24, 2016) identified impacts of TPH in soil and groundwater and elevated arsenic concentrations in groundwater above MTCA action levels. Terracon understands that the City of Shoreline reported the presence of impacts to Ecology on August 4, 2017.

Activities to remediate the identified soil and groundwater impacts could include focused soil excavation, long-term groundwater monitoring, and/or implementation of an environmental covenant precluding the use of groundwater from the property and precluding earthwork activities unless additional soil samples are collected.

8.0 RECOMMENDATIONS

In the event that Category 1 soil cleanup criteria for soils left in place are determined by Ecology or other regulatory/permitting agencies to apply to a future constructed wetland or creek daylighting project, Terracon recommends that confirmation sampling be conducted during excavation in order to verify that soil above the Category 1 criteria has been successfully removed. Additionally, we recommend that the Ecology *Guidance for Remediation of Petroleum Contaminated Soils* be followed for the proper guidelines for on-site reuse or off-site disposal of any petroleum-contaminated soil.

Terracon also recommends that an environmental media management plan (EMMP) be prepared for the site to address the identified TPH and other impacts that could be encountered during any future earthwork activities conducted at the site. The EMMP will include guidance to the earthwork contractor for the following: health and safety; general contractor/subcontractor environmental qualifications; equipment decontamination; worker exposure, monitoring and field screening of soils; excavation and stockpiling of impacted soils; soil segregation; soil sampling methodology and frequency of testing; remedial excavations; disposition of excavation spoils; dewatering procedures of impacted groundwater; disposition of impacted groundwater; and documentation and reporting. Terracon is available to prepare the EMMP for the project, if desired.

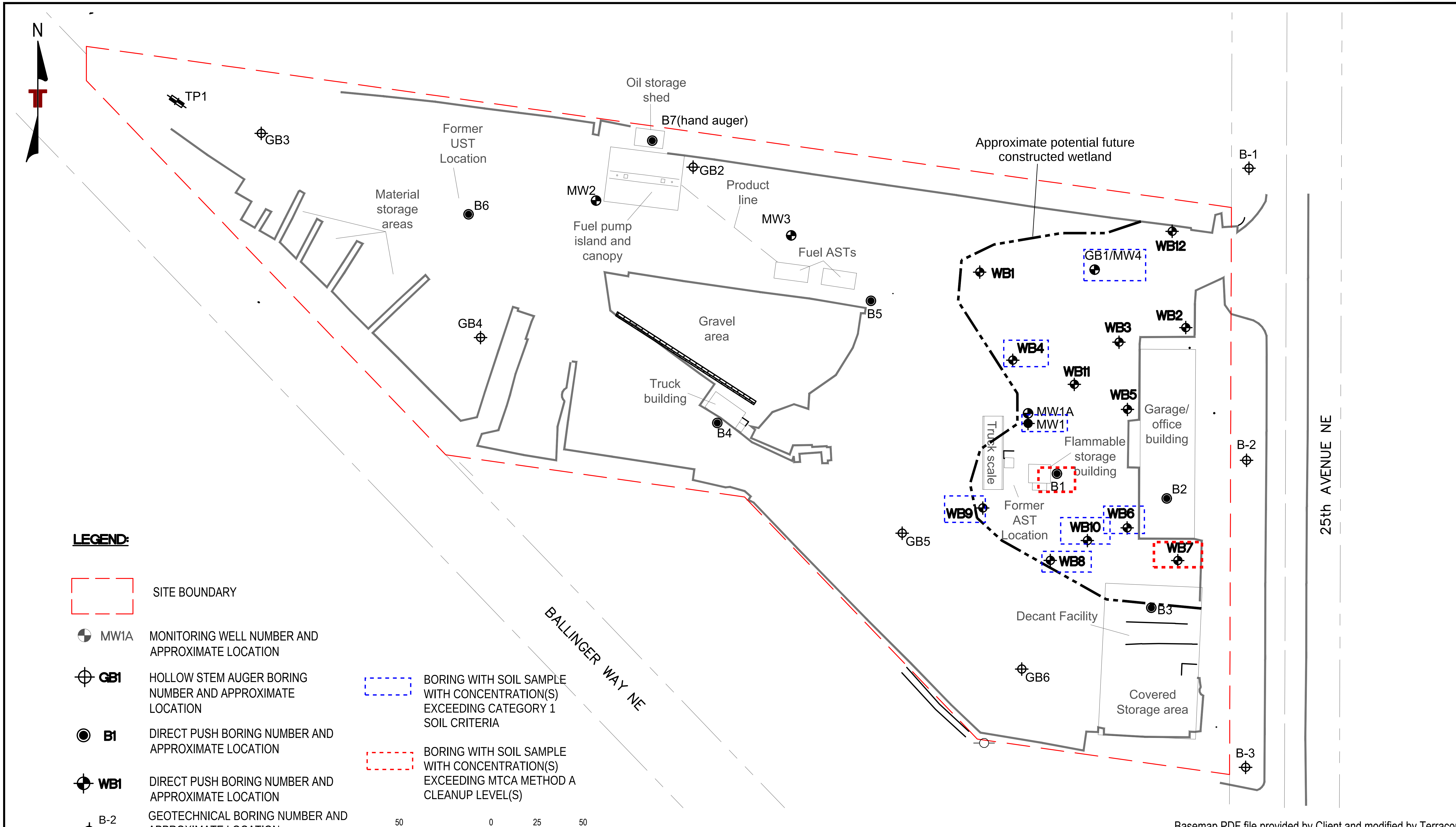
APPENDIX A – EXHIBITS

Exhibit 1 – Topographic Map

Exhibit 2 – Site Diagram

TOPOGRAPHIC MAP IMAGE COURTESY OF THE U.S. GEOLOGICAL SURVEY
QUADRANGLES INCLUDE: EDMONDS EAST, WA (1/1/1981).

Project Manager: MDN	81157201	Terracon	TOPOGRAPHIC MAP	Exhibit
Drawn by:	1"=2,000'	21905 64th Ave W Suite 100	Proposed Shoreline North Maintenance Facility	1
Checked by: SKL	Exhibit 1	Mountlake Terrace, WA 98043	19547 25th Avenue NE	
Approved by: MDN	Date: January2016		Shoreline, Washington	



Project Mngr: MDN	Project No. 81157201	Terracon Consulting Engineers and Scientists	**SITE DIAGRAM**
Drawn By: AMP	Scale: AS SHOWN	21905 64th Avenue W, Ste 100 Mountlake Terrace, WA 98043	Shoreline North Maintenance Facility LSI
Checked By: KSB	File No. Exhibit 2	PH. (425) 771-3304 FAX. (425) 771-3549	19547 25th Avenue NE
Approved By: MDN	Date: June 2017		Shoreline, King County, Washington

EXHIBIT

2

APPENDIX B – TABLE

Table 1 – Summary of Soil Analytical Results

TABLE 1

SUMMARY OF SOIL ANALYTICAL RESULTS

Proposed Shoreline North Maintenance Facility
19547 25th Ave NE
Shoreline, Washington
Terracon Project No. 81165045

all concentrations are in milligrams per kilogram (mg/kg)

Boring ID	Sample ID	Sample Date	Sample Depth (feet)	TPH			VOCs [1]		
				Gasoline-Range	Diesel-Range	Oil-Range	Acetone	2-Butanone	Chlorobenzene
January 2016 Environmental Limited Site Investigation									
B1	B1-3'	1/11/2016	3	**450**	**4,800**	ND (<500)	ND (<0.050)	ND (<0.050)	ND(<0.010)
MW1	MW1-3.5'	1/11/2016	3.5	ND (<3.0)	**130**	**330**	ND (<0.050)	ND (<0.050)	ND(<0.010)
GB1/MW4	GB1-2.5'	1/20/2016	2.5	ND (<3.0)	**200**	**510**	ND (<0.050)	ND (<0.050)	ND(<0.010)
June 2017 Supplemental Environmental Limited Site Investigation									
WB1	WB1-2	6/16/2017	2	ND (<3.0)	ND (<25)	ND (<50)	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB2	WB2-4.5	6/16/2017	4.5	ND (<3.0)	ND (<25)	**58**	**0.72**	ND (<0.050)	ND(<0.010)
WB3	WB3-4	6/16/2017	4	ND (<3.0)	ND (<25)	ND (<50)	**0.40**	ND (<0.050)	ND(<0.010)
WB4	WB4-1.5	6/16/2017	1.5	**23**	**58**	**120**	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB5	WB5-9.5	6/16/2017	9.5	ND (<3.0)	ND (<25)	ND (<50)	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB6	WB6-4	6/16/2017	4	ND (<3.0)	**25**	**86**	**0.50**	**0.10**	ND(<0.010)
WB7	WB7-6	6/16/2017	6	**150**	**510**	**750**	**0.38**	ND (<0.050)	ND(<0.010)
	WB7-9	6/16/2017	9	ND (<3.0)	ND (<25)	ND (<50)	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB8	WB8-1.5	6/16/2017	1.5	**13**	ND (<25)	**140**	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB9	WB9-1.5	6/16/2017	1.5	**7.1**	ND (<25)	**200**	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB10	WB10-3	6/16/2017	3	**7.7**	**58**	**180**	**0.20**	ND (<0.050)	**0.015**
WB11	WB11-3.5	6/16/2017	3.5	ND (<3.0)	ND (<25)	ND (<50)	ND (<0.050)	ND (<0.050)	ND(<0.010)
WB12	WB12-3	6/16/2017	3	ND (<3.0)	ND (<25)	ND (<50)	**0.43**	ND (<0.050)	ND(<0.010)
MTCA Method A or Method B Cleanup Level				**100 [2]**	**2,000**	**2,000**	**72,000***	**48,000***	**1,600***
Soil Category 1				**<5**	**<25**	**<100**	**NA**	**NA**	**NA**
Soil Category 2				**5 - 30**	**25 - 200**	**100 - 200**	**NA**	**NA**	**NA**

Note: Concentrations detected above laboratory method reporting limits (MRLs) are in **BOLD** type.
Concentrations detected above MTCA cleanup levels are in **BOLD** type and in a shaded cell.

MTCA - Model Toxics Control Act
NA - Not applicable
ND (<MRL) - Not detected above laboratory method reporting limit (MRL)
TPH - Total petroleum hydrocarbons
VOCs - Volatile organic compounds
* - MTCA Method B Cleanup Level - cancer/noncancer direct contact.
1 - Compounds detected above laboratory MRLs listed. See laboratory report for full list of analytes.
2 - Gasoline-range TPH Method A cleanup level is 100 mg.kg when benzene is not present

APPENDIX C – SOIL BORING LOGS

Boring Logs for WB1 through WB12

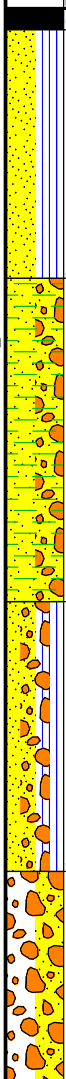
BORING LOG NO. WB1

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2



DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray, trace gravels, no sheen, no odor, moist, (PROBABLE FILL)					
	Becomes increasingly course					
2.5				■	12.6	WB1 -2
	SANDY ORGANIC SILT WITH GRAVEL (ML), dark brown, no sheen, no odor, moist					
	Grades to wet		∇			
					1.4	
5.5		5				
	SAND WITH SILT AND GRAVEL (SP-SM), gray, no sheen, no odor, wet					
					<1	
8.0	**SANDY GRAVEL (GP)**, gray, no sheen, no odor, wet					
				■	<1	WB1 -9
10.0		10				
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

∇ *While drilling*

21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-1

BORING LOG NO. WB2

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray, trace gravel, no sheen, no odor, moist, (PROBABLE FILL)					
	Becomes increasingly course				2.0	
2.5	**SANDY ORGANIC SILT WITH GRAVEL (ML)**, dark brown, no sheen, no odor, moist					
	Grades to wet		▽		<1	WB2 -4.5
5.0	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray, no sheen, no odor, wet	5				
					<1	
8.0	**SANDY GRAVEL (GP)**, gray, no sheen, no odor, wet					
10.0		10			<1	WB2 -9.5
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-2

BORING LOG NO. WB3

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION
0.2	**ASPHALT**
1.5	**SAND WITH SILT (SP-SM)**, gray, trace gravels, no sheen, no odor, moist, (PROBABLE FILL)
5.5	**SANDY ORGANIC SILT WITH GRAVEL (ML)**, dark brown, no sheen, stong organic odor, moist Becomes increasingly course
8.0	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray grades to dark gray, course sand, no sheen, no odor, wet
8.5	**SILTY CLAY LENSE (CL-ML)**, gray, no sheen, no odor, wet
10.0	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray, course sand, no sheen, no odor, wet
	Boring Terminated at 10 Feet

DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
			<1	
		■	1.2	WB3 -4
5	▽		<1	
		■	<1	WB3 -7.5
10		■	<1	WB3 -9.5

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-3

BORING LOG NO. WB4

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger, Seattle, Washington

SITE: 19547 25th Avenue NE, Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray, trace gravels, no sheen, no odor, moist, (PROBABLE FILL)			■	<1	WB4 -1.5
	Grades to wet		▽		<1	
5.5		5				
	SAND WITH SILT AND GRAVEL (SP-SM), brown to gray, no sheen, no odor, wet				<1	
	Becomes increasingly fine			■	<1	WB4 -8.5
9.0	**SILTY CLAY (CL-ML)**, gray, no sheen, no odor, wet					
10.0	***Boring Terminated at 10 Feet***	10				

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-4

BORING LOG NO. WB5

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger, Seattle, Washington

SITE: 19547 25th Avenue NE, Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT AND GRAVEL (SP-SM), gray to brown, slight sheen, no odor, moist, (PROBABLE FILL)					
	Becomes increasingly course				<1	
				■	<1	WB5-4
5.0		5	▽			
	SAND WITH SILT AND GRAVEL (SP-SM), brown to gray, course sand, no sheen, no odor, iron oxide staining, wet				<1	
					<1	
8.5	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray, no sheen, no odor, wet				<1	WB5-9.5
10.0		10				
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-5

BORING LOG NO. WB6

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger, Seattle, Washington

SITE: 19547 25th Avenue NE, Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray, no sheen, no odor, moist, (PROBABLE FILL)				<1	
4.0	**SANDY ORGANIC SILT WITH GRAVEL (ML)**, dark brown, slight sheen, no odor, wet			■	<1	WB6 -4
	Becomes increasingly course	5	▽			
5.5	**SAND WITH SILT AND GRAVEL (SP-SM)**, brown to gray, no sheen, no odor, wet			■	<1	WB6 -6
	Becomes increasingly course				<1	
10.0		10		■	<1	WB6 -9.5
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-6

BORING LOG NO. WB7

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT AND GRAVEL (SP-SM), brown to gray, no sheen, no odor, iron oxide staining, moist, (PROBABLE FILL)				<1	WB7 -1.5
	Grades to wet		▽			
	Relic asphalt approximately 2" thick	5			10.5	WB7 -4.5
6.0	**SANDY ORGANIC SILT WITH GRAVEL (ML)**, dark brown, no sheen, no odor, wet				12.8	WB7 -6
	Becomes increasingly course					
8.5	**SILTY CLAY (CL-ML)**, gray, no sheen, no odor, wet					
9.0	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray, no sheen, no odor, wet				1.2	WB7 -9
10.0	***Boring Terminated at 10 Feet***	10				

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-7

BORING LOG NO. WB8

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT AND GRAVEL (SP-SM), gray to brown, course sand, no sheen, no odor, moist, (PROBABLE FILL)					
	Grades to wet		▽	■	6.8	WB8 -1.5
3.5						
	SANDY ORGANIC SILT (ML), dark brown, trace gravel, no sheen, organic odor, wet				2.0	
5.0		5				
	SAND WITH SILT AND GRAVEL (SP-SM), brown to gray, course sand, no sheen, no odor, wet				1.2	
	Becomes increasingly fine					
	Grades to fine sand with silt and gravel					
8.0						
	SILTY CLAY (CL-ML), gray, no sheen, no odor, wet					
8.5						
	SAND WITH SILT AND GRAVEL (SP-SM), gray, course sand, no sheen, no odor, wet			■	<1	WB8 -9.5
10.0		10				
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-8

BORING LOG NO. WB9

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray to brown, course sand, trace gravel, no sheen, no odor, moist, (PROBABLE FILL)					
	Grades to wet		▽	■	3.0	WB9 -1.5
		5				
6.0					<1	
	SAND WITH SILT (SP-SM), brown to gray, trace gravel, no sheen, no odor, wet					
7.5						
	SANDY ORGANIC SILT (ML), dark brown, trace gravel, no sheen, organic odor, wet			■	1.4	WB9 -7.5
	Becomes increasingly course					
9.0						
	SAND WITH SILT AND GRAVEL (SP-SM), gray, no sheen, no odor, wet			■	<1	WB9 -9.5
10.0		10				
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-9

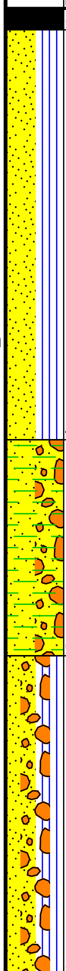
BORING LOG NO. WB10

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

SITE: 19547 25th Avenue NE
Shoreline, Washington

CLIENT: Louis Berger
Seattle, Washington

LOCATION See Exhibit 2



DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray to brown, no sheen, no odor, moist, (PROBABLE FILL)				4.9	
				■	7.7	WB10 -3
4.0	**SANDY ORGANIC SILT (ML)**, dark brown, no sheen, no odor, wet					
	Becomes increasingly course	5	▽			
6.0	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray, course sand, no sheen, no odor, wet			■	<1	WB10 -6
	Becomes increasingly fine					
9.0	**SILT (ML)**, gray, no sheen, no odor, wet			■	<1	WB10 -9
10.0	***Boring Terminated at 10 Feet***	10				

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-10

BORING LOG NO. WB11

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT (SP-SM), gray to brown, fine sand, no sheen, no odor, moist, (PROBABLE FILL)					
					<1	
				■	<1	WB11 -3.5
4.5	**SANDY ORGANIC SILT (ML)**, dark brown, no sheen, organic odor, moist					
	Becomes increasingly course	5				
			▽			
5.5	**SAND WITH SILT AND GRAVEL (SP-SM)**, gray, course sand, no sheen, no odor, wet					
	Becomes increasingly fine					
				■	<1	WB11 -7
8.0	**SAND WITH SILT (SP-SM)**, gray, no sheen, no odor, wet					
				■	<1	WB11 -9.5
10.0	***Boring Terminated at 10 Feet***	10				

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-11

BORING LOG NO. WB12

PROJECT: 25th Avenue NE Drainage-Shoreline North Maintenance Facility Site

CLIENT: Louis Berger
Seattle, Washington

SITE: 19547 25th Avenue NE
Shoreline, Washington

LOCATION See Exhibit 2

DEPTH	MATERIAL DESCRIPTION	DEPTH (ft)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	OVA/PID (ppm)	SAMPLE NUMBER
0.2	**ASPHALT**					
	SAND WITH SILT AND GRAVEL (SP-SM), gray to brown, no sheen, no odor, moist, (PROBABLE FILL)					
				■	1.3	WB12-3
	Grades to wet		▽			
4.5						
	SANDY ORGANIC SILT (ML), dark brown, no sheen, no odor, wet					
	Becomes increasingly course	5				
5.5						
	SAND WITH SILT AND GRAVEL (SP-SM), brown to gray, no sheen, no odor, wet					
					<1	
					<1	
				■	1.2	WB12-9.5
10.0		10				
	Boring Terminated at 10 Feet					

The stratification lines represent the approximate transition between differing soil types and/or rock types; in-situ these transitions may be gradual or may occur at different depths than shown.

Advancement Method:
Direct Push Technology

Abandonment Method:
Borings backfilled with bentonite chips upon completion

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
21905 64th Ave W Ste 100
Mountlake Terrace, WA

Boring Started: 6/16/2017	Boring Completed: 6/16/2017
Drill Rig: Geoprobe 7782DT	Driller: Holocene
Project No.: 81165045	Exhibit: WB-12

APPENDIX D – ANALYTICAL REPORT AND CHAIN OF CUSTODY FORM

June 28, 2017

Ms. Carol Lybeer
Terracon
21905 - 64th Ave W, Suite 100
Mountlake Terrace, WA 98043

Dear Ms. Lybeer,

On June 16th, 31 samples were received by our laboratory and assigned our laboratory project number EV17060119. The project was identified as your 81165045. The sample identification and requested analyses are outlined on the attached chain of custody record.

No abnormalities or nonconformances were observed during the analyses of the project samples.

Please do not hesitate to call me if you have any questions or if I can be of further assistance.

Sincerely,

ALS Laboratory Group

Rick Bagan
Laboratory Director

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-01
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:10:00 AM
CLIENT SAMPLE ID	WB1-2	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/22/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	U	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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ALS Group USA, Corp dba ALS Environmental

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-01
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:10:00 AM
CLIENT SAMPLE ID	WB1-2	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**72.7**	06/22/2017	SNC
C25	NWTPH-DX	**95.9**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**97.1**	06/19/2017	DLC
Toluene-d8	EPA-8260	**98.0**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**98.5**	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS			
CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-01
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:10:00 AM
CLIENT SAMPLE ID	WB1-2	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

U - Analyte analyzed for but not detected at level above reporting limit.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-03
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:24:00 AM
CLIENT SAMPLE ID	WB2-4.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/22/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	**58**	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	**0.72**	0.23	1	MG/KG	06/21/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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ALS Group USA, Corp dba ALS Environmental

ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-03
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:24:00 AM
CLIENT SAMPLE ID	WB2-4.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**61.8**	06/22/2017	SNC
C25	NWTPH-DX	**94.1**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**101**	06/19/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**97.1**	06/21/2017	DLC
Toluene-d8	EPA-8260	**103**	06/19/2017	DLC
Toluene-d8	EPA-8260	**96.4**	06/21/2017	DLC

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ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-03
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:24:00 AM
CLIENT SAMPLE ID	WB2-4.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
4-Bromofluorobenzene	EPA-8260	**103**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**99.4**	06/21/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.
Chromatogram indicates that it is likely that sample contains an unidentified oil range product.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-05
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:46:00 AM
CLIENT SAMPLE ID	WB3-4	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/22/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	U	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	**0.40**	0.13	1	MG/KG	06/21/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-05
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:46:00 AM
CLIENT SAMPLE ID	WB3-4	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**65.4**	06/22/2017	SNC
C25	NWTPH-DX	**102**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**104**	06/19/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**104**	06/21/2017	DLC
Toluene-d8	EPA-8260	**102**	06/19/2017	DLC
Toluene-d8	EPA-8260	**97.0**	06/21/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-05
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 8:46:00 AM
CLIENT SAMPLE ID	WB3-4	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
4-Bromofluorobenzene	EPA-8260	**104**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**97.4**	06/21/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

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ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-08
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:00:00 AM
CLIENT SAMPLE ID	WB4-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	**23**	3.0	1	MG/KG	06/22/2017	SNC
TPH-Diesel Range	NWTPH-DX	**58**	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	**120**	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-08
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:00:00 AM
CLIENT SAMPLE ID	WB4-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**89.9**	06/22/2017	SNC
C25	NWTPH-DX	**106**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**99.2**	06/19/2017	DLC
Toluene-d8	EPA-8260	**96.5**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**103**	06/19/2017	DLC

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ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-08
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:00:00 AM
CLIENT SAMPLE ID	WB4-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

U - Analyte analyzed for but not detected at level above reporting limit.

Chromatogram indicates that it is likely that sample contains highly weathered gasoline, highly weathered diesel and lube oil.

Gasoline range product results biased high due to semivolatile range product overlap.

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ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-11
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:25:00 AM
CLIENT SAMPLE ID	WB5-9.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	U	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-11
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:25:00 AM
CLIENT SAMPLE ID	WB5-9.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**88.8**	06/23/2017	SNC
C25	NWTPH-DX	**102**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**94.4**	06/19/2017	DLC
Toluene-d8	EPA-8260	**99.7**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**99.4**	06/19/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-12
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:30:00 AM
CLIENT SAMPLE ID	WB6-4	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/22/2017	SNC
TPH-Diesel Range	NWTPH-DX	**25**	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	**86**	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	**0.50**	0.39	1	MG/KG	06/21/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	**0.10**	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-12
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:30:00 AM
CLIENT SAMPLE ID	WB6-4	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**60.6**	06/22/2017	SNC
C25	NWTPH-DX	**103**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**101**	06/19/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**73.0**	06/21/2017	DLC
Toluene-d8	EPA-8260	**100**	06/19/2017	DLC
Toluene-d8	EPA-8260	**78.8**	06/21/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-12
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 9:30:00 AM
CLIENT SAMPLE ID	WB6-4	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
4-Bromofluorobenzene	EPA-8260	**105**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**83.1**	06/21/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-16
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:05:00 AM
CLIENT SAMPLE ID	WB7-6	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	**150**	6.0	2	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	**510**	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	**750**	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	**0.38**	0.16	1	MG/KG	06/21/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-16
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:05:00 AM
CLIENT SAMPLE ID	WB7-6	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT 2X Dilution	NWTPH-GX	**79.6**	06/23/2017	SNC
C25	NWTPH-DX	**111**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**99.2**	06/19/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**99.7**	06/21/2017	DLC
Toluene-d8	EPA-8260	**92.8**	06/19/2017	DLC
Toluene-d8	EPA-8260	**92.5**	06/21/2017	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-16
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:05:00 AM
CLIENT SAMPLE ID	WB7-6	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
4-Bromofluorobenzene	EPA-8260	**114**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**101**	06/21/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.
Chromatogram indicates that it is likely that sample contains highly weathered gasoline, weathered diesel and lube oil.
Chromatogram indicates that it is likely that sample contains highly weathered gasoline, weathered diesel 1 and lube oil.
Diesel range product results biased high due to oil range product overlap.
Gasoline range product results biased high due to semivolatile range product overlap.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-17
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:10:00 AM
CLIENT SAMPLE ID	WB7-9	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/28/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/26/2017	DLC
TPH-Oil Range	NWTPH-DX	U	50	1	MG/KG	06/26/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**83.4**	06/28/2017	SNC
C25	NWTPH-DX	**107**	06/26/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-18
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:15:00 AM
CLIENT SAMPLE ID	WB8-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	**13**	3.0	1	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	**140**	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-18
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:15:00 AM
CLIENT SAMPLE ID	WB8-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**98.1**	06/23/2017	SNC
C25	NWTPH-DX	**111**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**102**	06/19/2017	DLC
Toluene-d8	EPA-8260	**98.0**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**101**	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-18
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:15:00 AM
CLIENT SAMPLE ID	WB8-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

U - Analyte analyzed for but not detected at level above reporting limit.
Chromatogram indicates that it is likely that sample contains highly weathered gasoline and lube oil.
Gasoline range product results biased high due to semivolatile range product overlap.

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ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-20
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:35:00 AM
CLIENT SAMPLE ID	WB9-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	**7.1**	3.0	1	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	**200**	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-20
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:35:00 AM
CLIENT SAMPLE ID	WB9-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**94.9**	06/23/2017	SNC
C25	NWTPH-DX	**109**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**101**	06/19/2017	DLC
Toluene-d8	EPA-8260	**95.4**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**104**	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-20
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 10:35:00 AM
CLIENT SAMPLE ID	WB9-1.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

U - Analyte analyzed for but not detected at level above reporting limit.
Chromatogram indicates that it is likely that sample contains lube oil.
Gasoline range product results biased high due to semivolatile range product overlap.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-23
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:00:00 AM
CLIENT SAMPLE ID	WB10-3	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	**7.7**	3.0	1	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	**58**	25	1	MG/KG	06/23/2017	DLC
TPH-Oil Range	NWTPH-DX	**180**	50	1	MG/KG	06/23/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	**0.20**	0.13	1	MG/KG	06/21/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-23
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:00:00 AM
CLIENT SAMPLE ID	WB10-3	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	**0.015**	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**89.1**	06/23/2017	SNC
C25	NWTPH-DX	**104**	06/23/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**97.3**	06/19/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**98.7**	06/21/2017	DLC
Toluene-d8	EPA-8260	**91.9**	06/19/2017	DLC
Toluene-d8	EPA-8260	**102**	06/21/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-23
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:00:00 AM
CLIENT SAMPLE ID	WB10-3	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
4-Bromofluorobenzene	EPA-8260	**98.3**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**98.7**	06/21/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.
Chromatogram indicates that it is likely that sample contains highly weathered diesel.
Diesel range product results biased high due to oil range product overlap.
Gasoline range product results biased high due to semivolatile range product overlap.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-27
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:40:00 AM
CLIENT SAMPLE ID	WB11-9.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	U	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-27
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:40:00 AM
CLIENT SAMPLE ID	WB11-9.5	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**100**	06/23/2017	SNC
C25	NWTPH-DX	**111**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**97.6**	06/19/2017	DLC
Toluene-d8	EPA-8260	**95.0**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**97.9**	06/19/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-28
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:50:00 AM
CLIENT SAMPLE ID	WB12-3	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	3.0	1	MG/KG	06/23/2017	SNC
TPH-Diesel Range	NWTPH-DX	U	25	1	MG/KG	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	U	50	1	MG/KG	06/22/2017	DLC
Dichlorodifluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Acetone	EPA-8260	**0.43**	0.19	1	MG/KG	06/21/2017	DLC
1,1-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Butanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Chloroform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Benzene	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Trichloroethene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Dibromomethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
Toluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Hexanone	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS JOB#: ALS SAMPLE#:	6/28/2017 EV17060119 EV17060119-28
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:50:00 AM
CLIENT SAMPLE ID	WB12-3	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

ANALYTE	METHOD	RESULTS	REPORTING LIMITS	DILUTION FACTOR	UNITS	ANALYSIS DATE	ANALYSIS BY
Dibromochloromethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	0.0050	1	MG/KG	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	0.020	1	MG/KG	06/19/2017	DLC
Styrene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
o-Xylene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromoform	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Bromobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	0.050	1	MG/KG	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
Naphthalene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	0.010	1	MG/KG	06/19/2017	DLC

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
TFT	NWTPH-GX	**86.0**	06/23/2017	SNC
C25	NWTPH-DX	**114**	06/22/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**108**	06/19/2017	DLC
1,2-Dichloroethane-d4	EPA-8260	**97.9**	06/21/2017	DLC
Toluene-d8	EPA-8260	**101**	06/19/2017	DLC
Toluene-d8	EPA-8260	**97.7**	06/21/2017	DLC

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE:	6/28/2017
		ALS JOB#:	EV17060119
		ALS SAMPLE#:	EV17060119-28
CLIENT CONTACT:	Carol Lybeer	DATE RECEIVED:	06/16/2017
CLIENT PROJECT:	81165045	COLLECTION DATE:	6/16/2017 11:50:00 AM
CLIENT SAMPLE ID	WB12-3	WDOE ACCREDITATION:	C601

SAMPLE DATA RESULTS

SURROGATE	METHOD	%REC	ANALYSIS DATE	ANALYSIS BY
4-Bromofluorobenzene	EPA-8260	**101**	06/19/2017	DLC
4-Bromofluorobenzene	EPA-8260	**96.0**	06/21/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	6/28/2017 EV17060119 C601
CLIENT CONTACT:	Carol Lybeer		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MBG-062217S3 - Batch 117386 - Soil by NWTPH-GX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	MG/KG	3.0	06/22/2017	SNC

U - Analyte analyzed for but not detected at level above reporting limit.

MBG-062717S - Batch 117596 - Soil by NWTPH-GX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range	NWTPH-GX	U	MG/KG	3.0	06/28/2017	SNC

U - Analyte analyzed for but not detected at level above reporting limit.

MB2-062217S - Batch 117452 - Soil by NWTPH-DX

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
TPH-Diesel Range	NWTPH-DX	U	MG/KG	25	06/22/2017	DLC
TPH-Oil Range	NWTPH-DX	U	MG/KG	50	06/22/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

MB-061917S - Batch 117313 - Soil by EPA-8260

ANALYTE	METHOD	RESULTS	UNITS	REPORTING LIMITS	ANALYSIS DATE	ANALYSIS BY
Dichlorodifluoromethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Chloromethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Vinyl Chloride	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Bromomethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Chloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Carbon Tetrachloride	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Trichlorofluoromethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Carbon Disulfide	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Acetone	EPA-8260	U	MG/KG	0.050	06/19/2017	DLC
1,1-Dichloroethene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Methylene Chloride	EPA-8260	U	MG/KG	0.020	06/19/2017	DLC
Acrylonitrile	EPA-8260	U	MG/KG	0.050	06/19/2017	DLC
Methyl T-Butyl Ether	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Trans-1,2-Dichloroethene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,1-Dichloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
2-Butanone	EPA-8260	U	MG/KG	0.050	06/19/2017	DLC
Cis-1,2-Dichloroethene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
2,2-Dichloropropane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Bromochloromethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC

CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	6/28/2017 EV17060119 C601
CLIENT CONTACT:	Carol Lybeer		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MB-061917S - Batch 117313 - Soil by EPA-8260

Chloroform	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,1,1-Trichloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,1-Dichloropropene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2-Dichloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Benzene	EPA-8260	U	MG/KG	0.0050	06/19/2017	DLC
Trichloroethene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2-Dichloropropane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Dibromomethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Bromodichloromethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Trans-1,3-Dichloropropene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
4-Methyl-2-Pentanone	EPA-8260	U	MG/KG	0.050	06/19/2017	DLC
Toluene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Cis-1,3-Dichloropropene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,1,2-Trichloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
2-Hexanone	EPA-8260	U	MG/KG	0.050	06/19/2017	DLC
1,3-Dichloropropane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Tetrachloroethylene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Dibromochloromethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2-Dibromoethane	EPA-8260	U	MG/KG	0.0050	06/19/2017	DLC
Chlorobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,1,1,2-Tetrachloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Ethylbenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
m,p-Xylene	EPA-8260	U	MG/KG	0.020	06/19/2017	DLC
Styrene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
o-Xylene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Bromoform	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Isopropylbenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,1,2,2-Tetrachloroethane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2,3-Trichloropropane	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Bromobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
N-Propyl Benzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
2-Chlorotoluene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,3,5-Trimethylbenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
4-Chlorotoluene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
T-Butyl Benzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2,4-Trimethylbenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
S-Butyl Benzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
P-Isopropyltoluene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,3-Dichlorobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,4-Dichlorobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
N-Butylbenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	6/28/2017 EV17060119 C601
CLIENT CONTACT:	Carol Lybeer		
CLIENT PROJECT:	81165045		

LABORATORY BLANK RESULTS

MB-061917S - Batch 117313 - Soil by EPA-8260

1,2-Dichlorobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2-Dibromo 3-Chloropropane	EPA-8260	U	MG/KG	0.050	06/19/2017	DLC
1,2,4-Trichlorobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Hexachlorobutadiene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
Naphthalene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC
1,2,3-Trichlorobenzene	EPA-8260	U	MG/KG	0.010	06/19/2017	DLC

U - Analyte analyzed for but not detected at level above reporting limit.

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CERTIFICATE OF ANALYSIS

CLIENT:	Terracon 21905 - 64th Ave W, Suite 100 Mountlake Terrace, WA 98043	DATE: ALS SDG#: WDOE ACCREDITATION:	6/28/2017 EV17060119 C601
CLIENT CONTACT:	Carol Lybeer		
CLIENT PROJECT:	81165045		

LABORATORY CONTROL SAMPLE RESULTS

ALS Test Batch ID: 117386 - Soil by NWTPH-GX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range - BS	NWTPH-GX	**87.8**			66.5	122.7	06/22/2017	SNC
TPH-Volatile Range - BSD	NWTPH-GX	**85.1**	**3**		66.5	122.7	06/22/2017	SNC

ALS Test Batch ID: 117596 - Soil by NWTPH-GX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Volatile Range - BS	NWTPH-GX	**110**			66.5	122.7	06/28/2017	SNC
TPH-Volatile Range - BSD	NWTPH-GX	**113**	**3**		66.5	122.7	06/28/2017	SNC

ALS Test Batch ID: 117452 - Soil by NWTPH-DX

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
TPH-Diesel Range - BS	NWTPH-DX	**99.4**			75.5	122.1	06/22/2017	DLC
TPH-Diesel Range - BSD	NWTPH-DX	**102**	**3**		75.5	122.1	06/22/2017	DLC

ALS Test Batch ID: 117313 - Soil by EPA-8260

SPIKED COMPOUND	METHOD	%REC	RPD	QUAL	LIMITS MIN	LIMITS MAX	ANALYSIS DATE	ANALYSIS BY
1,1-Dichloroethene - BS	EPA-8260	**95.6**			73	138	06/19/2017	DLC
1,1-Dichloroethene - BSD	EPA-8260	**92.5**	**3**		73	138	06/19/2017	DLC
Benzene - BS	EPA-8260	**91.1**			75	138	06/19/2017	DLC
Benzene - BSD	EPA-8260	**88.6**	**3**		75	138	06/19/2017	DLC
Trichloroethene - BS	EPA-8260	**95.1**			75	136	06/19/2017	DLC
Trichloroethene - BSD	EPA-8260	**92.5**	**3**		75	136	06/19/2017	DLC
Toluene - BS	EPA-8260	**100**			76	134	06/19/2017	DLC
Toluene - BSD	EPA-8260	**97.7**	**3**		76	134	06/19/2017	DLC
Chlorobenzene - BS	EPA-8260	**98.4**			79	128	06/19/2017	DLC
Chlorobenzene - BSD	EPA-8260	**94.1**	**4**		79	128	06/19/2017	DLC

APPROVED BY

Laboratory Director

ADDRESS 8620 Holly Drive, Suite 100, Everett, WA 9820 | PHONE 425-356-2600 | FAX 425-356-2626
ALS Group USA, Corp dba ALS Environmental

ALS Environmental
8620 Holly Drive, Suite 100
Everett, WA 98208
Phone (425) 356-2600
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http://www.alsglobal.com

Chain Of Custody/ Laboratory Analysis Request

ALS Job# (Laboratory Use Only): EV17060119

Date 6-16-17 Page 1 Of 3

PROJECT ID: 81165045
REPORT TO COMPANY: Terracon Consultants inc (TC)
PROJECT MANAGER: Carol Lybeer
ADDRESS: 21905 64th Ave W. Suite 100
Mountlake Terrace, WA, 98043
PHONE: 425-771-3304 FAX:
P.O. #: E-MAIL: Carol.Lybeer@Terracon.com
INVOICE TO COMPANY:
ATTENTION:
ADDRESS:

ANALYSIS REQUESTED / OTHER (Specify)

SAMPLE I.D.	DATE	TIME	TYPE	LAB#	NWTPH-HCID	NWTPH-DX	NWTPH-GX	BTEX by EPA 8021 ☐ BTEX by EPA 8260 ☐	MTBE by EPA 8021 ☐ MTBE by EPA 8260 ☐	Halogenated Volatiles by EPA 8260	Volatile Organic Compounds by EPA 8260	EDB / EDC by EPA 8260 SIM (water)	EDB / EDC by EPA 8260 (soil)	Semivolatile Organic Compounds by EPA 8270	Polycyclic Aromatic Hydrocarbons (PAH) by EPA 8270 SIM	PCB by EPA 8082 ☐ Pesticides by EPA 8081 ☐	Metals-MTCA-5 ☐ RCRA-8 ☐ Pri Pol ☐ TAL ☐	Metals Other (Specify)	TCLP-Metals ☐ VOA ☐ Semi-Vol ☐ Pest ☐ Herbs ☐	HOLD							NUMBER OF CONTAINERS	RECEIVED IN GOOD CONDITION?
1. WB1-2	6-16-17	810	Soil	1		X	X				X																	
2. WB1-9		815		2																X								
3. WB2-4.5		824		3		X	X				X																	
4. WB2-9.5		830		4																X								
5. WB3-4		846		5		X	X				X																	
6. WB3-7.5		850		6																X								
7. WB3-9.5		851		7																X								
8. WB4-1.5		900		8		X	X				X																	
9. WB4-8.5		905		9																X								
10.																												

SPECIAL INSTRUCTIONS

SIGNATURES (Name, Company, Date, Time):
1. Relinquished By: [signature], TC, 6-16-17, 1310
Received By: Trent Tollen, ALS, 6-16-17, 1310
2. Relinquished By:
Received By:

TURNAROUND REQUESTED in Business Days*
Organic, Metals & Inorganic Analysis: 10 (Standard) ☐ ~~5~~ ☒ 3 ☐ 2 ☐ 1 ☐ SAME DAY ☐
Fuels & Hydrocarbon Analysis: ~~5~~ ☒ (Standard) 3 ☐ 1 ☐ SAME DAY ☐
OTHER:
Specify:

*Turnaround request less than standard may incur Rush Charges

ALS Environmental
8620 Holly Drive, Suite 100
Everett, WA 98208
Phone (425) 356-2600
Fax (425) 356-2626
http://www.alsglobal.com

Chain Of Custody/ Laboratory Analysis Request

ALS Job# (Laboratory Use Only): EV17060119

Date ________ Page 2 Of 3

PROJECT ID: 81165045
REPORT TO COMPANY: Terracon consultants
PROJECT MANAGER: Carol Lybeer
ADDRESS:
PHONE: FAX:
P.O. #: E-MAIL:
INVOICE TO COMPANY:
ATTENTION:
ADDRESS:

ANALYSIS REQUESTED / OTHER (Specify)

SAMPLE I.D.	DATE	TIME	TYPE	LAB#	NWTPH-HCID	NWTPH-DX	NWTPH-GX	BTEX by EPA 8021 ☐ BTEX by EPA 8260 ☐	MTBE by EPA 8021 ☐ MTBE by EPA 8260 ☐	Halogenated Volatiles by EPA 8260	Volatile Organic Compounds by EPA 8260	EDB / EDC by EPA 8260 SIM (water)	EDB / EDC by EPA 8260 (soil)	Semivolatile Organic Compounds by EPA 8270	Polycyclic Aromatic Hydrocarbons (PAH) by EPA 8270 SIM	PCB by EPA 8082 ☐ Pesticides by EPA 8081 ☐	Metals-MTCA-5 ☐ RCRA-8 ☐ Pri Pol ☐ TAL ☐	Metals Other (Specify)	TCLP-Metals ☐ VOA ☐ Semi-Vol ☐ Pest ☐ Herbs ☐	HOLD							NUMBER OF CONTAINERS	RECEIVED IN GOOD CONDITION?
1. WB5-4	6-16-17	920	Soil	10																X								
2. WB5-9.5		925		11		X	X				X																	
3. WB6-4		930		12		X	X				X																	
4. WB6-6		935		13																X								
5. WB6-9.5		940		14																X								
6. WB7-1.5		1000		15																X								
7. WB7-6		1005		16		X	X				X																	
8. WB7-9		1010		17		X	X													X								
9. WB8-1.5		1015		18		X	X				X																	
10. WB8-9.5		1025		19																X								

SPECIAL INSTRUCTIONS: X Added 6/23/17 on 3-day TAT. Sn

SIGNATURES (Name, Company, Date, Time):
1. Relinquished By: JCB, TC, ~~TB~~ 6-16-17, 1310
Received By: Trent Tollen, ALS, 6-16-17, 1310
2. Relinquished By:
Received By:

TURNAROUND REQUESTED in Business Days*
Organic, Metals & Inorganic Analysis: 10 (Standard) ~~5~~ 3 2 1 SAME DAY
Fuels & Hydrocarbon Analysis: ~~5~~ (Standard) X 1 SAME DAY
OTHER:
Specify:

*Turnaround request less than standard may incur Rush Charges

ALS Environmental
8620 Holly Drive, Suite 100
Everett, WA 98208
Phone (425) 356-2600
Fax (425) 356-2626
http://www.alsglobal.com

Chain Of Custody/ Laboratory Analysis Request

ALS Job# (Laboratory Use Only): EV17060119

Date ______ Page 3 Of 3

PROJECT ID: 81165045
REPORT TO COMPANY: Terracon Consultants inc.
PROJECT MANAGER: Carol Lybeer
ADDRESS:
PHONE: FAX:
P.O. #: E-MAIL:
INVOICE TO COMPANY:
ATTENTION:
ADDRESS:

ANALYSIS REQUESTED

SAMPLE I.D.	DATE	TIME	TYPE	LAB#	NWTPH-HCID	NWTPH-DX	NWTPH-GX	BTEX by EPA 8021 ☐ BTEX by EPA 8260 ☐	MTBE by EPA 8021 ☐ MTBE by EPA 8260 ☐	Halogenated Volatiles by EPA 8260	Volatile Organic Compounds by EPA 8260	EDB / EDC by EPA 8260 SIM (water)	EDB / EDC by EPA 8260 (soil)	Semivolatile Organic Compounds by EPA 8270	Polycyclic Aromatic Hydrocarbons (PAH) by EPA 8270 SIM	PCB by EPA 8082 ☐ Pesticides by EPA 8081 ☐	Metals-MTCA-5 ☐ RCRA-8 ☐ Pri Pol ☐ TAL ☐	Metals Other (Specify)	TCLP-Metals ☐ VOA ☐ Semi-Vol ☐ Pest ☐ Herbs ☐	OTHER (Specify): HOLD	NUMBER OF CONTAINERS	RECEIVED IN GOOD CONDITION?
1. WB9-1.5	6-16-17	1035	Soil	20		X	X	~~X~~	no		X											
2. WB9-7.5		1040		21																X		
3. WB9-9.5		1045		22																X		
4. WB10-3		1100		23		X	X	~~X~~	[illegible]		X											
5. WB10-9		1110		24																X		
6. WB11-3.5		1130		25																X		
7. WB11-7		1135		26																X		
8. WB11-9.5		1140		27		X	X	~~X~~	[illegible]		X											
9. WB12-3		1150		28		X	X	~~X~~	[illegible]		X											
10. WB12-9.5		1155		29																X		
WB7-4.5		10:01		30																X		
WB10-6		11:05		31																X		

SPECIAL INSTRUCTIONS

SIGNATURES (Name, Company, Date, Time):

1. Relinquished By: [signature] TC, 6-16-17, 1310
   Received By: Trent Tollen, ALS, 6-16-17, 1310
2. Relinquished By:
   Received By:

TURNAROUND REQUESTED in Business Days*

Organic, Metals & Inorganic Analysis: 10 (Standard) ~~5~~ 3 2 1 SAME DAY

Fuels & Hydrocarbon Analysis: ~~5~~ (Standard) 3 1 SAME DAY

OTHER:
Specify:

*Turnaround request less than standard may incur Rush Charges

APPENDIX E – TABLE 12.1 GUIDELINES FOR REUSE OF PETROLUEM-CONTAMINATED SOIL

Table 12.1 Guidelines for Reuse of Petroleum-Contaminated Soil					
Parameter	**Analytical Method**	**Soil Category (8)(9)(10)**			
		1 No detectable Petroleum Components (mg/kg)	**2** Commercial Fill Above Water Table (mg/kg)	**3** Paving Base Material & Road Construction (mg/kg)	**4** Landfill Daily Cover or Asphalt Manufacturing (mg/kg)
Total Petroleum Hydrocarbons (1)(2) See Table 7.1 for petroleum products that fall within these categories.					
Gasoline Range Organics	NWTPH-Gx	<5	5 - 30	>30 - 100	>100
Diesel Range Organics	NWTPH-Dx	<25	25 - 200	>200 - 500	>500
Heavy Fuels and Oils*	NWTPH-Dx	<100	100 - 200	>200 – 500	>500
Mineral Oil	NWTPH-Dx	<100	100 - 200	>200 – 500	>500
Volatile Petroleum Components					
Benzene	SW8260B	<0.005	0.005 - 0.03	0.03 or less	See Table 12.2
Ethylbenzene	SW8260B	<0.005	0.005 - 6	6 or less	>6
Toluene	SW8260B	<0.005	0.005 - 7	7 or less	>7
Xylenes (3)	SW8260B	<0.015	0.015 - 9	9 or less	>9
Fuel Additives & Blending Components					
(MTBE) Methyl Tert-Butyl Ether	SW8260B	<0.005	0.005 - 0.1	0.1 or less	>0.1
Lead	SW6010A	<17	17 - 50	>50 - 220	See Table 12.2
Other Petroleum Components					
Polychlorinated (4) Biphenyls (PCBs)	SW8082	<0.04	<0.04	<0.04	See Table 12.2
Naphthalenes (5)	SW8260B	<0.05	0.05 - 5	5 or less	>5
cPAHs (6)	SW8270C	<0.05	0.05 - 0.1	>0.1 - 2	>2
Other Petroleum Characteristics (Applies to soils contaminated with any petroleum product.)					
Odors	Smell	No detectable odor			
Staining	Visual	No unusual color or staining			
Sheen Test	See Footnote # 7	No visible sheen			
IMPORTANT: See Table 12.2 and the footnotes to this Table on the following pages! ***Test soil for the parameters specified in Table 7.2.*** ****Does NOT include waste oil contaminated soils, which should be disposed of in a landfill.*** ***"<" means less than; ">" means greater than***					

Table 12.1 Guidelines for reuse of petroleum-contaminated soil.

Appendix J
Critical Areas Report

DRAFT
CRITICAL AREAS REPORT/ SENSITIVE AREAS STUDY

25TH AVENUE NORTHEAST FLOOD REDUCTION PROJECT

Prepared for
City of Shoreline
and
Louis Berger

Prepared by
Herrera Environmental Consultants, Inc.

HERRERA

Note:
Some pages in this document have been purposely skipped or blank pages inserted so that this document will copy correctly when duplexed.

CRITICAL AREAS REPORT/ SENSITIVE AREAS STUDY

25TH AVENUE NORTHEAST FLOOD REDUCTION PROJECT

Prepared for
City of Shoreline
Contact: John Featherstone
Public Works Department
17500 Midvale Avenue North
Shoreline, Washington 98133

and

Louis Berger
Contact: Mike Giseburt
520 Pike Street, Suite 1005
Seattle, Washington 98101

Prepared by
Herrera Environmental Consultants, Inc.
2200 Sixth Avenue, Suite 1100
Seattle, Washington 98121
Telephone: 206-441-9080

DRAFT
September 19, 2016

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DISCLAIMER

Herrera Environmental Consultants, Inc. has prepared this report for use by the City of Shoreline, Washington. The results and conclusions in this report represent the professional opinion of Herrera Environmental Consultants, Inc. They are based upon examination of public domain information concerning the study area, site reconnaissance, and data analysis.

The work was performed according to accepted standards in the field of jurisdictional wetland determination and delineation using the *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987) and the *Regional Supplement to the Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010). In addition, work was conducted according to accepted standards of determining the ordinary high water mark (OHWM) of streams using the definition set forth in Washington Administrative Code 173 22 030(11) and *Determining the Ordinary High Water Mark on Streams in Washington State* (Olson and Stockdale 2010). However, final determination of jurisdictional wetland and OHWM boundaries pertinent to Section 404 of the Clean Water Act is the responsibility of the Seattle District of the US Army Corps of Engineers. Various agencies of the State of Washington and local jurisdictions may require a review of final site development plans that could potentially affect zoning, buffer requirements, water quality, or habitat functions of lands in question. Therefore, the findings and conclusions in this report should be reviewed by appropriate regulatory agencies before any detailed site planning or construction activities.

HERRERA QUALIFICATIONS

Established in 1980, Herrera Environmental Consultants, Inc. (Herrera) is an innovative, employee-owned, consulting firm focused on three practice areas: water, restoration, and sustainable development. Herrera's interdisciplinary teams of scientists, engineers, and planners provide scientifically defensible and realistic solutions to complex resources challenges facing municipalities, utilities, government agencies, tribes, nonprofits, and businesses. Herrera's philosophy is to integrate protection of environmental, cultural, and economic values into all of our projects.

The following staff authored this report and conducted field work in support of this report. A summary of their qualifications is provided.

Shelby Petro, MESM, WPIT

Shelby Petro is a wetland scientist and environmental permit coordinator with 8 years of experience in environmental consulting, specializing in natural resources management, wetland science, and regulatory compliance for public and private projects. Shelby conducts biological resources surveys for special-status plant and wildlife species; performs wetland delineations and critical areas assessments; prepares technical reports and documentation for National and State Environmental Policy Act (NEPA and SEPA) compliance; and prepares mitigation plans for impacts to wetlands and streams. Shelby coordinates with local, state, and federal agencies, completes applications, and obtains permits and approvals for project compliance with regulations including Critical Area Ordinances, Shoreline Management Act, State Hydraulic Code, SEPA, NEPA, Endangered Species Act (ESA), and Clean Water Act (CWA) Sections 401 and 404.

Credentials

- MESM, Master of Environmental Science and Management, University of California, Santa Barbara, 2014
- BS, Biology, Indiana Wesleyan University, 2007
- Certificate in Wetland Science and Management, University of Washington, 2015
- WPIT, Wetland Professional in Training, Society of Wetland Scientists, 2015
- Certified Wetland and Wildlife Biologist, Pierce County, 2014 – present
- Certified Biological Assessment Junior Author, WSDOT, 2015 – present

Julia Munger, WPIT

Julia Munger is a natural resources scientist with 6 years of professional experience in stream, wetland, and forest restoration; integrated pest management; wildlife surveys and habitat assessment; and parks maintenance and construction. Julia has extensive experience in habitat restoration, including the planning, implementation, monitoring and maintenance of restoration and mitigation sites. She has delineated wetland in Washington, Alaska, Oregon, and Montana. She has worked in Washington and California to identify, map, and eradicate invasive plant species. Julia conducts vegetation monitoring of mitigation and restoration sites; wetland and stream delineations; and provides recommendations and technical reports to support permit compliance and performance standards.

Credentials

- BS, Environmental Science, Huxley College at Western Washington University, 2008
- ISA Certified Arborist, International Society of Arboriculture, PN-7903A, 2014
- Certificate in Wetland Science and Management, University of Washington, 2013
- Wetland Professional in Training, Society of Wetland Scientists, 2014
- Commercial Pesticide Applicator with Aquatic Application Credentials, Washington State Department of Agriculture

EXECUTIVE SUMMARY

This critical areas report/sensitive areas study was prepared for the 25th Avenue NE Flood Reduction Project in accordance with current federal, state, and local regulations and guidance. Critical areas/environmentally sensitive areas, including wetlands and streams/fish and wildlife habitat conservation areas, are covered in this report. Other critical areas/environmentally sensitive areas, if present, are covered in separate reports and, therefore, are not mentioned in this report.

Wetland delineations were conducted in compliance with the *Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010) and *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

The Watershed Company (Watershed 2016) previously delineated one wetland in the study area, Wetland A, and Herrera biologists delineated one additional wetland in the study area, Wetland B (Table ES-1). Wetland A is a riparian wetland along Ballinger Creek within Brugger's Bog Park in the city of Shoreline. Wetland B is a riverine and depressional wetland south of NE 195th Street along Ballinger Creek in the city of Lake Forest Park.

Table ES-1. Wetlands Delineated in the Study Area for the 25th Avenue NE Flood Reduction Project.

Wetland Name	Size of Wetland (square feet/acre)	USFWS Classification[a]	Hydrogeomorphic Classification[b]	Wetland Rating Category	Standard Buffer Width (feet)	Minimum Buffer Width (feet)
A	10,197/0.23	PFO	Riverine	II[c,d]	165[f]	n/a[f]
B	54,808/1.26	PSS/PFO	Riverine, Depressional	II[c]/II[e]	100[g]	70[g]

[a] US Fish and Wildlife Service classification is based on Cowardin et al. (1979): palustrine forested (PFO) and palustrine scrub-shrub (PSS).

[b] Hydrogeomorphic classification is based on Brinson (1993).

[c] Wetland Category is based on the Washington State Department of Ecology (Ecology) wetland rating system (Hruby 2014).

[d] The City of Shoreline requires the use of Ecology's 2014 rating system.

[e] Wetland Category is based on the criteria outlined in Lake Forest Park Municipal Code (LFPMC) 16.16.040.AA. The City of Lake Forest Park does not require the Ecology rating system.

[f] Wetland buffer widths are based on the Ecology wetland rating and habitat score, per Shoreline Municipal Code (SMC) 20.80.330. Standard buffer widths assume the incorporation of mitigation measures outlined in SMC Table 20.80.330(A)(2). If an applicant chooses not to apply the mitigation measures, then a 33 percent increase in the width of all buffers is required.

[g] Wetland buffer widths are based on LFPMC 16.16.320.A. The City of Lake Forest Park allows for a minimum buffer width in accordance with the criteria outlined in LFPMC 16.16.320.E.

The ordinary high water marks (OHWMs) of streams within the study area were delineated using the definition provided in the Washington Administrative Code [WAC], Section 222-16-010, which has been adopted by the Cities of Shoreline and Lake Forest Park. In addition, methods in the publication *Determining the Ordinary High Water Mark on Streams in Washington State* (Olson and Stockdale 2010) were applied. Herrera biologists flagged the OHWM of two segments of Ballinger Creek within the study area. The Watershed Company (Watershed 2016) previously delineated the OHWM of Ballinger Creek within Brugger's Bog Park. Ballinger Creek flows south through the study area from Brugger's Bog Park in the north, through a culvert under 25th Avenue NE, in an open channel east of 25th Avenue NE and north of NE 195th Street, through a culvert under NE 195th Street, and continues southeast along the east side of Ballinger Way NE out of the study area.

Within the city of Shoreline, Ballinger Creek is a Type F stream, is regulated as a critical area (fish and wildlife conservation area), and is afforded a 115-foot standard buffer (SMC 20.80.280). Within the city of Lake Forest Park, Ballinger Creek is a Category I stream, is regulated as an environmentally sensitive area (stream), and is afforded a 115-foot standard buffer and 70-foot minimum buffer (LFPMC 16.16.350).

INTRODUCTION

This critical areas report/sensitive areas study was prepared for the 25th Avenue NE Flood Reduction Project (hereafter referred to as the project). The City of Shoreline proposes to reduce flooding along 25th Avenue NE by upgrading two undersized culverts, one along Ballinger Creek at 25th Avenue NE and the second along Ballinger Creek at NE 195th Street.

The project study area begins along Ballinger Creek at the northern boundary of Brugger's Bog Park in the city of Shoreline and ends approximately 300 feet south of the intersection of NE 195th Street and Ballinger Way NE in the city of Lake Forest Park (Figure 1). The Watershed Company (Watershed 2016) delineated wetlands and streams in the study area within Brugger's Bog Park in August 2013 and April 2016. Herrera Environmental Consultants, Inc. (Herrera) conducted an additional wetland and stream delineation in May 2016, the results of which are described herein.

This report describes the conditions of wetlands and fish and wildlife habitat conservation areas (e.g., streams), as well as wetland and stream ratings and required buffer widths. It also identifies applicable federal, state, and local laws and regulations.

Impacts associated with the project and proposed mitigation and monitoring will be incorporated into a future version of this report during Phase II of project design and development.

PROJECT SETTING

The study area is located in the cities of Shoreline and Lake Forest Park, King County, Washington (Figure 1). The study area is in Section 4 of Township 26 North, Range 4 East of the Willamette Meridian (WDFW 2009) on portions of parcels 4022901132, 4022901111, 1324000000, 0426049049, and 8665900022. The study area is in the northern portion of Water Resource Inventory Area (WRIA) 8 (Cedar-Sammamish) within the Lyon Creek drainage basin, which discharges into Lake Washington.

Land use in the surrounding vicinity is a mix of residential, commercial, and park properties. Ballinger Creek flows south through the study area from Brugger's Bog Park in the north, through a culvert under 25th Avenue NE, in an open channel east of 25th Avenue NE and north of NE 195th Street, through a culvert under NE 195th Street, and continues southeast along the east side of Ballinger Way NE and flows into Lyon Creek downstream of the study area. The City of Shoreline's North Maintenance Facility and Shoreline School District's Aldercrest Annex are both large properties located along 25th Avenue NE, adjacent to the study area (Figure 1).

Legend

- Study area
- Park
- City limit
- Stream

Figure 1.
Vicinity Map for the 25th Avenue NE Flood Reduction Project.

N

0 750 1,500 3,000 Feet

HERRERA

USDA, Aerial (2015)

K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\vicinity_map.mxd (8/18/2016)

STUDY OBJECTIVES

The objectives of Herrera's study were to:

- Delineate (flag) all wetlands and streams in the study area.
- Classify vegetation classes within delineated wetlands using the US Fish and Wildlife Service (USFWS) classification system (Cowardin et al. 1979).
- Classify all delineated wetlands using the hydrogeomorphic classification system (Brinson 1993).
- Evaluate wetland functions and values using the *Washington State Wetland Rating System for Western Washington: 2014 Update* (Hruby 2014) (also referred to as the Ecology rating system).
- Determine wetland categories and classes; stream type; and applicable wetland and stream buffer widths required by Shoreline and Lake Forest Park municipal codes.
- Identify regulations and guidance applicable to project impacts on wetlands, streams, and buffers set forth by local, state, and federal authorities.
- Classify all streams within the study area according to the Washington Department of Natural Resources (WDNR) Forest Practices Water Typing as described in the Washington Administrative Code (WAC 222-16-031).
- Identify fish and wildlife habitat conservation areas as described by Shoreline Municipal Code (SMC) 20.80.260.
- Identify wildlife habitat conservation areas as described by Lake Forest Park Municipal Code (LFPMC) 16.16.040.DD and 16.16.380.

APPLICABLE LAWS AND REGULATIONS

Wetlands and streams are subject to a variety of federal, state, and local regulations. Federal laws regulating wetlands and streams include Sections 404 and 401 of the Clean Water Act (United States Code, Title 33, Chapter 1344 [33 USC 1344]). Washington State laws and programs designed to control the loss of wetland acreage include the State Environmental Policy Act (SEPA) and Section 401 of the Clean Water Act (administered by the Washington State Department of Ecology [Ecology], as mandated by the Washington State Water Pollution Control Act). The study area is located within the city limits of Shoreline and Lake Forest Park and are, therefore, subject to those jurisdictions' municipal codes, which specify wetland categories/classes, stream types/classes, required buffer widths, development standards, and mitigation requirements for critical or environmentally sensitive areas within their jurisdiction.

Clean Water Act Sections 404 and 401

Section 404 of the federal Clean Water Act regulates the placement or removal of soil or other fill, grading, or alteration (hydrologic or vegetative) in waters of the United States, including wetlands and streams (33 USC 1344). The US Army Corps of Engineers (USACE) administers the permitting program under the act. The permits include nationwide (general) permits for projects involving minor fills, grading, or alteration; and individual permits for projects that require larger areas of disturbance to waters of the United States. USACE does not regulate wetland or stream buffers.

Section 401 of the Clean Water Act requires that proposed dredge (removal) and fill activities permitted under Section 404 be reviewed and certified to ensure that such activities meet state water quality standards. Washington State 401 certification is administered by Ecology for all Section 404 permits. Washington State 401 certification is granted without the need for a separate permit from Ecology for projects that qualify for a Section 404 nationwide permit, meet specific Section 401 certification conditions of the nationwide permit, and meet Ecology 401 General Conditions. If that is not the case, Ecology requires an Individual 401 Water Quality Certification permit.

Washington State Laws

Washington State laws and programs designed to control the loss of wetland acreage include SEPA and Section 401 of the Clean Water Act (a federal law that is implemented in the state by Ecology as noted above and as mandated by the Washington State Water Pollution Control Act).

The Washington Department of Fish and Wildlife (WDFW) administers the Hydraulic Project Approval (HPA) program under the state Hydraulic Code (WAC 220-110), which was specifically designed to protect fish life. An HPA permit is required for projects that will use, divert, obstruct, or change the natural flow or bed of any of the salt or fresh waters of the state.

City of Shoreline Code

The City of Shoreline regulates wetlands, fish and wildlife habitat conservation areas, and adjacent buffers within its jurisdiction as critical areas. Buffers are required around critical areas to protect their functions and values.

Wetlands

The City of Shoreline rates wetlands according to the *Washington State Wetland Rating System for Western Washington: 2014 Update* (SMC 20.80.320; Hruby 2014). Wetlands are rated as Category I, II, III, or IV, according to the level of function they provide and how highly they score on the Ecology rating system. Standard buffer widths defined by SMC 20.80.330 are based on the wetland rating and habitat score.

Fish and Wildlife Habitat Conservation Areas

The City of Shoreline designates fish and wildlife habitat conservation area as critical areas that include: 1) areas where State or Federally designated endangered, threatened, and sensitive species have a primary association; 2) areas where State priority habitats and areas associate with State priority species; 3) commercial and recreational shellfish areas; 4) kelp and eelgrass beds and herring and smelt spawning areas; and 5) Waters of the State (SMC 20.80.270). The City of Shoreline types streams in accordance with the WDNR water typing system (WAC 222-16-030; SMC 20.80.270.E). Standard buffer widths are based on stream type (SMC 20.80.280).

City of Lake Forest Park Code

The City of Lake Forest Park regulates wetlands, streams, wildlife habitat conservation areas, and adjacent buffers within its jurisdiction as environmentally sensitive areas. Buffers are required around environmentally sensitive areas to protect their functions and values.

Wetlands

The City of Lake Forest Park categorizes wetlands according to LFPMC 16.16.040.AA. Wetlands are rated as Category I, II, or III, according to criteria outlined in the code. Standard buffer widths defined by LFPMC 16.16.320 are based on the wetland rating. Minimum buffer widths may be authorized in accordance with criteria outlined in LFPMC 16.16.320.E.

Streams

The City of Lake Forest Park types streams according to criteria outlined under LFPMC 16.16.040.X. Standard buffer widths are based on stream type (LFPMC 16.16.350). Minimum buffer widths may be authorized in accordance with criteria outlined in LFPMC 16.16.350.G.

Wildlife Habitat Conservation Areas

The City of Lake Forest Park designates wildlife habitat conservation areas as feeding, breeding, and nesting sites for priority, endangered, or threatened species (LFPMC 16.16.040.DD). These areas include: 1) priority habitats with priority species; 2) naturally occurring ponds under 20 acres and their submerged aquatic beds that provide fish or wildlife habitat; 3) Waters of the State; 4) lakes, ponds, streams, and rivers planted with game fish by a governmental or tribal entity; or 5) state natural area preserves and natural resource conservation areas.

METHODS AND MATERIALS

Evaluating the presence, extent, and type of wetlands, streams, and fish and wildlife conservation areas requires a review of available information about the site (e.g., surveys, studies), followed by an onsite wetland and stream delineation and confirmation of existing delineations. The following sections describe the research methods and field protocols for the wetland and stream evaluations. More information about the methodology used in the wetland delineation performed for the project is available in Appendix A.

REVIEW OF AVAILABLE INFORMATION

Herrera staff reviewed available literature to determine the historical and current presence of wetlands and streams in and near the study area. Sources of information included:

- Aerial photographs of the study area and project vicinity
- National Wetlands Inventory map of wetland areas in the study area (USFWS 2014)
- City of Shoreline wetland and stream inventory (Shoreline 2016)
- City of Shoreline Lyon Creek Basin Plan (Shoreline 2015)
- City of Lake Forest Park Sensitive Areas Map (Lake Forest Park 2009a)
- City of Lake Forest Park Surface Water Management Plan (Lake Forest Park 2009b)
- City of Shoreline Maintenance Facility, Wetland and Stream Delineation Report (Watershed 2016)
- Hydrographic data (stream locations) for King County (USGS 2016)
- A Catalog of Washington Streams and Salmon Utilization (WDF 1975)
- SalmonScape computer mapping system (WDFW 2016a)
- Washington State Priority Habitats and Species (PHS) data (WDFW 2016b).
- Washington State Natural Heritage data (WDNR 2016)
- Climate data (NRCS 2016a)
- King County soil survey maps for the study area (NRCS 2016b)
- Hydric soils list and soil unit descriptions for the study area (NRCS 2016c)

Wetland Delineation

The wetland delineation was performed in accordance with the *Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010) and *Corps of Engineers Wetlands Delineation Manual* (Environmental Laboratory 1987).

The methods in the manuals listed above use a three-parameter approach for identifying and delineating wetlands, and rely on the presence of field indicators for hydrophytic vegetation, hydric soils, and hydrology. The methods for evaluating those three parameters are described in Appendix A. The wetland delineation for the project was performed according to procedures specified under the routine wetland determination method (Environmental Laboratory 1987).

To identify potential wetlands, Herrera wetland biologists evaluated field conditions by traversing the study area and noting wetlands, streams, other aquatic features. The biologists evaluated field conditions within 300 feet of the study area boundary in the city of Shoreline and within 150 feet of the study area boundary in the city of Lake Forest Park. For parcels without permission to access, biologists observed the surrounding areas from within the study area boundaries.

A test plot was established for each area that appeared to have potential wetland characteristics. For each test plot, data on dominant plant species, soil conditions in test plots, and evidence of hydrologic conditions were recorded on wetland determination data forms (Appendix B). Plants, soils, and hydrologic conditions were also analyzed and documented in adjacent upland test plot locations. Based on collected data, a determination of wetland or upland was made for each area examined. Observations of wildlife species and signs of their presence were also noted during the field visit.

Following confirmation of wetland conditions in a given area, the wetland boundary was delineated by placing sequentially numbered, pink "WETLAND BOUNDARY" flagging along the wetland perimeter. Test plot locations were marked with pink-and-black-striped flagging. The locations of wetland boundaries and test plots were subsequently surveyed by Perteet. Wetland boundaries outside of the study area were estimated using aerial photography.

For wetlands delineated within Brugger's Bog Park by The Watershed Company (Watershed 2016), Herrera biologists walked the delineated boundary and confirmed that all areas that met the three wetland characteristics within the study area were included in the delineated wetland boundary.

Wetland Classification, Rating, and Functional Assessment

Wetland Classification

Wetlands observed on the study area were classified according to the USFWS classification system (Cowardin et al. 1979). That system is based on an evaluation of attributes such as vegetation class, hydrologic regime, salinity, and substrate. The wetlands were also classified according to the hydrogeomorphic system, which is based on an evaluation of attributes such as the position of the wetland within the surrounding landscape, the source and location of water just before it enters the wetland, and the pattern of water movement in the wetland (Brinson 1993).

Wetland Rating

Wetlands in the city of Shoreline were rated using *Washington State Wetland Rating System for Western Washington: 2014 Update* (Hruby 2014), hereafter referred to as the Ecology rating system. The Ecology rating system categorizes wetlands according to specific attributes such as rarity; sensitivity to disturbance; hydrologic, water quality, and habitat functions; and special characteristics (e.g., mature forested wetland and bog). The total score for all functions determines the wetland rating. The rating system consists of four categories, with Category I wetlands exhibiting outstanding functions and/or special characteristics, and Category IV wetlands exhibiting minimal attributes and functions. The rating categories are used to identify permitted uses in the wetland and its buffer, to determine the width of buffers needed to protect the wetland from adjacent development, and to identify the mitigation ratios required to compensate for potential impacts on wetlands and wetland buffers. The City of Shoreline requires the use of the Ecology rating system (SMC 20.80.320).

Wetlands within the city of Lake Forest Park were rated using the criteria described in LFPMC 16.16.040.AA. Using those criteria, wetlands are rated into one of three categories, Category I, II, or III. Category I wetlands are those that contain federally listed endangered or threatened species; habitat for listed species; 40 to 60 percent permanent open water in dispersed patches with two or more vegetation classes; equal to or greater than 10 acres in size with three or more classes and one of the classes is open water; or wetlands with plant associations of infrequent occurrence that are associated with wetland values and functions. Category II wetlands are those that are greater than 1 acre in size, equal to or less than 1 acre with three wetland vegetation classes or a forested class, contain heron rookeries, or contain raptor nesting trees. Category III wetlands are those that do not meet the criteria for another category and are equal to or less than 1 acre in size with two or fewer wetland classes.

Wetland Functional Assessment

Wetland functions are those physical and chemical processes that occur within a wetland, such as the storage of water, cycling of nutrients, and maintenance of diverse plant communities and habitat that benefit wildlife. Wetland functions are grouped into three broad categories: water quality, hydrologic, and habitat.

- Water quality functions include the potential for removing sediment, nutrients, heavy metals, and toxic organic compounds in the water passing through the wetland.
- Hydrologic functions include reducing the velocity of stormwater, recharging and discharging groundwater, and providing flood storage.
- Habitat functions include providing food, water, and shelter for fish, shellfish, birds, amphibians, and mammals. Wetlands also serve as a breeding ground and nursery for numerous species.

For wetlands within Shoreline and Lake Forest Park, wetland functions were assessed using the *Washington State Wetland Rating System for Western Washington: 2014 Update* (Hruby 2014), which is approved by Ecology for evaluating wetland functions in Washington. This system generates a qualitative functional rating (high, moderate, or low) for each of the functions (water quality, hydrology, and habitat) provided by wetlands. The City of Lake Forest Park, per LFPMC 16.16.040.CC, evaluates wetland functions according to those set forth in the USACE regulations (33 CFR 320.4(b)(2)), which are included in the Ecology rating system (Hruby 2014).

Fish and Wildlife Habitat Conservation Area Delineation and Classification

A fish and wildlife conservation area is an area that supports regulated fish or wildlife species or habitats, typically identified by known point locations of specific species, habitat areas, or both. Streams are considered to be one type of fish and wildlife habitat conservation area according to SMC 20.80.270 and LFPMC 16.16.040.DD.

The OHWMs of streams within the study area were delineated using the definition provided in WAC Section 222-16-010, which has been adopted by the Cities of Shoreline and Lake Forest Park. According to that definition, the OHWM of streams is “that mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland, in respect to vegetation.” In addition, methods in the publication *Determining the Ordinary High Water Mark on Streams in Washington State* (Olson and Stockdale 2010) were applied.

To delineate the OHWM, Herrera biologists examined the bed and adjacent banks of streams in the study area for indications of regular high water events. Factors considered when assessing changes in vegetation include:

- Scour (removal of vegetation and exposure of gravel, sand, or other soil substrate)
- Drainage patterns
- Elevation of floodplain benches
- Changes in sediment texture across the floodplain
- Sediment layering
- Sediment or vegetation deposition
- Changes in vegetation communities across the floodplain

Herrera hung white/blue-dotted flagging on vegetation at the site, indicating the horizontal location of the OHWM along the stream. The locations of OHWM flags were subsequently surveyed by Perteet.

For the stream delineated within Brugger's Bog Park by The Watershed Company (Watershed 2016), Herrera biologists walked the mapped OHWM and confirmed the delineated boundary.

Streams within the city limits of Shoreline were classified using the WDNR water-typing system based on WAC 222-16-030. That system is based primarily on fish, wildlife, and human use, and consists of four stream types: Type S, F, Np, or Ns. Type S streams are those surface waters that are inventoried as "Shorelines of the State" under the Shoreline Management Master Program for Shoreline, pursuant to Revised Code of Washington (RCW) Chapter 90.58.030. Type F streams and waterbodies are those known to be used by fish, or meet the physical criteria to be potentially used by fish. Type F streams may or may not have flowing water all year; they may be perennial or seasonal. The City of Shoreline further describes Type F streams as F-anadromous and F-nonanadromous streams (SMC 20.80.260.E). Type F-anadromous streams are those streams where there is naturally recurring use by anadromous fish populations, streams that are fish passable or have the potential to be fish passable by anadromous populations, and streams with planned restoration or removal of dams that will result in a fish passable connection to Lake Washington or Puget Sound. Type F-nonanadromous streams are those streams that contain existing or potential fish habitat but do not have the potential for anadromous fish use due to natural barriers to fish passage. Type Np streams have flow year-round and may have spatially intermittent dry reaches downstream of perennial flow but do not meet the physical criteria of a Type F stream to provide fish habitat. Type Ns streams do not have surface flow during at least some portion of the year, and do not meet the physical criteria of a Type F stream to provide fish habitat.

Streams within the city limits of Lake Forest Park were classified using the criteria outlined in LFPMC 16.16.040.X. That system is based primarily on fish habitat use and consists of Type I, II, and III streams. Type I streams are those that are used at least seasonally by fish for spawning, rearing, or migration; streams that are fish passable from Lake Washington; and streams or parts thereof that are waters of the state (WAC 222-16-031). Type II streams are those that are perennial, non-fish-bearing streams. Type III streams are those that are seasonal, non-fish-bearing streams.

RESULTS

This section discusses the results of the wetland and stream delineations, including a review of information obtained from various references, and an analysis of wetland and stream conditions in the study area as observed during field investigations.

ANALYSIS OF AVAILABLE INFORMATION

The available existing information compiled for the wetland and stream delineation is summarized in the following subsections.

Previously Mapped Wetlands and Streams

The National Wetlands Inventory does not indicate any wetlands within or adjacent to the study area. The City of Shoreline's wetland inventory GIS data indicates one wetland along the boundary between Brugger's Bog Park and the North Maintenance Facility and a wetland along Ballinger Creek within the study area, in addition to two offsite wetlands (Figure 2). The wetland along Ballinger Creek in Brugger's Bog Park was delineated and named Wetland A in 2013 and reconfirmed in 2016 (Watershed 2016). The City of Lake Forest Park's wetland inventory indicates one wetland within Brugger's Bog Park along Ballinger Creek, one wetland located in the southeast corner of the intersection of NE 195th Street and Ballinger Way NE, and several offsite wetlands (Figure 2).

The hydrography GIS data for the study area indicates one stream, Ballinger Creek, flowing south through the study area (Figure 2). The stream then continues generally south until it flows into Lyon Creek and eventually into Lake Washington.

Mapped Soils

No soil data were available for the study area (NRCS 2016b).

Climate Data

Precipitation characteristics in the weeks and months preceding wetland delineation work for the project are important to understand with respect to potential for drier or wetter than normal wetland conditions on the site. Nearby precipitation gage records were evaluated for that purpose. Precipitation data were obtained from the Natural Resources Conservation Service (NRCS) WETS database (NRCS 2016a). The historical average measurements were based on data collected in Seattle, Washington (WETS Station Seattle Sand PT WSFO, WA290 (Latitude 47°41′N, Longitude 122°15′W) for the period of record 1971 to 2000. The station is approximately 8 miles south of the study area.

Legend

- Study area
- Sensitive Area Ordinance wetland (King County)
- Wetland (City of Lake Forest Park)
- Wetland (City of Shoreline)
- Stream (King County)
- Stream (City of Shoreline)
- City limit

Figure 2.
Previously Mapped Wetlands and Streams in the Vicinity of the 25th Avenue NE Flood Reduction Project.

N

0 200 400 800 Feet

HERRERA

USDA, Aerial (2015)

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Precipitation was evaluated for a 2-week and a 3-month period prior to field investigations, which occurred on May 31, 2016. Between May 16 and May 30, the historical average precipitation recorded 1.09 inches. Between May 16 and May 30, 2016, 1.18 inches of rain were recorded, which is 0.09 inch above average (NRCS 2016a). In the 3 months preceding the field investigations, the measured rainfall for March was wetter than normal, April was drier than normal, and May fell within the normal conditions (Table 1).

Table 1. Precipitation for the Three-Month Period Preceding Field Investigations.

Prior Month	WETS Historical Rainfall Percentile (inch)		WETS 2016 Measured Rainfall (inch)	Condition: Dry, Wet, Normal
	30th	70th		
March	2.95	4.45	5.22	Wet
April	2.04	3.36	1.57	Dry
May	1.49	2.49	1.63	Normal

Source: WETS Station: Seattle Sand PT WSFO, WA290, 1971–2000 (NRCS 2016a)

Fish Habitat Use

Based on WDFW's SalmonScape and PHS mapping, there is no documented fish habitat use in Ballinger Creek within the study area (WDFW 2016a, 2016b). Approximately 1 mile downstream of the study area, presence of coho salmon (*Oncorhynchus kisutch*) and resident coastal cutthroat trout (*O. clarkii clarkii*) has been documented within Ballinger Creek and further downstream within Lyon Creek (WDF 1979). Both coho salmon and resident coastal cutthroat are State priority species (WDFW 2016b). The culvert under 25th Avenue NE is identified as a total fish passage barrier; the culvert under NE 195th Street is identified as a partial barrier; and several additional partial barriers are documented downstream of the project area (WDFW 2016a).

Wildlife Habitat Use

According to WDFW PHS data (WDFW 2016b), there are no specific locations of priority habitats or species within the study area or immediate vicinity of the study area. The nearest mapped bald eagle (*Haliaeetus leucocephalus*) nest is greater than 1 mile from the study area. The nearest concentration of waterfowl is greater than 1 mile northwest of the study area at Ballinger Lake. The nearest biodiversity area and corridor is approximately 0.7 mile northeast of the study area along Lyon Creek, adjacent to Abbey View Memorial Park.

Analysis of Wetland Conditions

Wetland delineation field activities were conducted by Herrera biologists Shelby Petro and Julia Munger on May 31, 2016. The weather conditions during the fieldwork consisted of daytime high temperatures of approximately 78 degrees Fahrenheit (°F), with mostly sunny conditions. It was determined that the growing season (as defined in Appendix A) had begun, because aboveground growth and development of vascular plant species was occurring, as indicated by herbaceous species growing in wetland areas.

Herrera biologists delineated one wetland in the study area, Wetland B, and confirmed the previously delineated boundary of Wetland A (Watershed 2016; Figure 3). Buffer widths shown in Figure 3 provide a representation of the potential regulatory constraints. Actual buffer widths will be dependent upon review of the project and site conditions by the cities of Shoreline and Lake Forest Park (SMC 20.80.310-350, LFPMC 16.16.320-330). Detailed descriptions of wetlands delineated in the study area are provided in Tables 2 through 4. The biologists completed wetland delineation and rating forms (Appendix B) for Wetland B. Detailed information about Wetland A, including delineation and rating forms, are included in Appendix C.

Table 2. Wetlands Delineated in the Study Area for the 25th Avenue NE Flood Reduction Project.

Wetland Name	Size of Wetland (square feet/acre)	USFWS Classification[a]	Hydrogeomorphic Classification[b]	Wetland Rating Category	Standard Buffer Width (feet)	Minimum Buffer Width (feet)
A	10,197/ 0.23	PFO	Riverine	II[c,d]	165[f]	n/a[f]
B	54,808/ 1.26	PSS/PFO	Riverine, Depressional	II[c]/II[e]	100[g]	70[g]

[a] US Fish and Wildlife Service classification is based on Cowardin et al. (1979): palustrine forested (PFO) and palustrine scrub-shrub (PSS).

[b] Hydrogeomorphic classification is based on Brinson (1993).

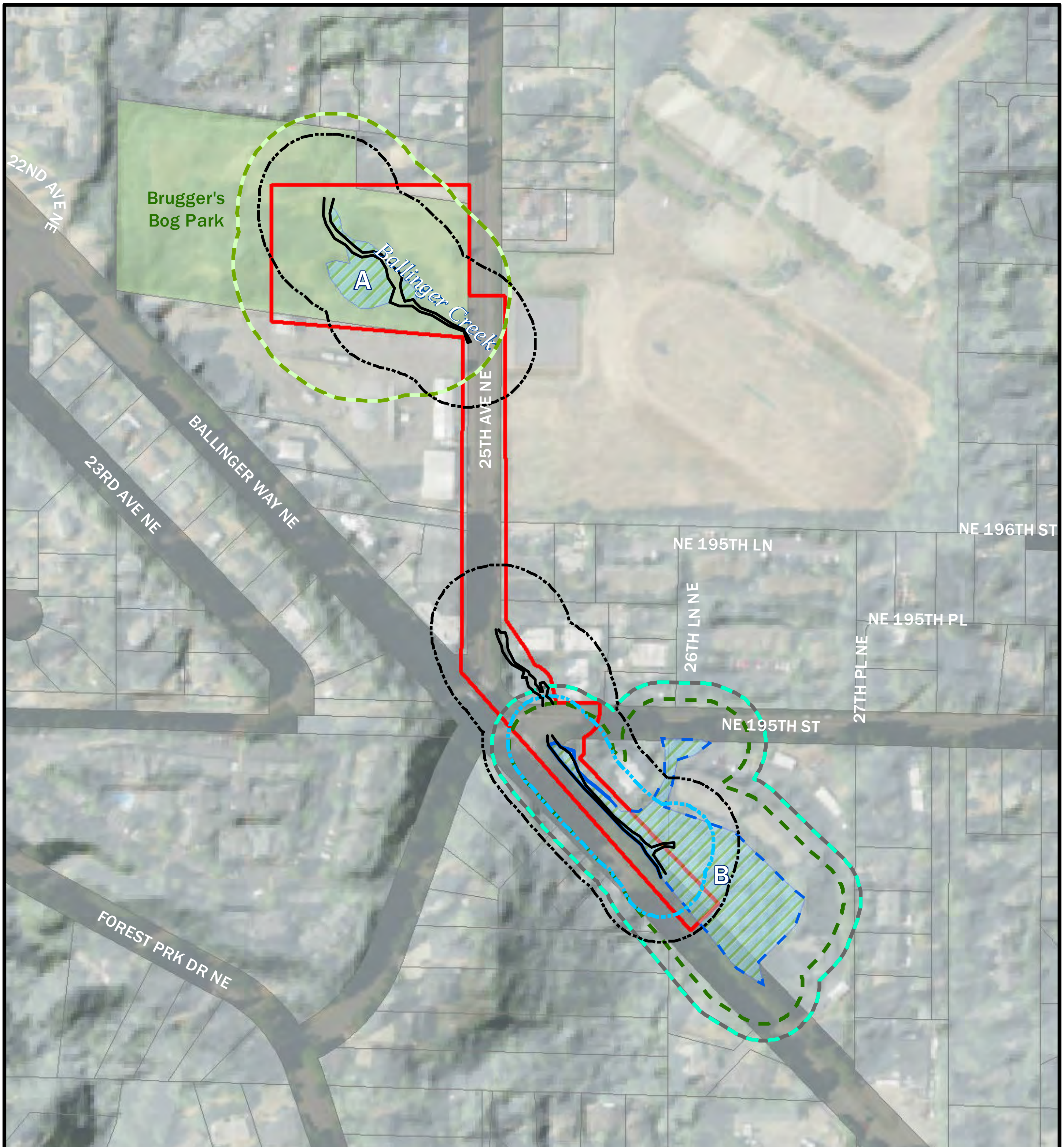
[c] Wetland Category is based on the Washington State Department of Ecology (Ecology) wetland rating system (Hruby 2014).

[d] The City of Shoreline requires the use of Ecology's 2014 rating system.

[e] Wetland Category is based on the criteria outlined in Lake Forest Park Municipal Code (LFPMC) 16.16.040.AA. The City of Lake Forest Park does not require the Ecology rating system.

[f] Wetland buffer widths are based on the Ecology wetland rating and habitat score, per Shoreline Municipal Code (SMC) 20.80.330. Standard buffer widths assume the incorporation of mitigation measures outlined in SMC Table 20.80.330(A)(2). If an applicant chooses not to apply the mitigation measures, then a 33 percent increase in the width of all buffers is required.

[g] Wetland buffer widths are based on LFPMC 16.16.320.A. The City of Lake Forest Park allows for a minimum buffer width in accordance with the criteria outlined in LFPMC 16.16.320.E.



Legend

- Study area
- Parcel
- Wetland area
- Surveyed wetland boundary
- Estimated wetland boundary
- OHWM

Wetland buffers

- 165-ft buffer (City of Shoreline)
- 100-ft buffer (City of Lake Forest Park)
- 70-ft buffer (City of Lake Forest Park - min.)

Stream buffers

- 115-ft buffer (City of Shoreline & City of Lake Forest Park - standard)
- 70-ft buffer (City of Lake Forest Park - min.)

Figure 3.
Wetlands and Streams Delineated in the Project Area for the 25th Avenue NE Flood Reduction Project.

N

0 125 250 500 Feet

HERRERA

USDA, Aerial (2015)

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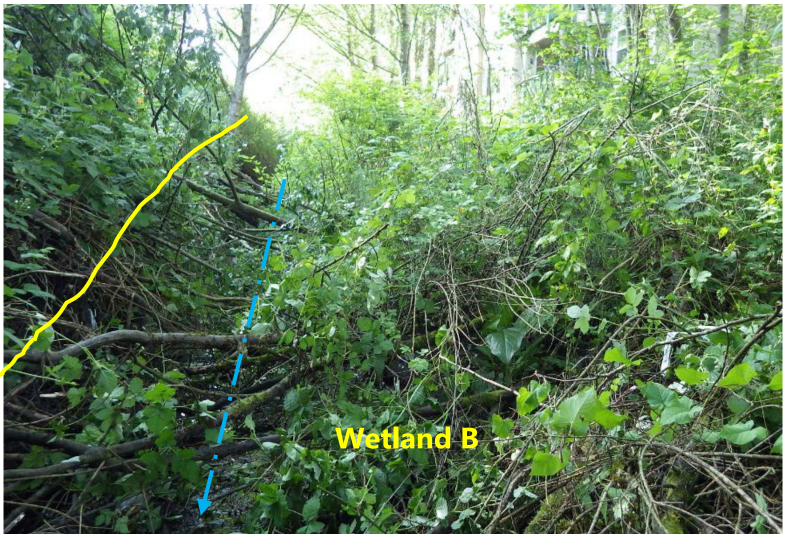
<table>
<tr><th colspan="4">Table 3. Summary for Wetland A.</th></tr>
<tr><td>Wetland Name</td><td colspan="3">Wetland A</td></tr>
<tr><td>Location</td><td colspan="3">Southeast corner of Brugger’s Bog Park along Ballinger Creek</td></tr>
<tr><td colspan="2" rowspan="8">
</td><td>Local Jurisdiction</td><td>City of Shoreline</td></tr>
<tr><td>WRIA</td><td>8</td></tr>
<tr><td>Wetland Rating (2014)</td><td>Category II</td></tr>
<tr><td>City of Shoreline Buffer Width</td><td>165 feet</td></tr>
<tr><td>Cowardin Classification</td><td>Palustrine forested</td></tr>
<tr><td>Hydrogeomorphic Classification</td><td>Riverine</td></tr>
<tr><td>Wetland Data Form(s)</td><td>Appendix C, DP-1</td></tr>
<tr><td>Upland Data Form(s)</td><td>Appendix C, DP-2</td></tr>
<tr><td>Size of Entire Wetland</td><td colspan="3">10,197 square feet (0.23 acre).</td></tr>
<tr><td>Dominant Vegetation</td><td colspan="3">Wetland A is dominated by a forested community of red alder (Alnus rubra), black cottonwood (Populus balsamifera), and Pacific willow (Salix lucida), with a scrub-shrub community of Sitka willow (Salix sitchensis), red-osier dogwood (Cornus alba), and salmonberry (Rubus spectabilis), and with an emergent community of skunk cabbage (Lysichiton americanus), small-fruited bulrush (Scirpus microcarpus), and creeping buttercup (Ranunculus repens) (Watershed 2016).</td></tr>
<tr><td>Soils</td><td colspan="3">Soils were examined to at least a 16-inch depth and exhibited hydric characteristics. At DP-1, the soil in the top 16 inches below the surface was black (10YR 2/1) sandy loam, with organic accumulations masking redoximorphic features. The soil is naturally problematic as the wetland is located within the active floodplain of Ballinger Creek; therefore, it does not meet any hydric soil indicators but is a hydric soil. At the upland test plot (DP-2), the top 8 inches of soil was a dark brown (10YR 3/3) loam (100 percent). The upland soil profile does not meet criteria of a hydric soil indicator (Watershed 2016).</td></tr>
<tr><td>Hydrology</td><td colspan="3">At DP-1, soils were saturated to the surface with a water table depth of approximately 14 inches. The wetland plot met the hydrology indicators for saturation (A3). Hydrologic inputs to this wetland include overbank flooding from Ballinger Creek, precipitation, groundwater, and runoff from surrounding uplands (Watershed 2016).</td></tr>
<tr><td>Rationale for Delineation</td><td colspan="3">All three wetland parameters are met.</td></tr>
<tr><td>Rationale for Local Rating</td><td colspan="3">The City of Shoreline Municipal Code classifies wetlands according to the current Ecology rating system (Hruby 2014), which rates Wetland A as a Category II.</td></tr>
<tr><td>Buffer Condition</td><td colspan="3">Buffers adjacent to the wetland consist of pockets of mixed coniferous-deciduous forest and shrubs scattered throughout mowed lawn in Brugger’s Bog Park. 25th Avenue NE is located between 100 to 200 feet east of the wetland, and the North Maintenance Facility is located 50 feet south. Invasive species, including Himalayan blackberry (Rubus armeniacus), are dominant downstream of Wetland A along the stream corridor to 25th Avenue NE. Existing buffers provide moderate to low wildlife habitat and water quality functions.</td></tr>
</table>

<table>
<tr><th colspan="4">Table 4. Summary for Wetland B.</th></tr>
<tr><td>Wetland Name</td><td colspan="3">Wetland B</td></tr>
<tr><td>Location</td><td colspan="3">Southeast of the intersection of NE 195th Street and Ballinger Way NE</td></tr>
<tr><td colspan="2" rowspan="9">
</td><td>Local Jurisdiction</td><td>Lake Forest Park</td></tr>
<tr><td>WRIA</td><td>8</td></tr>
<tr><td>Wetland Rating</td><td>Category II</td></tr>
<tr><td>Lake Forest Park Buffer Width</td><td>100 feet (standard)/ 70 feet (minimum)</td></tr>
<tr><td>Cowardin Classification</td><td>Palustrine forested/ scrub-shrub</td></tr>
<tr><td>Hydrogeomorphic Classification</td><td>Depressional/ Riverine</td></tr>
<tr><td>Wetland Data Form(s)</td><td>Appendix B, TP-B-WET</td></tr>
<tr><td>Upland Data Form(s)</td><td>Appendix B, TP-B-UPL</td></tr>
<tr></tr>
<tr><td>Size of Entire Wetland</td><td colspan="3">Approximately 54,808 square feet (1.26 acres). Not delineated in entirety; extends southeast of project area.</td></tr>
<tr><td>Dominant Vegetation</td><td colspan="3">Wetland B is dominated by a forested community of red alder, black cottonwood, and Pacific willow, with salmonberry, Sitka willow, red-osier dogwood, creeping buttercup, large-leaf avens (Geum macrophyllum), and horsetail (Equisetum telmateia) in the understory.</td></tr>
<tr><td>Soils</td><td colspan="3">At TP-B-WET, the top 17 inches of soil was black (10YR 2/1) silty clay loam and hemic muck with redoximorphic concentrations (7.5YR 4/6, 5 percent in the matrix). From 17 to 20+ inches below the surface, the soil was greenish gray (10GY 5/1) clay loam, with redoximorphic concentrations (10YR 4/6, 2 percent, in the matrix). This profile meets the criteria for the hydric soil indicators of thick dark surface (A12) and redoximorphic dark surface (F6). The upland soil profile does not meet criteria of a hydric soil indicator.</td></tr>
<tr><td>Hydrology</td><td colspan="3">At TP-B-UPL, soils were saturated to the surface with a water table depth of approximately 10 inches. The wetland plot met the hydrologic indicators for saturation (A3) and high water table (A2). Hydrologic inputs to this wetland include water from Ballinger Creek, precipitation, groundwater, and runoff from surrounding uplands. The wetland outlet discharges into Ballinger Creek, which flows south from the project area.</td></tr>
<tr><td>Rationale for Delineation</td><td colspan="3">All three wetland parameters are met.</td></tr>
<tr><td>Rationale for Local Rating</td><td colspan="3">The Lake Forest Park Municipal Code classifies wetlands according to specific criteria, which rates Wetland B as a Category II. Wetland B also rates as a Category II using the Ecology rating system (Hruby 2014).</td></tr>
<tr><td>Buffer Condition</td><td colspan="3">Buffers surrounding the wetland consist of NE 195th Street to the north, apartment buildings to the east and south, and Ballinger Way NE to the west. The vegetated buffer around the wetland consists of mowed lawn to the east and upland trees, shrubs, and invasive species including Himalayan blackberry and English ivy (Hedera helix), in a thin strip to the east of Ballinger Way NE. Existing buffers provide low wildlife habitat and water quality functions.</td></tr>
</table>

Evaluation of Wetland Functions

Wetland functions for each wetland within the study area were evaluated according to data in the *Washington State Wetland Rating System for Western Washington: 2014 Update* (Hruby 2014). This system generates a qualitative functional rating (high, moderate, or low) for each of the functions (water quality, hydrology, and habitat) provided by wetlands. A summary of the function scores, the total wetland score, and the associated rating (category) for each wetland is provided in Table 5. The City of Lake Forest Park evaluates wetland functions according to those set forth in the USACE regulations (33 CFR 320.4(b)(2), which are included in the Ecology rating system (Hruby 2014). The functions of Wetland A were evaluated by Herrera using the data collected and provided by The Watershed Company (Watershed 2016; Appendix C).

Wetland A

Wetland A, a riverine wetland, has a moderate potential to improve water quality (i.e., remove toxins) at the site because the wetland has depressions over half the area of the wetland and herbaceous plants greater than 6 inches tall over two-thirds of the area of the wetland that can trap sediments during a flooding event. It has high potential on a landscape level to improve water quality functions because the area nearby generates pollutants. The wetland has a high value to society because it discharges to Lyon Creek, which is on Ecology's 303(d) list of impaired waters (Ecology 2016).

The wetland has a moderate potential to improve hydrologic functions at the site, because the wetland provides overbank storage and the vegetation present can slow down water velocities during flood events. At a landscape level, the wetland has high potential to improve hydrologic functions because the land around the wetland is impacted by development. The wetland has a high value to society because it captures water that would otherwise flow into the Ballinger Creek, where flooding is known to damage human and natural resources.

The wetland has a moderate potential for habitat at the site level. The wetland has a forested class with multiple strata and two hydroperiods, which lends to a low interspersion of habitats, but has a high richness of plant species and multiple special habitat features (e.g., large, downed, woody debris). The wetland has a low potential for habitat on a landscape level, due to the large amount of disturbed habitat adjacent to the wetland. The habitat provided by the site is valuable to society because there are three or more priority habitats within 100 meters of the wetland.

Wetland B

Wetland B, a riverine and depressional wetland, has a moderate potential to improve water quality at the site because the wetland has a highly constricted, permanently flowing outlet; persistent, ungrazed plants throughout most of the area; and seasonal ponding throughout more than a quarter of the wetland area. It has moderate potential on a landscape level to improve water quality functions because the area nearby generates pollutants and the wetland receives stormwater discharges. The wetland has a high value to society because it discharges to Lyon Creek, which is on Ecology's 303(d) list of impaired waters (Ecology 2016).

Table 5. Individual Wetland Function Scores for Wetlands in the Study Area for the 25th Avenue NE Flood Reduction Project.											
	Water Quality Functions Rating[a]			Functions Hydrologic Rating[a]			Habitat Functions Rating[a]				
Wetland Name	**Site Potential**	**Landscape Potential**	**Value**	**Site Potential**	**Landscape Potential**	**Value**	**Site Potential**	**Landscape Potential**	**Value**	**Total Score[b]**	**Washington State Department of Ecology Rating Category[c]**
A	M	H	H	M	H	H	M	L	H	22	II
B	M	M	H	M	H	H	M	L	H	21	II

[a] Qualitative ratings of H (high), M (moderate), and L (low) are based on the Washington State Department of Ecology (Ecology) rating system (Hruby 2014).

[b] Total score is derived by adding all qualitative ratings together. Low ratings are worth 1 point, while Moderate ratings are worth 2 points, and High ratings are worth 3 points.

[c] Wetland category is based on the Ecology rating system (Hruby 2014).

The wetland has a moderate potential to improve hydrologic functions (storage of water) at the site because the wetland has a highly constricted, permanently flowing outlet; ponding up to a depth of 2 feet from the bottom of the outlet; and is relatively large compared to the contributing basin. At a landscape level, the wetland has high potential to improve hydrologic functions because the land around the wetland is impacted by development. The wetland has a high value to society because it captures water that would otherwise flow into Ballinger Creek, where flooding is known to damage human and natural resources.

The wetland has a moderate potential for habitat at the site level. The wetland has two vegetation classes, three hydroperiods, a high richness of plant species, a high interspersion of habitats, and multiple special habitat features (e.g., standing snags). The wetland has a low potential for habitat on a landscape level due to the large amount of disturbed habitat and urbanized area adjacent to the wetland. The habitat provided by the site is valuable to society because there are three or more priority habitats within 100 meters of the wetland.

Analysis of Fish and Wildlife Habitat Conservation Areas

Within the study area, Ballinger Creek is the only fish and wildlife habitat conservation area (SMC 20.80.270; LFPMC 16.16.040.DD). According to SalmonScape and PHS mapping (WDFW 2016a, 2016b), there is no documented fish habitat use in Ballinger Creek within the study area. Coho salmon and resident coastal cutthroat trout presence is documented downstream of the study area; several partial and total fish passage barriers prevent fish movement upstream (WDFW 2016a). The nearest mapped bald eagle nest and waterfowl concentrations are greater than 1 mile from the study area. The nearest biodiversity area and corridor is 0.7 mile from the study area. Furthermore, there are no State or Federally designated endangered, threatened, or sensitive species, State priority habitats, or State priority species within the study area or immediate vicinity of the study area. In addition, there are no commercial or recreational shellfish areas, kelp or eelgrass beds, herring or smelt spawning areas, naturally occurring ponds under 20 acres, waters planted with game fish, State natural area preserves, or natural resource conservation areas within the study area or the vicinity.

Ballinger Creek

Herrera biologists Shelby Petro and Julia Munger completed the stream delineation on May 25, 2016. The OHWMs of two segments of Ballinger Creek were delineated and the OHWM of one segment was confirmed in the study area. Herrera delineated the OHWM of Ballinger Creek in the segment on the northeast corner of the intersection of 25th Avenue NE and NE 195th Street, and the segment of Ballinger Creek in the southeast corner of the intersection of NE 195th Street and Ballinger Way NE for 300 feet south of NE 195th Street (Figure 3). Herrera confirmed the OHWM delineation of Ballinger Creek within Brugger's Bog Park, which was previously delineated by The Watershed Company (Watershed 2016). The stream characteristics are summarized in this section (Table 6).

Table 6. Stream Summary Table—Ballinger Creek.	
Stream Name	**Ballinger Creek**
	
Local Jurisdiction	City of Shoreline (north of NE 195th Street); City of Lake Forest Park (south of NE 195th Street)
WDNR Stream Type	n/a
Local Stream Rating	Type F-anadromous (Shoreline); Type I (Lake Forest Park)
Local Jurisdiction Buffer Width	115 feet standard (Shoreline); 115 feet standard/70 feet minimum (Lake Forest Park)
Documented Fish Habitat Use	No documented habitat use by fish within the study area; however, coho salmon and resident coastal cutthroat trout presence is documented downstream (WDFW 2016a; WDF 1979). The culvert under 25th Avenue NE is identified as a total fish passage barrier; the culvert under NE 195th Street is identified as a partial barrier; and several additional partial barriers are documented downstream of the project area (WDFW 2016a).
Location of Stream Relative to Project Corridor	Stream flows south through Brugger's Bog Park and Wetland A, under 25th Avenue NE (in a culvert), through an open channel north of NE 195th Street, under NE 195th Street (in a culvert), then continues southeast on the east side of Ballinger Way NE through Wetland B.
Connectivity (where stream flows from/to)	Stream flows south from Ballinger Open Space into Brugger's Bog Park, through the project area, then continues south through Lake Forest Park where it joins Lyon Creek and flows to Lake Washington.
Riparian/Buffer Condition	Within Brugger's Bog Park, the stream is surrounded by Wetland A and a forested riparian buffer provides shading and is generally of moderate quality. However, outside of this narrow riparian corridor, the buffer consists of lawn and development. The open segment north of NE 195th Street also has a narrow riparian buffer with adjacent lawn and development. South of NE 195th Street, the stream flows through Wetland B, which provides a forested buffer of generally high quality to the east. The western buffer of the stream is the steep fill slope and gabion wall of Ballinger Way NE. The remainder of the buffer is lawn and development.

IMPACTS ANALYSIS

To be evaluated in Phase II of the project design and development.

MITIGATION

To be evaluated in Phase II of the project design and development.

MAINTENANCE AND MONITORING

To be evaluated in Phase II of the project design and development.

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APPENDIX A

Wetland Delineation Methods

WETLAND DELINEATION METHODS

The wetland delineation for the 25th Avenue NE Flood Reduction Project was performed in accordance with the Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region (Environmental Laboratory 2010), which is consistent with the Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987). These methods use a three-parameter approach for identifying and delineating wetlands: the presence of field indicators for hydrophytic vegetation, hydric soils, and hydrology. This wetland delineation was performed according to procedures specified for the routine wetland determination method (Environmental Laboratory 1987).

Hydrophytic Vegetation

Hydrophytic vegetation is characterized by the ability to grow, effectively compete, reproduce, and persist in anaerobic soil conditions resulting from periodic or long-term saturation (Environmental Laboratory 1987). Vegetation must meet at least one of the four indicators (described below) that are used to determine the presence of hydrophytic vegetation in wetlands. Problematic and atypical situations for hydrophytic vegetation are also described in the US Army Corps of Engineers delineation manual and supplement (Environmental Laboratory 1987, 2010).

Plant Species Identification

Plant species were identified using *Flora of the Pacific Northwest* (Hitchcock and Cronquist 1987) and *A Field Guide to the Common Wetland Plants of Western Washington and Northwestern Oregon* (Cooke 1997). The indicator status of each plant species is based on the *National Wetland Plant List* (Lichvar 2016) for the Western Mountains, Valleys, and Coast Region.

Dominant Species Determination

Dominant species are those that contribute more than other species to the character of a plant community. To determine dominance, a vegetation sampling area is determined by the field biologist to accurately characterize the plant community that occurs in the area to be evaluated. These are commonly circular sampling areas, centered on the location of the test plot (where soil and hydrologic data is also collected). The radius of the circle is determined in the field, based on site conditions. In large wetlands, a typical sampling radius would be 2 to 5 meters for tree and sapling/shrub species, and 1 meter for herbaceous species. In a small or narrow wetland (or upland), the radius might be reduced to accurately sample wetland (upland) areas, thereby avoiding an overlap into an adjacent community having different vegetation, soils, or hydrologic conditions (Environmental Laboratory 2010).

Within the vegetation sampling area, a complete list of plant species that occur in the sampling area is compiled and the species divided into four strata: tree, shrub (including saplings, see criteria below), herb, and woody vines. A plant is included in the tree stratum if it is a woody plant 3 inches in diameter at breast height (dbh) or greater; in the shrub stratum if it is a woody plant less than 3 inches dbh (including tree saplings under 3 inches dbh); in the herb stratum if it is an herbaceous (non-woody) plant; and in the woody vine stratum if it is a woody vine of any height (Environmental Laboratory 2010). To be included in the sampling, 50 percent or more of the plant base must be within the radius of the sampling area. For trees specifically, more than 50 percent of the trunk (diameter) must be within the sampling radius to be included.

A rapid test, dominance test (e.g., the 50/20 rule), or prevalence index are commonly used to determine which species are considered dominant and to assess whether the criteria for hydrophytic vegetation are met at each test plot (Environmental Laboratory 2010). Additional hydrophytic vegetation indicators are discussed in the following section.

To conduct a rapid test (Indicator 1 on the wetland determination data form), the dominant species are evaluated visually and if all are FACW or OBL, the vegetation data passes the rapid test. To conduct a dominance test (Indicator 2 on the wetland determination data form), the absolute areal coverage of the plant species within a stratum are totaled, starting with the most abundant species and including other species in descending order of coverage, until the cumulative coverage exceeds 50 percent of the total coverage for the stratum. The plant species that constitute this first 50 percent of areal coverage are considered the dominant species in the stratum. In addition, any other any single plant species that constitutes at least 20 percent of the total percent cover in the stratum is also considered a dominant species (Environmental Laboratory 2010). The indicator status category for each plant (shown in Table A-1) is also listed on the wetland determination form. If more than 50 percent of the dominant species across all strata are rated OBL, FACW, or FAC, the hydrophytic vegetation dominance test (Indicator 2) is met.

The prevalence index (Indicator 3 on the wetland determination data form) is a weighted-average wetland indicator status of all plant species in the sampling plot, where weighting is by abundance (Environmental Laboratory 2010). This method is used where indicators of hydric soil and wetland hydrology are present, but the vegetation initially fails the rapid and dominance tests (Indicators 1 and 2). To determine the prevalence index, the absolute cover of each species in each stratum is determined. All species (across all strata) are organized into wetland indicator status groups (i.e., OBL, FACW, FAC, FACU, or UPL) and their cover values are summed within the groups. The formula for the prevalence index is applied. If the prevalence index (which ranges from 1.0 to 5.0) equals 3.0 or less, this hydrophytic vegetation indicator is met.

Table A-1. Plant Indicator Status Categories.		
Indicator Status	**Indicator Symbol**	**Definition**
Obligate wetland plants	OBL	Plants that occur almost always (estimated probability >99%) in wetlands under natural conditions but also occur rarely (estimated probability <1%) in upland areas
Facultative wetland plants	FACW	Plants that usually occur (estimated probability >67%) in wetlands under natural conditions but also occur (estimated probability 1% to 33%) in upland areas
Facultative plants	FAC	Plants with a similar likelihood (estimated probability 33% to 67%) of occurring in both wetlands and upland areas
Facultative upland plants	FACU	Plants that sometimes occur (estimated probability 1% to 33%) in wetlands but occur more often (estimated probability >67% to 99%) in upland areas
Obligate upland plants	UPL	Plants that rarely occur (estimated probability <1%) in wetlands under natural conditions
WET ⟷ *DRY* *OBL – FACW – FAC – FACU – UPL*		

Source: Environmental Laboratory (1987).

Additional Hydrophytic Vegetation Indicators

The presence of morphological adaptations to wetland conditions in plants that lack a published hydrophytic vegetation indicator status or with an indicator status of FACU or drier is also a hydrophytic vegetation indicator (Indicator 4). Evidence of physiological, morphological, or reproductive adaptations indicating growth in hydrophytic conditions can include, but are not limited to, buttressed roots, adventitious roots, multi-stemmed trunks, or tussocks. To determine whether Indicator 4 is met, the morphological features must be observed on more than 50 percent of the individuals of a FACU species (or species without a published indicator status) living in an area where hydric soil and wetland hydrology are present. On the wetland determination data form, the indicator status of the species with morphological adaptations would be changed to FAC (with supporting notes), and the dominance test (Indicator 2) and/or prevalence index (Indicator 3) would then be recalculated.

Wetland non-vascular plants, referred to as bryophytes and consisting of mosses, liverworts, and hornworts, may also meet the hydric vegetation criteria, under Indicator 5 (Environmental Laboratory 2010). These plants must be present in areas containing hydric soils and wetland hydrology. The percent cover of wetland specialist bryophytes is determined in 10-inch by 10-inch square plots placed at the base of hummocks, if present. The summed cover of wetland specialist bryophytes must be more than 50 percent of the total bryophyte cover in the vegetation sampling area.

The problematic hydrophytic vegetation indicator section in the Corps regional supplement further explains how to interpret situations in which hydric soils and wetland hydrology are present but hydrophytic vegetation Indicators 1 through 5 are lacking (Environmental

Laboratory 2010). Procedures for looking at settings such as areas with active vegetation management (e.g. farms), areas dominated by aggressive invasive species, active floodplains, and low terraces are described, as well as explanations for specific situations, such as seasonal shifts in plant communities, extended drought conditions, and riparian areas.

HYDRIC SOILS

A hydric soil is a soil that is saturated, flooded, or inundated long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (Environmental Laboratory 1987, 2010). The evaluation of existing soil maps (developed by NRCS and other sources) is used to understand hydric soil distribution and to identify the likely locations of hydric soils (by verifying their inclusion on the hydric soils list). Comparison of these mapped soils to conditions found on site help verify the presence of hydric soils.

For on-site soils characterization, hydric soils data were obtained generally by digging test pits at least 20 inches deep and 4 inches wide. Hydric soil conditions were evaluated using indicators outlined in *Field Indicators of Hydric Soils in the United States* (NRCS 2006), and adopted by the *Regional Supplement to the US Army Corps of Engineers Wetlands Delineation Manual: Western Mountains, Valleys, and Coast Region* (Environmental Laboratory 2010).

Hydric soil indicators applicable to the Western Mountains, Valleys, and Coast region include, but are not limited to, the presence of organic soils (i.e., histosols or histic epipedons); sulfidic material (i.e., hydrogen sulfide); depleted, gleyed, or reduced soil matrices; and/or the presence of iron or manganese concretions (Environmental Laboratory 2010). Soil color characterization (i.e., hue, value, and chroma) is a critical tool in determining depleted, gleyed, and reduced soil conditions. Soil color was evaluated by comparing soil colors at test plots to standardized color samples in *Munsell Soil Color Charts* (Munsell Color 2000).

WETLAND HYDROLOGY

Wetland hydrology is indicated by site conditions that demonstrate the periodic inundation or saturation to the soil surface for a sufficient duration during the total growing season. A *sufficient duration* during the growing season is defined as 14 or more consecutive days of flooding, ponding, or presence of a water table at 12 inches or less from the soil surface (Environmental Laboratory 2010). The growing season is the period of consecutive frost-free days, or the longest period during which the soil temperature stays above biological zero (41°F), when measured at 12 inches below the soil surface.

Two indicators of biological activity can be used to determine whether the growing season has begun and is ongoing (Environmental Laboratory 2010):

- Occurrence of aboveground growth and development of at least two non-evergreen vascular plant species growing within the wetland. Examples of this growth include the emergence or elongation of leaves on woody plants and the emergence or opening of flowers.

- Soil temperature, which can be measured once during a single site visit, should be at least 41°F or higher at a depth of 12 inches.

For this assessment, onsite hydrologic indicators were examined at the test plots. Hydrologic indicators include the presence of surface water, standing water in the test pit at a depth of 12 inches or less, saturation in the root zone, watermarks, drift lines, sediment deposits, drainage patterns within wetlands, oxidized rhizospheres surrounding living roots, and water-stained leaves.

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APPENDIX B

Wetland B Delineation Data Sheets and Rating Forms

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

Project/Site: 25th Avenue NE Flood Reduction Project **City/County:** Lake Forest Park/King **Sampling Date:** 31-May-16

Applicant/Owner: City of Shoreline **State:** WA **Sampling Point:** TP-B-UPL

Investigator(s): Shelby Petro, Julia Munger **Section, Township, Range:** S 4 T 26N R 4E

Landform (hillslope, terrace, etc.): Lowland **Local relief (concave, convex, none):** flat **Slope:** 0.0 % / 0.0 °

Subregion (LRR): LRR A **Lat.:** 47.003064 **Long.:** 122.301689 **Datum:** WGS84

Soil Map Unit Name: none mapped **NWI classification:** None

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 ● No ○	**Is the Sampled Area within a Wetland?**	Yes ○ No ●
Hydric Soil Present?	Yes ○ No ●		
Wetland Hydrology Present?	Yes ○ No ●		

Remarks:

VEGETATION - Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Rel.Strat. Cover	Indicator Status
Tree Stratum (Plot size: 3 m)				
1. Alnus rubra	50	☑	100.0%	FAC
2.	0	☐	0.0%	
3.	0	☐	0.0%	
4.	0	☐	0.0%	
	50	= Total Cover		
Sapling/Shrub Stratum (Plot size: 2 m)				
1. Acer circinatum	80	☑	88.9%	FAC
2. Rubus armeniacus	5	☐	5.6%	FAC
3. Rubus spectabilis	5	☐	5.6%	FAC
4.	0	☐	0.0%	
5.	0	☐	0.0%	
	90	= Total Cover		
Herb Stratum (Plot size: 1 m)				
1. Equisetum telmateia	2	☐	2.2%	FACW
2. Ranunculus repens	40	☑	43.5%	FAC
3. Phalaris arundinacea	50	☑	54.3%	FACW
4.	0	☐	0.0%	
5.	0	☐	0.0%	
6.	0	☐	0.0%	
7.	0	☐	0.0%	
8.	0	☐	0.0%	
9.	0	☐	0.0%	
10.	0	☐	0.0%	
11.	0	☐	0.0%	
	92	= Total Cover		
Woody Vine Stratum (Plot size: 1 m)				
1.	0	☐	0.0%	
2.	0	☐	0.0%	
	0	= Total Cover		

% Bare Ground in Herb Stratum: 8

Dominance Test worksheet:

Number of Dominant Species That are OBL, FACW, or FAC:	4	(A)
Total Number of Dominant Species Across All Strata:	4	(B)
Percent of dominant Species That Are OBL, FACW, or FAC:	100.0%	(A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	0	x 1 =	0
FACW species	52	x 2 =	104
FAC species	180	x 3 =	540
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	232 (A)		644 (B)

Prevalence Index = B/A = 2.776

Hydrophytic Vegetation Indicators:

- ☐ 1 - **Rapid Test for Hydrophytic Vegetation**
- ☑ 2 - **Dominance Test is > 50%**
- ☑ 3 - **Prevalence Index is ≤3.0** [1]
- ☐ 4 - **Morphological Adaptations** [1] **(Provide supporting data in Remarks or on a separate sheet)**
- ☐ 5 - **Wetland Non-Vascular Plants** [1]
- ☐ **Problematic Hydrophytic Vegetation** [1] **(Explain)**

[1] **Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.**

Hydrophytic Vegetation Present? Yes ● No ○

Remarks:

*Indicator suffix = National status or professional decision assigned because Regional status not defined by FWS.

Soil

Sampling Point: TP-B-UPL

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)		Matrix %	Redox Color (moist)		Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	10YR	3/2	100						Loam	
8-16	10YR	3/2	98	10YR	4/4	1	C	M	Loam	
				2.5Y	4/1	1	D	M		
16+										cobble

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

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Muck Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) (except in MLRA 1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

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

Restrictive Layer (if present):

Type: cobble

Depth (inches): 16

Hydric Soil Present? Yes ○ No ●

Remarks:

Hydrology

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (LRR A)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Water-Stained Leaves (B9) (MLRA 1, 2, 4A, and 4B)
- ☐ Drainage Patterns (B10)
- ☐ Dry Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (LRR A)
- ☐ Frost Heave Hummocks (D7)

Field Observations:

Surface Water Present?	Yes ○	No ●	Depth (inches):
Water Table Present?	Yes ○	No ●	Depth (inches):
Saturation Present? (includes capillary fringe)	Yes ○	No ●	Depth (inches):

Wetland Hydrology Present? Yes ○ No ●

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

Remarks:

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

Project/Site: 25th Avenue NE Flood Reduction Project **City/County:** Lake Forest Park/King **Sampling Date:** 31-May-16

Applicant/Owner: City of Shoreline **State:** WA **Sampling Point:** TP-B-WET

Investigator(s): Shelby Petro, Julia Munger **Section, Township, Range: S** 4 **T** 26N **R** 4E

Landform (hillslope, terrace, etc.): Channel (active) **Local relief (concave, convex, none):** concave **Slope:** 1.0 **%** / 0.6 **°**

Subregion (LRR): LRR A **Lat.:** 47.769553 **Long.:** 122.301592 **Datum:** WGS84

Soil Map Unit Name: none mapped **NWI classification:** None

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 (•) No ( )	**Is the Sampled Area within a Wetland?** Yes (•) No ( )	
Hydric Soil Present? Yes (•) No ( )		
Wetland Hydrology Present? Yes (•) No ( )		

Remarks:

VEGETATION - Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Rel.Strat. Cover	Indicator Status
Tree Stratum (Plot size: 3 m)				
1. Alnus rubra	60	✔	60.0%	FAC
2. Salix lucida	40	✔	40.0%	FACW
3.	0		0.0%	
4.	0		0.0%	
= Total Cover	100			
Sapling/Shrub Stratum (Plot size: 2 m)				
1.	0		0.0%	
2.	0		0.0%	
3.	0		0.0%	
4.	0		0.0%	
5.	0		0.0%	
= Total Cover	0			
Herb Stratum (Plot size: 1 m)				
1. Equisetum telmateia	5		5.0%	FACW
2. Oenanthe sarmentosa	90	✔	90.0%	OBL
3. Ranunculus repens	5		5.0%	FAC
4.	0		0.0%	
5.	0		0.0%	
6.	0		0.0%	
7.	0		0.0%	
8.	0		0.0%	
9.	0		0.0%	
10.	0		0.0%	
11.	0		0.0%	
= Total Cover	100			
Woody Vine Stratum (Plot size: 1 m)				
1.	0		0.0%	
2.	0		0.0%	
= Total Cover	0			

% Bare Ground in Herb Stratum: 0

Dominance Test worksheet:

Number of Dominant Species That are OBL, FACW, or FAC: 3 (A)

Total Number of Dominant Species Across All Strata: 3 (B)

Percent of dominant Species That Are OBL, FACW, or FAC: 100.0% (A/B)

Prevalence Index worksheet:

Total % Cover of:		Multiply by:	
OBL species	90	x 1 =	90
FACW species	45	x 2 =	90
FAC species	65	x 3 =	195
FACU species	0	x 4 =	0
UPL species	0	x 5 =	0
Column Totals:	200 (A)		375 (B)

Prevalence Index = B/A = 1.875

Hydrophytic Vegetation Indicators:

- [ ] 1 - **Rapid Test for Hydrophytic Vegetation**
- [x] 2 - **Dominance Test is > 50%**
- [x] 3 - **Prevalence Index is ≤3.0** [1]
- [ ] 4 - **Morphological Adaptations** [1] **(Provide supporting data in Remarks or on a separate sheet)**
- [ ] 5 - **Wetland Non-Vascular Plants** [1]
- [ ] **Problematic Hydrophytic Vegetation** [1] **(Explain)**

[1] **Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.**

Hydrophytic Vegetation Present? Yes (•) No ( )

Remarks:

*Indicator suffix = National status or professional decision assigned because Regional status not defined by FWS.

Soil

Sampling Point: TP-B-WET

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)		Matrix %	Redox Features Color (moist)		Redox %	Type[1]	Loc[2]	Texture	Remarks
0-17	10YR	2/1	95	7.5YR	4/4	5	C	M	Silty Clay Loam	
17-20	10GY	5/1	98	10YR	4/6	20	C	M	Clay Loam	

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

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☑ Thick Dark Surface (A12)
- ☐ Sandy Muck Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) (except in MLRA 1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☑ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox depressions (F8)

Indicators for Problematic Hydric Soils[3]:

- ☐ 2 cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (Explain in Remarks)

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

Restrictive Layer (if present):

Type:

Depth (inches):

Hydric Soil Present? Yes ◉ No ○

Remarks:

Hydrology

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required; check all that apply)

- ☐ Surface Water (A1)
- ☑ High Water Table (A2)
- ☑ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (B9) (except MLRA 1, 2, 4A, and 4B)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☑ Oxidized Rhizospheres on Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (LRR A)
- ☐ Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- ☐ Water-Stained Leaves (B9) (MLRA 1, 2, 4A, and 4B)
- ☐ Drainage Patterns (B10)
- ☐ Dry Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☑ FAC-neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (LRR A)
- ☐ Frost Heave Hummocks (D7)

Field Observations:

	Yes	No	Depth (inches)
Surface Water Present?	○	◉	
Water Table Present?	◉	○	10
Saturation Present? (includes capillary fringe)	◉	○	0

Wetland Hydrology Present? Yes ◉ No ○

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

Remarks:

RATING SUMMARY – Western Washington

Name of wetland (or ID #): Wetland B   Date of site visit: 5/31/2016

Rated by Shelby Petro   Trained by Ecology? ☑ Yes ☐ No   Date of training Mar-15

HGM Class used for rating Depressional & Flats   Wetland has multiple HGM classes? ☑ Yes ☐ No

NOTE: Form is not complete with out the figures requested (*figures can be combined*).
Source of base aerial photo/map Bing 2016

OVERALL WETLAND CATEGORY II (based on functions ☑ or special characteristics ☐)

1. Category of wetland based on FUNCTIONS

___ **Category I** - Total score = 23 - 27
X **Category II** - Total score = 20 - 22
___ **Category III** - Total score = 16 - 19
___ **Category IV** - Total score = 9 - 15

FUNCTION	Improving Water Quality	Hydrologic	Habitat	
	List appropriate rating (H, M, L)			
Site Potential	M	M	M	
Landscape Potential	M	H	L	
Value	H	H	H	**Total**
Score Based on Ratings	7	8	6	**21**

Score for each function based on three ratings
(*order of ratings is not important*)

9 = H, H, H
8 = H, H, M
7 = H, H, L
7 = H, M, M
6 = H, M, L
6 = M, M, M
5 = H, L, L
5 = M, M, L
4 = M, L, L
3 = L, L, L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	Category
Estuarine	
Wetland of High Conservation Value	
Bog	
Mature Forest	
Old Growth Forest	
Coastal Lagoon	
Interdunal	
None of the above	X

Maps and Figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	B-1
Hydroperiods	D 1.4, H 1.2	B-2
Location of outlet (*can be added to map of hydroperiods*)	D 1.1, D 4.1	B-2
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	D 2.2, D 5.2	B-1
Map of the contributing basin	D 4.3, D 5.3	B-3
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	B-4
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	B-5
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	B-6

Riverine Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Ponded depressions	R 1.1	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	R 2.4	
Plant cover of trees, shrubs, and herbaceous plants	R 1.2, R 4.2	
Width of unit vs. width of stream (*can be added to another figure*)	R 4.1	
Map of the contributing basin	R 2.2, R 2.3, R 5.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	R 3.1	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	R 3.2, R 3.3	

Lake Fringe Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	L 1.1, L 4.1, H 1.1, H 1.4	
Plant cover of trees, shrubs, and herbaceous plants	L 1.2	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	L 2.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	L 3.1, L 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	L 3.3	

Slope Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Plant cover of **dense** trees, shrubs, and herbaceous plants	S 1.3	
Plant cover of **dense, rigid** trees, shrubs, and herbaceous plants (*can be added to another figure*)	S 4.1	
Boundary of area within 150 ft of the wetland (*can be added to another figure*)	S 2.1, S 5.1	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	S 3.1, S 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	S 3.3	

HGM Classification of Wetland in Western Washington

For questions 1 -7, the criteria described must apply to the entire unit being rated.
If hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in questions 1 - 7 apply, and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides except during floods?

☑ NO - go to 2 ☐ **YES** - the wetland class is **Tidal Fringe** - go to 1.1

1.1 Is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

☐ **NO - Saltwater Tidal Fringe (Estuarine)** ☐ **YES - Freshwater Tidal Fringe**
If your wetland can be classified as a Freshwater Tidal Fringe use the forms for ***Riverine*** *wetlands. If it is Saltwater Tidal Fringe it is an* ***Estuarine*** *wetland and is not scored. This method* ***cannot*** *be used to score functions for estuarine wetlands.*

2. The entire wetland unit is flat and precipitation is the only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

☑ NO - go to 3 ☐ **YES** - The wetland class is **Flats**
If your wetland can be classified as a Flats wetland, use the form for ***Depressional*** *wetlands.*

3. Does the entire wetland unit **meet all** of the following criteria?
- ☐ The vegetated part of the wetland is on the shores of a body of permanent open water (without any plants on the surface at any time of the year) at least 20 ac (8 ha) in size;
- ☐ At least 30% of the open water area is deeper than 6.6 ft (2 m).

☑ NO - go to 4 ☐ **YES** - The wetland class is **Lake Fringe** (Lacustrine Fringe)

4. Does the entire wetland unit **meet all** of the following criteria?
- ☐ The wetland is on a slope (*slope can be very gradual*),
- ☐ The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks.
- ☐ The water leaves the wetland **without being impounded.**

☑ NO - go to 5 ☐ **YES** - The wetland class is **Slope**

NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 ft diameter and less than 1 ft deep).

5. Does the entire wetland unit **meet all** of the following criteria?
- ☐ The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river,
- ☐ The overbank flooding occurs at least once every 2 years.

☐ NO - go to 6 ☑ **YES** - The wetland class is **Riverine**

NOTE: The Riverine unit can contain depressions that are filled with water when the river is not flooding.

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

☐ NO - go to 7 ☑ **YES** - The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐ NO - go to 8 ☐ **YES** - The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a Depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within the wetland unit being scored.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	HGM class to use in rating
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake Fringe	Lake Fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake Fringe	Depressional
Riverine + Lake Fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE

If you are still unable to determine which of the above criteria apply to your wetland, or if you have ***more than 2 HGM classes*** *within a wetland boundary, classify the wetland as Depressional for the rating.*

NOTES and FIELD OBSERVATIONS:

DEPRESSIONAL AND FLATS WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

D 1.0. Does the site have the potential to improve water quality?	
D 1.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression (QUESTION 7 on key) with no surface water leaving it (no outlet). points = 3 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet. points = 2 ☐ Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 1 ☐ Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch. points = 1	2
D 1.2. The soil 2 in below the surface (or duff layer) is true clay or true organic (*use NRCS definitions*). Yes = 4 No = 0	0
D 1.3. Characteristics and distribution of persistent plants (Emergent, Scrub-shrub, and/or Forested Cowardin classes): Wetland has persistent, ungrazed, plants > 95% of area points = 5 Wetland has persistent, ungrazed, plants > ½ of area points = 3 Wetland has persistent, ungrazed plants > $^{1}/_{10}$ of area points = 1 Wetland has persistent, ungrazed plants < $^{1}/_{10}$ of area points = 0	5
D 1.4. Characteristics of seasonal ponding or inundation: *This is the area that is ponded for at least 2 months. See description in manual.* Area seasonally ponded is > ½ total area of wetland points = 4 Area seasonally ponded is > ¼ total area of wetland points = 2 Area seasonally ponded is < ¼ total area of wetland points = 0	2
Total for D 1 Add the points in the boxes above	**9**

Rating of Site Potential If score is: ☐ **12 - 16 = H** ☑ **6 - 11 = M** ☐ **0 - 5 = L** *Record the rating on the first page*

D 2.0. Does the landscape have the potential to support the water quality function of the site?	
D 2.1. Does the wetland unit receive stormwater discharges? Yes = 1 No = 0	1
D 2.2. Is > 10% of the area within 150 ft of the wetland in land uses that generate pollutants? Yes = 1 No = 0	1
D 2.3. Are there septic systems within 250 ft of the wetland? Yes = 1 No = 0	0
D 2.4. Are there other sources of pollutants coming into the wetland that are not listed in questions D 2.1 - D 2.3? Source Yes = 1 No = 0	0
Total for D 2 Add the points in the boxes above	**2**

Rating of Landscape Potential If score is: ☐ **3 or 4 = H** ☑ **1 or 2 = M** ☐ **0 = L** *Record the rating on the first page*

D 3.0. Is the water quality improvement provided by the site valuable to society?	
D 3.1. Does the wetland discharge directly (i.e., within 1 mi) to a stream, river, lake, or marine water that is on the 303(d) list? Yes = 1 No = 0	1
D 3.2. Is the wetland in a basin or sub-basin where an aquatic resource is on the 303(d) list? Yes = 1 No = 0	1
D 3.3. Has the site been identified in a watershed or local plan as important for maintaining water quality (*answer YES if there is a TMDL for the basin in which the unit is found*)? Yes = 2 No = 0	0
Total for D 3 Add the points in the boxes above	**2**

Rating of Value If score is: ☑ **2 - 4 = H** ☐ **1 = M** ☐ **0 = L** *Record the rating on the first page*

DEPRESSIONAL AND FLATS WETLANDS

Hydrologic Functions - Indicators that the site functions to reduce flooding and stream degradation

D 4.0. Does the site have the potential to reduce flooding and erosion?	
D 4.1. Characteristics of surface water outflows from the wetland: Wetland is a depression or flat depression with no surface water leaving it (no outlet) points = 4 Wetland has an intermittently flowing stream or ditch, OR highly constricted permanently flowing outlet points = 2 Wetland is a flat depression (QUESTION 7 on key), whose outlet is a permanently flowing ditch points = 1 Wetland has an unconstricted, or slightly constricted, surface outlet that is permanently flowing points = 0	2
D 4.2. Depth of storage during wet periods: *Estimate the height of ponding above the bottom of the outlet. For wetlands with no outlet, measure from the surface of permanent water or if dry, the deepest part.* Marks of ponding are 3 ft or more above the surface or bottom of outlet points = 7 Marks of ponding between 2 ft to < 3 ft from surface or bottom of outlet points = 5 ☐ Marks are at least 0.5 ft to < 2 ft from surface or bottom of outlet points = 3 ☐ The wetland is a "headwater" wetland points = 3 Wetland is flat but has small depressions on the surface that trap water points = 1 Marks of ponding less than 0.5 ft (6 in) points = 0	3
D 4.3. Contribution of the wetland to storage in the watershed: *Estimate the ratio of the area of upstream basin contributing surface water to the wetland to the area of the wetland unit itself.* ☐ The area of the basin is less than 10 times the area of the unit points = 5 The area of the basin is 10 to 100 times the area of the unit points = 3 The area of the basin is more than 100 times the area of the unit points = 0 ☐ Entire wetland is in the Flats class points = 5	3
Total for D 4 — Add the points in the boxes above	**8**

Rating of Site Potential If score is: ☐**12 - 16 = H** ☑**6 - 11 = M** ☐**0 - 5 = L** *Record the rating on the first page*

D 5.0. Does the landscape have the potential to support hydrologic function of the site?	
D 5.1. Does the wetland unit receive stormwater discharges? Yes = 1 No = 0	1
D 5.2. Is > 10% of the area within 150 ft of the wetland in land uses that generate excess runoff? Yes = 1 No = 0	1
D 5.3. Is more than 25% of the contributing basin of the wetland covered with intensive human land uses (residential at >1 residence/ac, urban, commercial, agriculture, etc.)? Yes = 1 No = 0	1
Total for D 5 — Add the points in the boxes above	**3**

Rating of Landscape Potential If score is: ☑**3 = H** ☐**1 or 2 = M** ☐**0 = L** *Record the rating on the first page*

D 6.0. Are the hydrologic functions provided by the site valuable to society?	
D 6.1. The unit is in a landscape that has flooding problems. *Choose the description that best matches conditions around the wetland unit being rated. Do not add points. Choose the highest score if more than one condition is met.* The wetland captures surface water that would otherwise flow down-gradient into areas where flooding has damaged human or natural resources (e.g., houses or salmon redds): • Flooding occurs in a sub-basin that is immediately down-gradient of unit. points = 2 ☐ • Surface flooding problems are in a sub-basin farther down-gradient. points = 1 ☐ Flooding from groundwater is an issue in the sub-basin. points = 1 ☐ The existing or potential outflow from the wetland is so constrained by human or natural conditions that the water stored by the wetland cannot reach areas that flood. Explain why points = 0 ☐ There are no problems with flooding downstream of the wetland. points = 0	2
D 6.2. Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan? Yes = 2 No = 0	0
Total for D 6 — Add the points in the boxes above	**2**

Rating of Value If score is: ☑ **2 - 4 = H** ☐**1 = M** ☐ **0 = L** *Record the rating on the first page*

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that site functions to provide important habitat

H 1.0. Does the site have the potential to provide habitat?

H 1.1. Structure of plant community: *Indicators are Cowardin classes and strata within the Forested class.* Check the Cowardin plant classes in the wetland. *Up to 10 patches may be combined for each class to meet the threshold of ¼ ac or more than 10% of the unit if it is smaller than 2.5 ac. Add the number of structures checked.*

☐ Aquatic bed	4 structures or more: points = 4
☐ Emergent	3 structures: points = 2
☑ Scrub-shrub (areas where shrubs have > 30% cover)	2 structures: points - 1
☑ Forested (areas where trees have > 30% cover)	1 structure: points = 0

If the unit has a Forested class, check if:

☑ The Forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the Forested polygon

2

H 1.2. Hydroperiods

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ ac to count (*see text for descriptions of hydroperiods*).

☐ Permanently flooded or inundated	4 or more types present: points = 3
☑ Seasonally flooded or inundated	3 types present: points = 2
☐ Occasionally flooded or inundated	2 types present: points = 1
☑ Saturated only	1 types present: points = 0
☑ Permanently flowing stream or river in, or adjacent to, the wetland	
☐ Seasonally flowing stream in, or adjacent to, the wetland	
☐ **Lake Fringe wetland**	**2 points**
☐ **Freshwater tidal wetland**	**2 points**

2

H 1.3. Richness of plant species

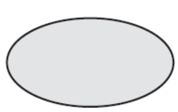
Count the number of plant species in the wetland that cover at least 10 ft^2.
Different patches of the same species can be combined to meet the size threshold and you do not have to name the species. ***Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle***

If you counted:		
	> 19 species	points = 2
	5 - 19 species	points = 1
	< 5 species	points = 0

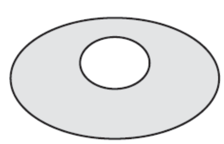
1

H 1.4. Interspersion of habitats

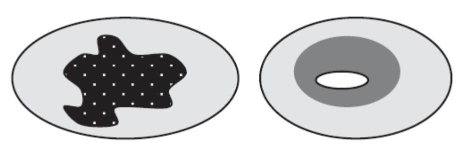
Decide from the diagrams below whether interspersion among Cowardin plants classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, moderate, low, or none. *If you have four or more plant classes or three classes and open water, the rating is always high.*



None = 0 points

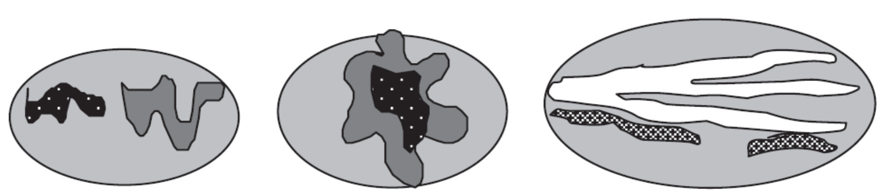


Low = 1 point



Moderate = 2 points

All three diagrams in this row are **HIGH** = 3 points



3

H 1.5. Special habitat features: Check the habitat features that are present in the wetland. *The number of checks is the number of points.* ☑ Large, downed, woody debris within the wetland (> 4 in diameter and 6 ft long) ☑ Standing snags (dbh > 4 in) within the wetland ☑ Undercut banks are present for at least 6.6 ft (2 m) **and/or** overhanging plants extends at least 3.3 ft (1 m) over a stream (or ditch) in, or contiguous with the wetland, for at least 33 ft (10 m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (> 30 degree slope) OR signs of recent beaver activity are present (*cut shrubs or trees that have not yet weathered where wood is exposed*) ☐ At least ¼ ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated (*structures for egg-laying by amphibians*) ☐ Invasive plants cover less than 25% of the wetland area in every stratum of plants (*see H 1.1 for list of strata*)	3
Total for H 1 — Add the points in the boxes above	**11**

Rating of Site Potential If Score is: ☐ **15 - 18 = H** ☑ **7 - 14 = M** ☐ **0 - 6 = L** *Record the rating on the first page*

H 2.0. Does the landscape have the potential to support the habitat function of the site?	
H 2.1 Accessible habitat (include *only habitat that directly abuts wetland unit*). *Calculate:* 0 % undisturbed habitat + (0 % moderate & low intensity land uses / 2) = 0% If total accessible habitat is: > $^{1}/_{3}$ (33.3%) of 1 km Polygon — points = 3 20 - 33% of 1 km Polygon — points = 2 10 - 19% of 1 km Polygon — points = 1 < 10 % of 1 km Polygon — points = 0	0
H 2.2. Undisturbed habitat in 1 km Polygon around the wetland. *Calculate:* 2 % undisturbed habitat + (2 % moderate & low intensity land uses / 2) = 3% Undisturbed habitat > 50% of Polygon — points = 3 Undisturbed habitat 10 - 50% and in 1-3 patches — points = 2 Undisturbed habitat 10 - 50% and > 3 patches — points = 1 Undisturbed habitat < 10% of 1 km Polygon — points = 0	0
H 2.3 Land use intensity in 1 km Polygon: If > 50% of 1 km Polygon is high intensity land use — points = (-2) ≤ 50% of 1km Polygon is high intensity — points = 0	-2
Total for H 2 — Add the points in the boxes above	**-2**

Rating of Landscape Potential If Score is: ☐ **4 - 6 = H** ☐ **1 - 3 = M** ☑ **< 1 = L** *Record the rating on the first page*

H 3.0. Is the habitat provided by the site valuable to society?	
H 3.1. Does the site provide habitat for species valued in laws, regulations, or policies? *Choose only the highest score that applies to the wetland being rated*. Site meets ANY of the following criteria: — points = 2 ☑ It has 3 or more priority habitats within 100 m (see next page) ☐ It provides habitat for Threatened or Endangered species (any plant or animal on the state or federal lists) ☐ It is mapped as a location for an individual WDFW priority species ☐ It is a Wetland of High Conservation Value as determined by the Department of Natural Resources ☐ It has been categorized as an important habitat site in a local or regional comprehensive plan, in a Shoreline Master Plan, or in a watershed plan Site has 1 or 2 priority habitats (listed on next page) with in 100m — points = 1 Site does not meet any of the criteria above — points = 0	2

Rating of Value If Score is: ☑ **2 = H** ☐ **1 = M** ☐ **0 = L** *Record the rating on the first page*

WDFW Priority Habitats

Priority habitats listed by WDFW (see complete descriptions of WDFW priority habitats, and the counties in which they can be found, in: Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp.
http://wdfw.wa.gov/publications/00165/wdfw00165.pdf or access the list from here:
http://wdfw.wa.gov/conservation/phs/list/

Count how many of the following priority habitats are within 330 ft (100 m) of the wetland unit: ***NOTE**: This question is independent of the land use between the wetland unit and the priority habitat.*

- ☐ **Aspen Stands**: Pure or mixed stands of aspen greater than 1 ac (0.4 ha).
- ☐ **Biodiversity Areas and Corridors**: Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report*).
- ☐ **Herbaceous Balds**: Variable size patches of grass and forbs on shallow soils over bedrock.
- ☑ **Old-growth/Mature forests**: Old-growth west of Cascade crest – Stands of at least 2 tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) > 32 in (81 cm) dbh or > 200 years of age. Mature forests – Stands with average diameters exceeding 21 in (53 cm) dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade crest.
- ☐ **Oregon White Oak**: Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158 – see web link above*).
- ☑ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.
- ☐ **Westside Prairies**: Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161 – see web link above*).
- ☑ **Instream**: The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.
- ☐ **Nearshore**: Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report – see web link on previous page*).
- ☐ **Caves**: A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.
- ☐ **Cliffs**: Greater than 25 ft (7.6 m) high and occurring below 5000 ft elevation.
- ☐ **Talus**: Homogenous areas of rock rubble ranging in average size 0.5 - 6.5 ft (0.15 - 2.0 m), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.
- ☑ **Snags and Logs**: Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 20 in (51 cm) in western Washington and are > 6.5 ft (2 m) in height. Priority logs are > 12 in (30 cm) in diameter at the largest end, and > 20 ft (6 m) long.

Note: All vegetated wetlands are by definition a priority habitat but are not included in this list because they are addressed elsewhere.

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Wetland Type *Check off any criteria that apply to the wetland. List the category when the appropriate criteria are met.*	Category
SC 1.0. Estuarine Wetlands Does the wetland meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt ☐ Yes - Go to **SC 1.1** ☑ No = **Not an estuarine wetland**	
SC 1.1. Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? ☐ Yes = **Category I** ☐ No - Go to **SC 1.2**	
SC 1.2. Is the wetland unit at least 1 ac in size and meets at least two of the following three conditions? ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. (If non-native species are *Spartina*, see page 25) ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. ☐ The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands. ☐ Yes = **Category I** ☐ No = **Category II**	
SC 2.0. Wetlands of High Conservation Value (WHCV) SC 2.1. Has the WA Department of Natural Resources updated their website to include the list of Wetlands of High Conservation Value? ☐ Yes - Go to **SC 2.2** ☑ No - Go to **SC 2.3** SC 2.2. Is the wetland listed on the WDNR database as a Wetland of High Conservation Value? ☐ Yes = **Category I** ☐ No = **Not WHCV** SC 2.3. Is the wetland in a Section/Township/Range that contains a Natural Heritage wetland? http://www1.dnr.wa.gov/nhp/refdesk/datasearch/wnhpwetlands.pdf ☐ Yes - **Contact WNHP/WDNR and to SC 2.4** ☑ No = **Not WHCV** SC 2.4. Has WDNR identified the wetland within the S/T/R as a Wetland of High Conservation Value and listed it on their website? ☐ Yes = **Category I** ☐ No = **Not WHCV**	
SC 3.0. Bogs Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below.* ***If you answer YES you will still need to rate the wetland based on its functions.*** SC 3.1. Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16 in or more of the first 32 in of the soil profile? ☐ Yes - Go to **SC 3.3** ☑ No - Go to **SC 3.2** SC 3.2. Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? ☐ Yes - Go to **SC 3.3** ☑ No = **Is not a bog** SC 3.3. Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least a 30% cover of plant species listed in Table 4? ☐ Yes = **Is a Category I bog** ☐ No - Go to **SC 3.4** **NOTE**: If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16 in deep. If the pH is less than 5.0 and the plant species in Table 4 are present, the wetland is a bog. SC 3.4. Is an area with peats or mucks forested (> 30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann spruce, or western white pine, AND any of the species (or combination of species) listed in Table 4 provide more than 30% of the cover under the canopy? ☐ Yes = **Is a Category I bog** ☐ No = **Is not a bog**	

SC 4.0. Forested Wetlands	
Does the wetland have at least 1 contiguous acre of forest that meets one of these criteria for the WA Department of Fish and Wildlife's forests as priority habitats? ***If you answer YES you will still need to rate the wetland based on its functions.*** ☐ **Old-growth forests** (west of Cascade crest): Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 in (81 cm) or more. ☐ **Mature forests** (west of the Cascade Crest): Stands where the largest trees are 80-200 years old OR the species that make up the canopy have an average diameter (dbh) exceeding 21 in (53 cm). ☐ Yes = **Category I** ☑ No = **Not a forested wetland for this section**	
SC 5.0. Wetlands in Coastal Lagoons Does the wetland meet all of the following criteria of a wetland in a coastal lagoon? ☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks ☐ The lagoon in which the wetland is located contains ponded water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon (*needs to be measured near the bottom*) ☐ Yes - Go to **SC 5.1** ☑ No = **Not a wetland in a coastal lagoon** SC 5.1. Does the wetland meet all of the following three conditions? ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species on p. 100). ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un-mowed grassland. ☐ The wetland is larger than $^{1}/_{10}$ ac (4350 ft^2) ☐ Yes = **Category I** ☐ No = **Category II**	
SC 6.0. Interdunal Wetlands Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ***If you answer yes you will still need to rate the wetland based on its habitat functions.*** In practical terms that means the following geographic areas: ☐ Long Beach Peninsula: Lands west of SR 103 ☐ Grayland-Westport: Lands west of SR 105 ☐ Ocean Shores-Copalis: Lands west of SR 115 and SR 109 ☐ Yes - Go to **SC 6.1** ☑ No = **Not an interdunal wetland for rating** SC 6.1. Is the wetland 1 ac or larger and scores an 8 or 9 for the habitat functions on the form (rates H,H,H or H,H,M for the three aspects of function)? ☐ Yes = **Category I** ☐ No - Go to **SC 6.2** SC 6.2. Is the wetland 1 ac or larger, or is it in a mosaic of wetlands that is 1 ac or larger? ☐ Yes = **Category II** ☐ No - Go to **SC 6.3** SC 6.3. Is the unit between 0.1 and 1 ac, or is it in a mosaic of wetlands that is between 0.1 and 1 ac? ☐ Yes = **Category III** ☐ No = **Category IV**	
Category of wetland based on Special Characteristics If you answered No for all types, enter "Not Applicable" on Summary Form	

Legend

Cowardin class

- Forested
- Scrub-shrub
- 150-ft buffer
- Stream (King County)
- Stream (City of Shoreline)
- City limit

Figure B-1.
Cowardin Classes and 150-Foot Buffer for Wetland B.

N

0 100 200 400 Feet

HERRERA

K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\Appendix\cowardin_class.mxd (7/13/2016)

Legend

Hydroperiods

- Saturated
- Seasonally flooded
- Outlet
- Drainage feature
- Stream (King County)
- Stream (City of Shoreline)

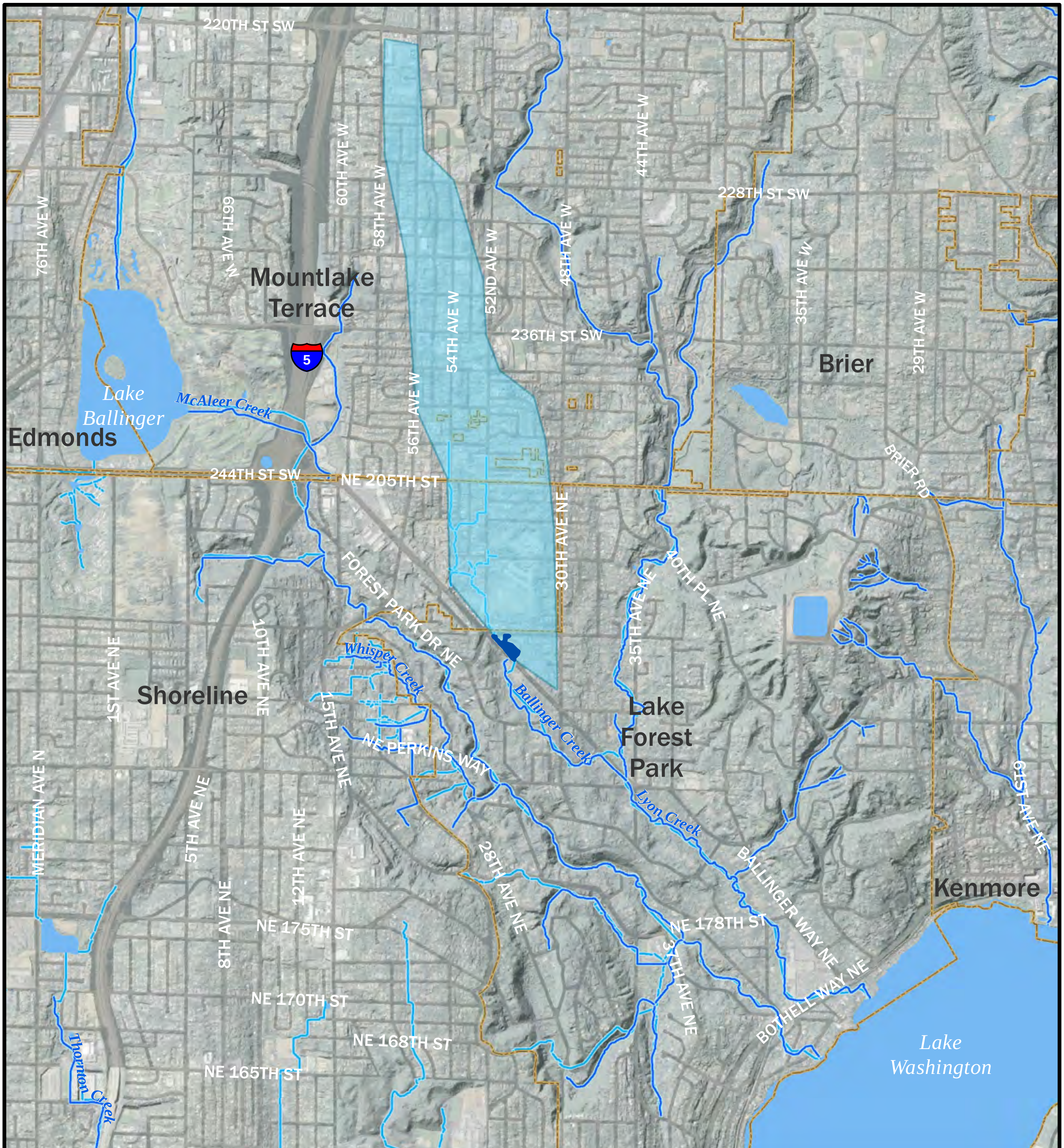
Figure B-2.
Hydroperiods and Outlets for Wetland B.

N

0 100 200 400 Feet

HERRERA

K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\Appendix\hydroperiods.mxd (7/13/2016)



Legend

- Wetland B
- Contributing basin
- City limit
- Stream (City of Shoreline)
- Stream (King County)

Figure B-3.
Map of Contributing Basin to Wetland B.

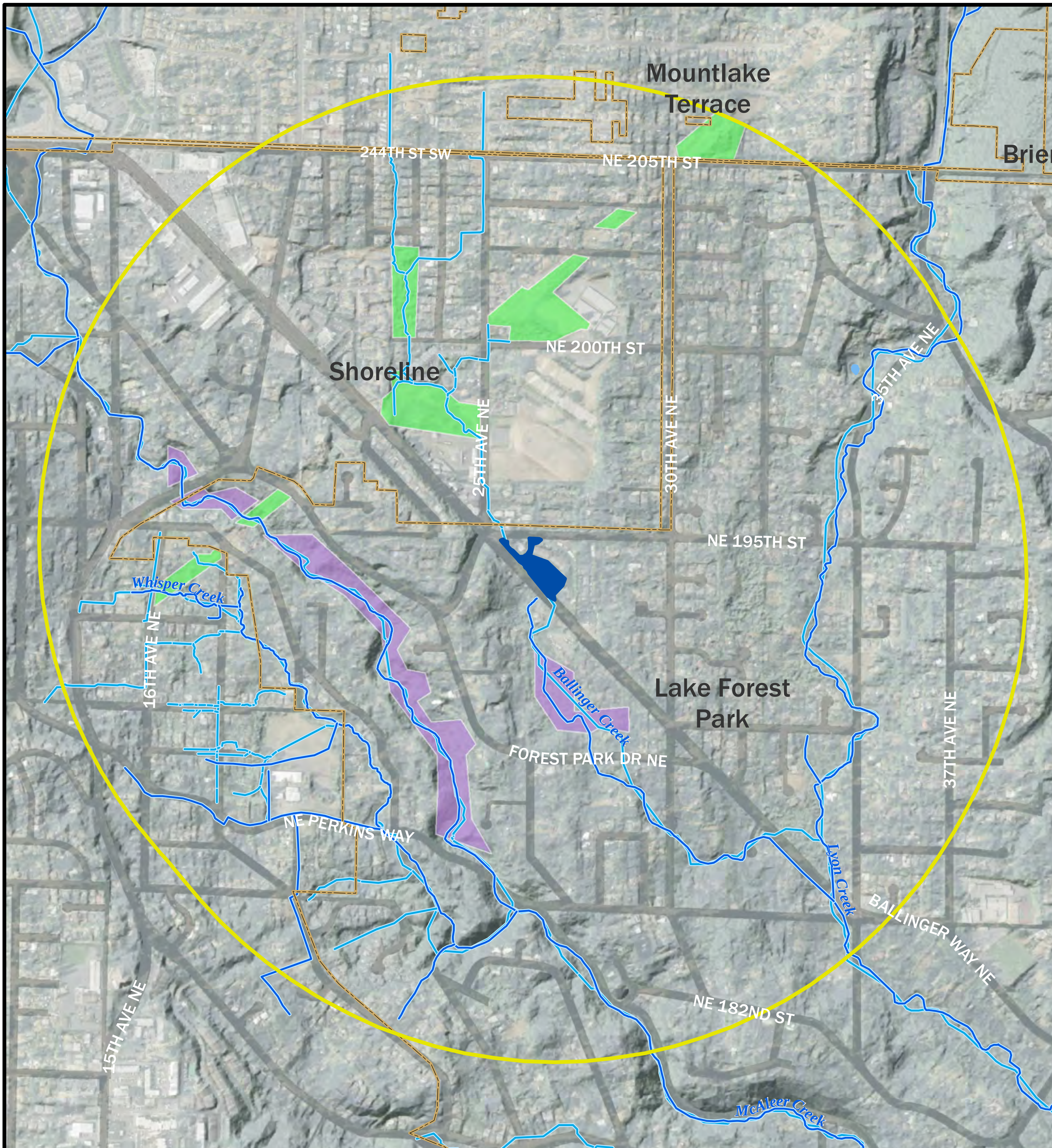
N

0 1,250 2,500 5,000 Feet

HERRERA

USDA, Aerial (2015)

K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\Appendix\contributing_basin.mxd (7/13/2016)



Legend

- Wetland B
- Habitat Type
- Moderate-Low Intensity
- Relatively Undisturbed
- 1-km buffer
- Stream (City of Shoreline)
- Stream (King County)
- City limit

Figure B-4.
Habitat Within 1 Kilometer of Wetland B.

N

0 500 1,000 2,000 Feet

HERRERA

USDA, Aerial (2015)

K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\Appendix\habitat_1km.mxd (7/13/2016)

Legend

- Wetland B
- 303(d) listed water
- Stream (City of Shoreline)
- Stream (King County)
- Park
- City limit

Figure B-5.
303(d) Listed Waters in Basin.

N

0 500 1,000 2,000 Feet

HERRERA

USDA, Aerial (2015)

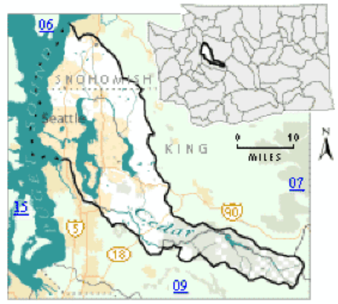
K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\Appendix\303d.mxd (7/13/2016)

Water Quality Improvement Projects (TMDLs)

Water Quality Improvement > Water Quality Improvement Projects by WRIA > WRIA 8: Cedar-Sammamish

WRIA 8: Cedar-Sammamish

The following table lists overview information for water quality improvement projects (including total maximum daily loads, or TMDLs) for this water resource inventory area (WRIA). Please use links (where available) for more information on a project.



Counties

- King
- Snohomish

Waterbody Name	Pollutants	Status**	TMDL Lead
Ballinger Lake	Total Phosphorus	Approved by EPA	Tricia Shoblom 425-649-7288
Bear-Evans Creek Basin	Fecal Coliform	Approved by EPA	Joan Nolan 425-649-4425
	Dissolved Oxygen Temperature	Approved by EPA	
Cottage Lake	Total Phosphorus	Approved by EPA Has an implementation plan	Tricia Shoblom 425-649-7288
Issaquah Creek Basin	Fecal Coliform	Approved by EPA	Joan Nolan 425-649-4425
Little Bear Creek Tributaries: Trout Stream Great Dane Creek Cutthroat Creek	Fecal Coliform	Approved by EPA	Ralph Svrjcek 425-649-7036
North Creek	Fecal Coliform	Approved by EPA Has an implementation plan	Ralph Svrjcek 425-649-7036
Pipers Creek	Fecal Coliform	Approved by EPA	Joan Nolan 425-649-4425
Sammamish River	Dissolved Oxygen Temperature	Field work starts summer 2015	Ralph Svrjcek 425-649-7036
Swamp Creek	Fecal Coliform	Approved by EPA Has an implementation plan	Ralph Svrjcek 425-649-7036

*** **Status** will be listed as one of the following: Approved by EPA, Under Development or Implementation*

For more information about WRIA 8:

- Waterbodies in WRIA 8 - using the Water Quality Assessment Query Tool
- Watershed Information for WRIA 8

* The Department of Ecology and other state resource agencies frequently use a system of 62 "Water Resource Inventory Areas" or "WRIAs" to refer to the state's major watershed basins.

Figure B-6.
TMDLs for WRIA8, Cedar Sammamish.

HERRERA

K:\Projects\Y2016\16-06217-000\Project\Critical_Area_Report\Appendix\TMDLs.mxd (7/8/2016)

APPENDIX C

City of Shoreline Maintenance Facility, Wetland and Stream Delineation Report (The Watershed Company 2016)

September 3, 2013, revised April 18, 2016

Noel Hupprich
Capital Project Manager II
City of Shoreline, Public Works Department
17500 Midvale Avenue N
Shoreline, WA 98133-4905

Re: City of Shoreline Maintenance Facility, Wetland and Stream Delineation Report
The Watershed Company Reference Number: 160329 and 100503

Dear Mr. Hupprich:

On April 13, 2016, I visited Brugger's Bog Park in Shoreline to update the wetland classification using the Department of Ecology *Wetland Rating System for Western Washington, 2014 Update* (Ecology Rating System) as currently required by the City of Shoreline. Prior to recent updates to the Shoreline Critical Areas Regulations, a wetland classification system specific to the City of Shoreline was used for all delineation studies in the City. Similarly, Shoreline has revised its stream classification system to be substantially similar to the Department of Natural Resources Stream Typing System.

The wetland and stream were originally delineated by The Watershed Company on August 22, 2013. The delineation and classification studies have been conducted, in part, to determine the extent of any buffer areas that may encumber the maintenance facility south of the park. Since no wetland or stream features are found within the maintenance facility property, this study focused on the areas south of the stream bridge to the park's southern property line.

This letter summarizes the findings of this study and details applicable federal, state, and local regulations. The following attachments are included:

- Wetland and Stream Delineation Map
- Wetland Determination Data Forms
- Wetland Rating Form

Methods

Public-domain information on the subject properties was reviewed for this delineation study. These sources include USDA Natural Resources Conservation Service Soil maps, U.S. Fish and Wildlife Service National Wetland Inventory maps, Washington Department of Fish and Wildlife interactive mapping programs (PHS on the Web and SalmonScape), King County's GIS mapping website (iMAP), *City of Shoreline Stream and Wetland Inventory and Assessment* (Tetra Tech/KCM, Inc. 2004), and *The City of Lake Forest Park Surface Water Comprehensive Plan Update* (Otak, Inc. 2009).

Prior to our visit, we conducted a review of the *Brugger's Bog Park, Wetland and Stream Delineation Report* (The Watershed Company, 2011) (2011 Watershed Report), which was prepared as part of a culvert replacement/bridge construction project over Ballinger Creek. The 2011 study focused on areas in the immediate vicinity of the proposed bridge crossing.

The study area was evaluated for wetlands using methodology from the *Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys, and Coast Region Version 2.0* (Regional Supplement) (US Army Corps of Engineers [Corps] May 2010). The wetland boundary was determined on the basis of an examination of vegetation, soils, and hydrology. Areas meeting the criteria set forth in the Regional Supplement were determined to be wetland. Soil, vegetation, and hydrologic parameters were sampled at several locations along the wetland boundary to make the determination. Data points on-site are marked with yellow- and black-striped flags. We recorded data at three of these locations.

Delineated wetlands were classified according to the criteria defined in the Shoreline Municipal Code (SMC).

The ordinary high water mark (OHWM) of Ballinger Creek was determined based on the definition provided by the Washington Department of Fish and Wildlife and WAC 220-110-020(69). The OHWM is located by examining the bed and bank physical characteristics and vegetation to ascertain the water elevation for mean annual floods. Areas meeting the definition were determined to be the OHWM and flagged. Field observations were used to classify streams according to the criteria defined in the SMC.

Findings

The study area is located in Brugger's Bog Park, a City of Shoreline municipal park. The park has large lawn areas, a play structure and patchy forested areas that are dominated by a mix of Douglas-fir, western hemlock, western red-cedars, Pacific madrone, and bitter cherry. Salal, Himalayan blackberry, and bracken fern are dominant in the understory. The study area covered those wetlands and streams that could potentially encumber the maintenance facility to the south. There is one wetland, Wetland A (see below), and one stream, Ballinger Creek (see below), located in the study area. There are no wetlands or streams located on the maintenance facility property.

Wetland A

Wetland A is a riverine wetland complex associated with Ballinger Creek. The wetland complex contains three sub-units on alternating sides of Ballinger Creek. Since the sub-units are in very close proximity and mutually influence one another, they are considered one wetland for the purposes of classification/rating. Wetland A contains a forested Cowardin vegetation community. Common vegetation includes black cottonwood, Pacific and Sitka willow, red alder, red-osier dogwood, salmonberry, skunk cabbage, small-fruited bulrush, mannagrass, and creeping buttercup. The soil in Wetland A is a black (10YR 2/1) sandy loam with organic accumulations masking redoximorphic features. Hydrology is provided by a high groundwater table and overbank flooding from Ballinger Creek. Soil saturation was present at the soil surface at our data point location. Other areas in Wetland A contained very shallow surface water during our inspection.

Ballinger Creek

The delineated portion of Ballinger Creek begins at the small, on-site bridge and flows southeast before exiting the property via a culvert at the southeast corner of the park property. The permanently-flowing creek continues southeast for approximately one mile before its confluence with Lyon Creek within the City of Lake Forest Park. Segments of the creek are alternately piped and ditched, and portions flow through braided channels, ponds, and wetlands within Lake Forest Park (*City of Lake Forest Park Surface Water Comprehensive Plan Update*). Several partial fish barriers and two total fish passage barriers are documented downstream of the project area (WDFW *SalmonScape,* 2016). However, downstream portions of Ballinger Creek are documented to contain Coho salmon habitat (WDFW *SalmonScape,* 2016), and resident cutthroat trout cannot be definitively ruled out of the reach within Brugger's Bog Park.

Ditch

An excavated ditch is located adjacent to the southern property line, south of Wetland A and Ballinger Creek. The ditch connects with Ballinger Creek approximately 50 feet upstream from the southeast property corner. The ditch is clearly constructed, as evidenced by its steeply excavated banks and geometrically-straight configuration. No active hydrology was present during our inspection, but water-stained leaves were observed at the bottom of the ditch, suggesting that occasional flooding occurs in the ditch. Despite containing evidence of hydrology and a hydrophytic plant community, the ditch did not satisfy the hydric soil criteria, as no organic matter or redoximorphic features were observed in the soil profile. Furthermore, regulated wetlands in the City of Shoreline do not include "artificial wetlands created entirely from non-wetland sites, including, but not limited to, irrigation and drainage ditches" (SMC 20.80.310.A). It also contains no historic stream flow based physical characteristics, lack of natural upstream channels, overall landscape position and the proximity to Ballinger Creek Therefore, the on-site ditch is not a jurisdictional wetland or stream and does not have an associated buffer.

Local Regulations

Wetlands and streams in Shoreline are regulated under SMC 20.80. Under the code, wetlands are rated as one of four categories based on the Ecology Rating System. According to the Rating System, Wetland A scored seven points for water quality functions, seven points for hydrologic functions, and six points for habitat functions, for a total score of 20 points. This score qualifies Wetland A as a Category II wetland. Wetland buffers in Shoreline are determined based on a combination of the wetland category and the habitat score. Category II wetlands with a habitat score of six points are required to have a standard buffer width of 165 feet (SMC 20.80.330.A.3).

Streams in Shoreline are classified as one of four categories based on inventory status as Shorelines of the State, fish use, and permanence of flow. Ballinger Creek is not considered a Shoreline of the State; therefore, it is not a Type S stream. Streams that are not Type S and have fish use or fish habitat are considered Type F streams. Since Ballinger Creek contains documented Coho salmon habitat downstream of the study area, cutthroat trout cannot be definitively ruled out of the study area; and downstream constructed fish migration barriers could theoretically be removed, the creek satisfies the criteria for a Type F stream with anadromous fish use. Type F streams with anadromous fish use are required to have a standard buffer width of 115 feet (SMC 20.80.280.C.1).

State and Federal Regulations

Wetlands, streams, and some ditches are also regulated by the U.S. Army Corps of Engineers (Corps) under section 404 of the Clean Water Act. Any filling of Waters of the State, including wetlands (except isolated wetlands), would require notification and permits from the Corps. However, in general, neither the Corps nor Ecology regulates wetland buffers, unless direct impacts are proposed. We understand the proposed project will not result in direct impacts to the wetland, stream, or ditch. Therefore, no state or federal wetland- or stream-related permitting would be triggered by the proposed improvements.

Disclaimer

The information contained in this letter or report is based on the application of technical guidelines currently accepted as the best available science and in conjunction with the manuals and criteria outlined in the methods section. All discussions, conclusions and recommendations reflect the best professional judgment of the author(s) and are based upon information available to us at the time the study was conducted. All work was completed within the constraints of budget, scope, and timing. The findings of this report are subject to verification and agreement by the appropriate local, State and Federal regulatory authorities. No other warranty, expressed or implied, is made.

Please call if you have any questions or if we can provide you with any additional information.

Sincerely,

Ryan Kahlo, PWS
Ecologist

Enclosures

LEGEND

- DELINEATED WETLAND BOUNDARY
- 165' STANDARD CATEGORY II WETLAND BUFFER
- 115' STANDARD TYPE F STREAM BUFFER

NOTES

1. CRITICAL AREAS DELINEATED BY THE WATERSHED COMPANY ON AUGUST 22, 2013.
2. SURVEY RECEIVED FROM WHPACIFIC, INC., 425-951-4897.

WETLAND AND STREAM DELINEATION MAP

SCALE 1"=50'

0 25' 50' 100'

THE WATERSHED COMPANY
750 Sixth Street South
Kirkland WA 98033
p 425.822.5242 f 425.827.8136
www.watershedco.com
Science & Design

BRUGGER'S BOG PARK

WETLAND AND STREAM DELINEATION MAP
PREPARED FOR KIM LEHMBERG
SITE ADDRESS:
19827 25TH AVE NE
SHORELINE, WA 98155

SUBMITTALS & REVISIONS

NO.	DATE	DESCRIPTION	BY
1	10-17-13	REVIEW SET	MD
2	4-18-2016	DELINEATION UPDATE	KMB

SHEET SIZE:
ORIGINAL PLAN IS 11X17.
SCALE ACCORDINGLY.

PROJECT MANAGER: HM
DESIGNED: --
DRAFTED: MD
CHECKED: RK
JOB NUMBER:
100503
SHEET NUMBER:
1 OF 1

DATE 10/14/2013 PRINTED BY KYLE BRAUN FILENAME 100503_BRUGGERS BOG WETLAND.DWG

750 Sixth Street South
Kirkland, Washington 98033
(425) 822-5242
watershedco.com

WETLAND DETERMINATION DATA FORM

Western Mountains, Valleys, and Coast Supplement to the 1987 COE Wetlands Delineation Manual

DP-1

Project Site:	**Brugger's Bog Park**	Sampling Date:	**8/22/2013**
Applicant/Owner:	**City of Shoreline**	Sampling Point:	DP- **1**
Investigator:	**Kahlo, R; Lund, N**	City/County:	**Shoreline / King Co.**
Sect., Township, Range	S **4** T **26N** R **4E**	State:	**WA**
Landform (hillslope, terrace, etc)	**Riverbank** Slope (%) **2**	Local relief (concave, convex, none)	**Concave**
Subregion (LRR)	**A** Lat	Long	Datum
Soil Map Unit Name	**No soil data available for this location**	NWI classification	**None**

Are climatic/hydrologic conditions on the site typical for this time of year? ☒ Yes ☐ No (If no, explain in remarks.)
Are "Normal Circumstances" present on the site? ☒ Yes ☐ No
Are Vegetation ☐, Soil, ☐, or Hydrology ☐ significantly disturbed?
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	☐ No
Hydric Soils Present?	☒ Yes	☐ No
Wetland Hydrology Present?	☒ Yes	☐ No

Is this Sampling Point within a Wetland? ☒ Yes ☐ No

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size 5m diam.)	Absolute % Cover	Dominant Species?	Indicator Status
1. ***Alnus rubra***	**50**	**Yes**	**FAC**
2. ***Salix babylonica****	**50**	**No***	**FACW**
3.			
4.			
		= Total Cover	
Sapling/Shrub Stratum (Plot size 3m diam.)			
1. ***Cornus sericea***	**25**	**Yes**	**FACW**
2.			
3.			
4.			
5.			
		= Total Cover	
Herb Stratum (Plot size 1m diam.)			
1. ***Equisetum telmateia***	**40**	**Yes**	**FACW**
2. ***Phalaris arundinacea***	**10**	**No**	**FACW**
3. ***Ranunculus repens***	**20**	**Yes**	**FACW**
4. ***Oenanthe sarmentosa***	**2**	**No**	**OBL**
5.			
6.			
7.			
8.			
9.			
10.			
11.			
		= Total Cover	
Woody Vine Stratum (Plot size)			
1. ***Convulvulus arvensis***	**70**	**No****	**NI**
2. ***Rubus armeniacus***	**5**	**No**	**FACU**
		= Total Cover	
% Bare Ground in Herb Stratum			

Dominance Test Worksheet

Number of Dominant Species that are OBL, FACW, or FAC:	**3**	(A)
Total Number of Dominant Species Across All Strata:	**3**	(B)
Percent of Dominant Species that are OBL, FACW, or FAC:	**100**	(A/B)

Prevalence Index Worksheet

Total % Cover of		Multiply by
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column totals	(A)	(B)

Prevalence Index = B / A =

Hydrophytic Vegetation Indicators

X	Dominance test is > 50%
	Prevalence test is ≤ 3.0 *
	Morphological Adaptations * (provide supporting data in remarks or on a separate sheet)
	Wetland Non-Vascular Plants *
	Problematic Hydrophytic Vegetation * (explain)

* Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks: ***Rooted out of feature – overhanging.**
****NI species not included in dominance calculations.**

SOIL **Sampling Point – DP-1**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features				Texture	Remarks
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]		
0-16	**10YR 2/1**	**100**					**Sandy loam**	

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

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA** 1**)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]

- ☐ 2cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (explain in remarks)
- ☐

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

Restrictive Layer (if present):
Type: ______________________________
Depth (inches): ______________________________

Hydric soil present? Yes ☒ No ☐

Remarks: **Organic masking redox**

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required: check all that apply):

- ☐ Surface water (A1)
- ☐ High Water Table (A2)
- ☒ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (**except MLRA 1, 2, 4A & 4B**) (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (**LRR A**)
- ☐ Other (explain in remarks)

Secondary Indicators (2 or more required):

- ☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A & 4B**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (**LRR A**)
- ☐ Frost-Heave Hummocks

Field Observations

Surface Water Present?	☐ Yes	☒ No	Depth (in):	
Water Table Present?	☒ Yes	☐ No	Depth (in):	**14**
Saturation Present? (includes capillary fringe)	☐ Yes	☐ No	Depth (in):	**Surface**

Wetland Hydrology Present? Yes ☒ No ☐

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

Remarks:

THE WATERSHED COMPANY

750 Sixth Street South
Kirkland, Washington 98033
(425) 822-5242
watershedco.com

WETLAND DETERMINATION DATA FORM

Western Mountains, Valleys, and Coast Supplement to the 1987 COE Wetlands Delineation Manual

DP-2

Project Site:	**Brugger's Bog Park**	Sampling Date:	**8/22/2013**
Applicant/Owner:	**City of Shoreline**	Sampling Point:	DP- **2**
Investigator:	**Kahlo, R; Lund, N**	City/County:	**Shoreline / King Co.**
Sect., Township, Range	S **4** T **26N** R **4E**	State:	**WA**
Landform (hillslope, terrace, etc)	**Terrace** Slope (%) **5**	Local relief (concave, convex, none)	**None**
Subregion (LRR)	**A** Lat	Long	Datum
Soil Map Unit Name	**No soil data available for this location**	NWI classification	**None**

Are climatic/hydrologic conditions on the site typical for this time of year? ☒ Yes ☐ No (If no, explain in remarks.)
Are "Normal Circumstances" present on the site? ☒ Yes ☐ No
Are Vegetation ☐, Soil, ☐, or Hydrology ☐ significantly disturbed?
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	☐ No
Hydric Soils Present?	☐ Yes	☒ No
Wetland Hydrology Present?	☐ Yes	☒ No

Is this Sampling Point within a Wetland? ☐ Yes ☒ No

Remarks:

VEGETATION – Use scientific names of plants.

Tree Stratum (Plot size 5m diam.)	Absolute % Cover	Dominant Species?	Indicator Status
1. ***Salix baylonica***	**90**	**Yes**	**FACW**
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size 3m diam.)			
1. ***Rosa nutkana***	**10**	**Yes**	**FAC**
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size 1m diam.)			
1. ***Equisetum telmateia***	**10**	**No**	**FACW**
2. ***Polystichum munitum***	**10**	**No**	**FACU**
3. ***Field grass***	**40**	**Yes**	**FAC***
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover			
Woody Vine Stratum (Plot size)			
1.			
2.			
= Total Cover			
% Bare Ground in Herb Stratum			

Dominance Test Worksheet

Number of Dominant Species that are OBL, FACW, or FAC:	**3**	(A)
Total Number of Dominant Species Across All Strata:	**3**	(B)
Percent of Dominant Species that are OBL, FACW, or FAC:	**100**	(A/B)

Prevalence Index Worksheet

Total % Cover of		Multiply by
OBL species		x 1 =
FACW species		x 2 =
FAC species		x 3 =
FACU species		x 4 =
UPL species		x 5 =
Column totals	(A)	(B)

Prevalence Index = B / A =

Hydrophytic Vegetation Indicators

X	Dominance test is > 50%
	Prevalence test is ≤ 3.0 *
	Morphological Adaptations * (provide supporting data in remarks or on a separate sheet)
	Wetland Non-Vascular Plants *
	Problematic Hydrophytic Vegetation * (explain)

* Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ☒ No ☐

Remarks: **Presumed FAC**

SOIL **Sampling Point – DP-2**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth	Matrix		Redox Features					
(inches)	Color (moist)	%	Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-8	**10YR 2/2**	**100**					**Sandy loam**	
8-12	**10YR 4/2**	**100**					**Sandy loam**	

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

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA** 1)
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]

- ☐ 2cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (explain in remarks)
- ☐

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

Restrictive Layer (if present):
Type: ______
Depth (inches): ______

Hydric soil present? Yes ☒ No ☐

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required: check all that apply):

- ☐ Surface water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☐ Water-Stained Leaves (**except MLRA 1, 2, 4A & 4B**) (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (**LRR A**)
- ☐ Other (explain in remarks)

Secondary Indicators (2 or more required):

- ☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A & 4B**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (**LRR A**)
- ☐ Frost-Heave Hummocks

Field Observations

Surface Water Present?	☐ Yes	☒ No	Depth (in):
Water Table Present?	☐ Yes	☒ No	Depth (in):
Saturation Present? (includes capillary fringe)	☐ Yes	☒ No	Depth (in):

Wetland Hydrology Present? Yes ☐ No ☒

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

Remarks:

The Watershed Company
750 Sixth Street South
Kirkland, Washington 98033
(425) 822-5242
watershedco.com

WETLAND DETERMINATION DATA FORM

Western Mountains, Valleys, and Coast Supplement to the 1987 COE Wetlands Delineation Manual

DP-3

Project Site:	**Brugger's Bog Park**	Sampling Date:	**8/22/2013**
Applicant/Owner:	**City of Shoreline**	Sampling Point:	DP- **3**
Investigator:	**Kahlo, R; Lund, N**	City/County:	**Shoreline / King Co.**
Sect., Township, Range	S **4** T **26N** R **4E**	State:	**WA**
Landform (hillslope, terrace, etc)	**Ditch** Slope (%) **2**	Local relief (concave, convex, none)	**Concave**
Subregion (LRR)	**A** Lat	Long	Datum
Soil Map Unit Name	**No soil data available for this location**	NWI classification	**None**

Are climatic/hydrologic conditions on the site typical for this time of year? ☒ Yes ☐ No (If no, explain in remarks.)
Are "Normal Circumstances" present on the site? ☒ Yes ☐ No
Are Vegetation ☐, Soil, ☐, or Hydrology ☐ significantly disturbed?
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	☐ No
Hydric Soils Present?	☐ Yes	☒ No
Wetland Hydrology Present?	☒ Yes	☐ No

Is this Sampling Point within a Wetland? ☐ Yes ☒ No

Remarks:

VEGETATION – Use scientific names of plants.

	Absolute % Cover	Dominant Species?	Indicator Status
Tree Stratum (Plot size 5m diam.)			
1. ***Salix lucida***	**90**	**Yes**	**FACW**
2.			
3.			
4.			
= Total Cover			
Sapling/Shrub Stratum (Plot size 3m diam.)			
1. ***Rubus spectabilis***	**50**	**Yes**	**FAC**
2.			
3.			
4.			
5.			
= Total Cover			
Herb Stratum (Plot size 1m diam.)			
1. ***Equisetum telmateia***	**10**	**Yes**	**FACW**
2. ***Ranunculus repens***	**10**	**Yes**	**FACW**
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
= Total Cover			
Woody Vine Stratum (Plot size)			
1. ***Rubus armeniacus***	**15**	**Yes**	**FACU**
2.			
= Total Cover			
% Bare Ground in Herb Stratum			

Dominance Test Worksheet

Number of Dominant Species that are OBL, FACW, or FAC:	**4**	(A)
Total Number of Dominant Species Across All Strata:	**5**	(B)
Percent of Dominant Species that are OBL, FACW, or FAC:	**80**	(A/B)

Prevalence Index Worksheet

	Total % Cover of	Multiply by	
OBL species		x 1 =	
FACW species		x 2 =	
FAC species		x 3 =	
FACU species		x 4 =	
UPL species		x 5 =	
Column totals		(A)	(B)

Prevalence Index = B / A =

Hydrophytic Vegetation Indicators

X	Dominance test is > 50%
	Prevalence test is ≤ 3.0 *
	Morphological Adaptations * (provide supporting data in remarks or on a separate sheet)
	Wetland Non-Vascular Plants *
	Problematic Hydrophytic Vegetation * (explain)

* Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic

Hydrophytic Vegetation Present? Yes ☐ No ☒

Remarks:

SOIL **Sampling Point – DP-3**

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	Matrix %	Redox Features Color (moist)	Redox %	Type[1]	Loc[2]	Texture	Remarks
0-8	**7.5YR 2.5/2**	**100**					**Loam**	
8-12	**2.5Y 3/1**	**100**					**Loamy sand**	

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

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Sandy Mucky Mineral (S1)
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Loamy Mucky Mineral (F1) **(except MLRA 1)**
- ☐ Loamy Gleyed Matrix (F2)
- ☐ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)

Indicators for Problematic Hydric Soils[3]

- ☐ 2cm Muck (A10)
- ☐ Red Parent Material (TF2)
- ☐ Other (explain in remarks)
- ☐

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

Restrictive Layer (if present):
Type: ____________
Depth (inches): ____________

Hydric soil present? Yes ☐ No ☒

Remarks:

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one required: check all that apply):

- ☐ Surface water (A1)
- ☐ High Water Table (A2)
- ☐ Saturation (A3)
- ☐ Water Marks (B1)
- ☐ Sediment Deposits (B2)
- ☐ Drift Deposits (B3)
- ☐ Algal Mat or Crust (B4)
- ☐ Iron Deposits (B5)
- ☐ Surface Soil Cracks (B6)
- ☐ Inundation Visible on Aerial Imagery (B7)
- ☐ Sparsely Vegetated Concave Surface (B8)
- ☒ Water-Stained Leaves (**except MLRA 1, 2, 4A & 4B**) (B9)
- ☐ Salt Crust (B11)
- ☐ Aquatic Invertebrates (B13)
- ☐ Hydrogen Sulfide Odor (C1)
- ☐ Oxidized Rhizospheres along Living Roots (C3)
- ☐ Presence of Reduced Iron (C4)
- ☐ Recent Iron Reduction in Tilled Soils (C6)
- ☐ Stunted or Stressed Plants (D1) (**LRR A**)
- ☐ Other (explain in remarks)

Secondary Indicators (2 or more required):

- ☐ Water-Stained Leaves (B9) (**MLRA 1, 2, 4A & 4B**)
- ☐ Drainage Patterns (B10)
- ☐ Dry-Season Water Table (C2)
- ☐ Saturation Visible on Aerial Imagery (C9)
- ☐ Geomorphic Position (D2)
- ☐ Shallow Aquitard (D3)
- ☐ FAC-Neutral Test (D5)
- ☐ Raised Ant Mounds (D6) (**LRR A**)
- ☐ Frost-Heave Hummocks

Field Observations

Surface Water Present? ☐ Yes ☒ No Depth (in):
Water Table Present? ☐ Yes ☒ No Depth (in):
Saturation Present? (includes capillary fringe) ☐ Yes ☒ No Depth (in):

Wetland Hydrology Present? Yes ☒ No ☐

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

Remarks:

RATING SUMMARY – Western Washington

Name of wetland (or ID Wetland A): Date of site visit: 4/11/2016

Rated by: Kahlo, R Trained by Ecology? ☒Y ☐N Date of training: 9/2014

HGM Class used for rating: Riverine Wetland has multiple HGM classes? ☒Y ☐N

NOTE: **Form is not complete without the figures requested** *(figures can be combined)*.
Source of base aerial photo/map: King County iMAP and Google Earth

OVERALL WETLAND CATEGORY (based on functions ☒ or special characteristics ☐)

1. Category of wetland based on FUNCTIONS

- ☐ **Category I** – Total score = 23 - 27
- ☒ **Category II** – Total score = 20 - 22
- ☐ **Category III** – Total score = 16 - 19
- ☐ **Category IV** – Total score = 9 - 15

FUNCTION	Improving Water Quality			Hydrologic			Habitat			
									Circle the appropriate ratings	
Site Potential	H	**M**	L	H	**M**	L	H	**M**	L	
Landscape Potential	**H**	M	L	**H**	M	L	H	M	**L**	
Value	**H**	M	L	**H**	M	L	**H**	M	L	**TOTAL**
Score Based on Ratings	8			8			6			22

Score for each function based on three ratings *(order of ratings is not important)*

9 = H,H,H
8 = H,H,M
7 = H,H,L
7 = H,M,M
6 = H,M,L
6 = M,M,M
5 = H,L,L
5 = M,M,L
4 = M,L,L
3 = L,L,L

2. Category based on SPECIAL CHARACTERISTICS of wetland

CHARACTERISTIC	CATEGORY
Estuarine	I II
Wetland of High Conservation Value	I
Bog	I
Mature Forest	I
Old Growth Forest	I
Coastal Lagoon	I II
Interdunal	I II III IV
None of the above	☒

Maps and figures required to answer questions correctly for Western Washington

Depressional Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	D 1.3, H 1.1, H 1.4	
Hydroperiods	D 1.4, H 1.2	
Location of outlet (*can be added to map of hydroperiods)*	D 1.1, D 4.1	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	D 2.2, D 5.2	
Map of the contributing basin	D 4.3, D 5.3	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	D 3.1, D 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	D 3.3	

Riverine Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	1
Hydroperiods	H 1.2	1
Ponded depressions	R 1.1	1
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	R 2.4	2
Plant cover of trees, shrubs, and herbaceous plants	R 1.2, R 4.2	2
Width of unit vs. width of stream *(can be added to another figure)*	R 4.1	2
Map of the contributing basin	R 2.2, R 2.3, R 5.2	4
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	3
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	R 3.1	5
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	R 3.2, R 3.3	6

Lake Fringe Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	L 1.1, L 4.1, H 1.1, H 1.4	
Plant cover of trees, shrubs, and herbaceous plants	L 1.2	
Boundary of area within 150 ft of the wetland *(can be added to another figure)*	L 2.2	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	L 3.1, L 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	L 3.3	

Slope Wetlands

Map of:	To answer questions:	Figure #
Cowardin plant classes	H 1.1, H 1.4	
Hydroperiods	H 1.2	
Plant cover of **dense** trees, shrubs, and herbaceous plants	S 1.3	
Plant cover of **dense, rigid** trees, shrubs, and herbaceous plants (*can be added to figure above)*	S 4.1	
Boundary of 150 ft buffer (can be added to another figure)	S 2.1, S 5.1	
1 km Polygon: Area that extends 1 km from entire wetland edge - including polygons for accessible habitat and undisturbed habitat	H 2.1, H 2.2, H 2.3	
Screen capture of map of 303(d) listed waters in basin (from Ecology website)	S 3.1, S 3.2	
Screen capture of list of TMDLs for WRIA in which unit is found (from web)	S 3.3	

HGM Classification of Wetlands in Western Washington

For questions 1-7, the criteria described must apply to the entire unit being rated.

If the hydrologic criteria listed in each question do not apply to the entire unit being rated, you probably have a unit with multiple HGM classes. In this case, identify which hydrologic criteria in questions 1-7 apply, and go to Question 8.

1. Are the water levels in the entire unit usually controlled by tides except during floods?

   ☒NO – go to 2 ☐**YES –** the wetland class is **Tidal Fringe** – go to 1.1

   1.1 Is the salinity of the water during periods of annual low flow below 0.5 ppt (parts per thousand)?

   NO – Saltwater Tidal Fringe (Estuarine) **YES – Freshwater Tidal Fringe**
   *If your wetland can be classified as a Freshwater Tidal Fringe use the forms for **Riverine** wetlands. If it is Saltwater Tidal Fringe it is an **Estuarine** wetland and is not scored. This method **cannot** be used to score functions for estuarine wetlands.*

2. The entire wetland unit is flat and precipitation is the only source (>90%) of water to it. Groundwater and surface water runoff are NOT sources of water to the unit.

   ☒NO – go to 3 ☐**YES –** The wetland class is **Flats**
   *If your wetland can be classified as a Flats wetland, use the form for **Depressional** wetlands.*

3. Does the entire wetland unit **meet all** of the following criteria?
   ☐The vegetated part of the wetland is on the shores of a body of permanent open water (without any plants on the surface at any time of the year) at least 20 ac (8 ha) in size;
   ☐At least 30% of the open water area is deeper than 6.6 ft (2 m).

   ☒NO – go to 4 ☐**YES –** The wetland class is **Lake Fringe** (Lacustrine Fringe)

4. Does the entire wetland unit **meet all** of the following criteria?
   ☐The wetland is on a slope (*slope can be very gradual*),
   ☐The water flows through the wetland in one direction (unidirectional) and usually comes from seeps. It may flow subsurface, as sheetflow, or in a swale without distinct banks,
   ☐The water leaves the wetland **without being impounded**.

   ☒NO – go to 5 ☐**YES –** The wetland class is **Slope**

   NOTE: Surface water does not pond in these type of wetlands except occasionally in very small and shallow depressions or behind hummocks (depressions are usually <3 ft diameter and less than 1 ft deep).

5. Does the entire wetland unit **meet all** of the following criteria?
   ☒The unit is in a valley, or stream channel, where it gets inundated by overbank flooding from that stream or river,
   ☒The overbank flooding occurs at least once every 2 years.

☐NO – go to 6 ☒**YES –** The wetland class is **Riverine**

NOTE: The Riverine unit can contain depressions that are filled with water when the river is not flooding

6. Is the entire wetland unit in a topographic depression in which water ponds, or is saturated to the surface, at some time during the year? *This means that any outlet, if present, is higher than the interior of the wetland.*

☐NO – go to 7 ☐**YES** – The wetland class is **Depressional**

7. Is the entire wetland unit located in a very flat area with no obvious depression and no overbank flooding? The unit does not pond surface water more than a few inches. The unit seems to be maintained by high groundwater in the area. The wetland may be ditched, but has no obvious natural outlet.

☐NO – go to 8 ☐**YES** – The wetland class is **Depressional**

8. Your wetland unit seems to be difficult to classify and probably contains several different HGM classes. For example, seeps at the base of a slope may grade into a riverine floodplain, or a small stream within a Depressional wetland has a zone of flooding along its sides. GO BACK AND IDENTIFY WHICH OF THE HYDROLOGIC REGIMES DESCRIBED IN QUESTIONS 1-7 APPLY TO DIFFERENT AREAS IN THE UNIT (make a rough sketch to help you decide). Use the following table to identify the appropriate class to use for the rating system if you have several HGM classes present within the wetland unit being scored.

NOTE: Use this table only if the class that is recommended in the second column represents 10% or more of the total area of the wetland unit being rated. If the area of the HGM class listed in column 2 is less than 10% of the unit; classify the wetland using the class that represents more than 90% of the total area.

HGM classes within the wetland unit being rated	HGM class to use in rating
Slope + Riverine	Riverine
Slope + Depressional	Depressional
Slope + Lake Fringe	Lake Fringe
Depressional + Riverine along stream within boundary of depression	Depressional
Depressional + Lake Fringe	Depressional
Riverine + Lake Fringe	Riverine
Salt Water Tidal Fringe and any other class of freshwater wetland	Treat as ESTUARINE

*If you are still unable to determine which of the above criteria apply to your wetland, or if you have **more than 2 HGM classes** within a wetland boundary, classify the wetland as Depressional for the rating.*

RIVERINE AND FRESHWATER TIDAL FRINGE WETLANDS

Water Quality Functions - Indicators that the site functions to improve water quality

R 1.0. Does the site have the potential to improve water quality?	
R 1.1. Area of surface depressions within the Riverine wetland that can trap sediments during a flooding event: Depressions cover > 3/4 area of wetland — points = 8 Depressions cover > 1/2 area of wetland — points = 4 Depressions present but cover < 1/2 area of wetland — points = 2 No depressions present — points = 0	4
R 1.2. Structure of plants in the wetland (areas with >90% cover at person height, **not** Cowardin classes) Trees or shrubs > 2/3 area of the wetland — points = 8 Trees or shrubs > 1/3 area of the wetland — points = 6 **Herbaceous plants (> 6 in high) > 2/3 area of the wetland — points = 6** Herbaceous plants (> 6 in high) > 1/3 area of the wetland — points = 3 Trees, shrubs, and ungrazed herbaceous < 1/3 area of the wetland — points = 0	6
Total for R 1 — Add the points in the boxes above	10

Rating of Site Potential If score is: ☐**12-16 = H** ☒**6-11 = M** ☐**0-5 = L** *Record the rating on the first page*

R 2.0. Does the landscape have the potential to support the water quality function of the site?	
R 2.1. Is the wetland within an incorporated city or within its UGA? Yes = 2 No = 0	2
R 2.2. Does the contributing basin to the wetland include a UGA or incorporated area? Yes = 1 No = 0	1
R 2.3. Does at least 10% of the contributing basin contain tilled fields, pastures, or forests that have been clearcut within the last 5 years? Yes = 1 No = 0	0
R 2.4. Is > 10% of the area within 150 ft of the wetland in land uses that generate pollutants? Yes = 1 No = 0	1
R 2.5. Are there other sources of pollutants coming into the wetland that are not listed in questions R 2.1-R 2.4 Other sources______________________ Yes = 1 No = 0	0
Total for R 2 — Add the points in the boxes above	4

Rating of Landscape Potential If score is: ☒**3-6 = H** ☐**1 or 2 = M** ☐**0 = L** *Record the rating on the first page*

R 3.0. Is the water quality improvement provided by the site valuable to society?	
R 3.1. Is the wetland along a stream or river that is on the 303(d) list or on a tributary that drains to one within 1 mi? Yes = 1 No = 0	1
R 3.2. Is the wetland along a stream or river that has TMDL limits for nutrients, toxics, or pathogens? Yes = 1 No = 0	1
R 3.3. Has the site been identified in a watershed or local plan as important for maintaining water quality? (*answer YES if there is a TMDL for the drainage in which the unit is found*) Yes = 2 No = 0	0
Total for R 3 — Add the points in the boxes above	2

Rating of Value If score is: ☒**2-4 = H** ☐**1 = M** ☐**0 = L** *Record the rating on the first page*

RIVERINE AND FRESHWATER TIDAL FRINGE WETLANDS

Hydrologic Functions - Indicators that site functions to reduce flooding and stream erosion

R 4.0. Does the site have the potential to reduce flooding and erosion?	
R 4.1. Characteristics of the overbank storage the wetland provides: *Estimate the average width of the wetland perpendicular to the direction of the flow and the width of the stream or river channel (distance between banks). Calculate the ratio: (average width of wetland)/(average width of stream between banks).* If the ratio is more than 20 points = 9 If the ratio is 10-20 points = 6 If the ratio is 5-<10 points = 4 If the ratio is 1-<5 points = 2 If the ratio is < 1 points = 1	4
R 4.2. Characteristics of plants that slow down water velocities during floods: *Treat large woody debris as forest or shrub. Choose the points appropriate for the best description (polygons need to have >90% cover at person height. These are NOT Cowardin classes).* Forest or shrub for > 1/3 area OR emergent plants > 2/3 area points = 7 Forest or shrub for > 1/10 area OR emergent plants > 1/3 area points = 4 Plants do not meet above criteria points = 0	7
Total for R 4 Add the points in the boxes above	11

Rating of Site Potential If score is: ☐**12-16 = H** ☒**6-11 = M** ☐**0-5 = L** *Record the rating on the first page*

R 5.0. Does the landscape have the potential to support the hydrologic functions of the site?	
R 5.1. Is the stream or river adjacent to the wetland downcut? Yes = 0 No = 1	1
R 5.2. Does the up-gradient watershed include a UGA or incorporated area? Yes = 1 No = 0	1
R 5.3. Is the up-gradient stream or river controlled by dams? Yes = 0 No = 1	1
Total for R 5 Add the points in the boxes above	3

Rating of Landscape Potential If score is: ☒**3 = H** ☐**1 or 2 = M** ☐**0 = L** *Record the rating on the first page*

R 6.0. Are the hydrologic functions provided by the site valuable to society?	
R 6.1. Distance to the nearest areas downstream that have flooding problems? *Choose the description that best fits the site.* The sub-basin immediately down-gradient of the wetland has flooding problems that result in damage to human or natural resources (e.g., houses or salmon redds) points = 2 Surface flooding problems are in a sub-basin farther down-gradient points = 1 No flooding problems anywhere downstream points = 0	2
R 6.2. Has the site been identified as important for flood storage or flood conveyance in a regional flood control plan? Yes = 2 No = 0	0
Total for R 6 Add the points in the boxes above	2

Rating of Value If score is: ☒**2-4 = H** ☐**1 = M** ☐**0 = L** *Record the rating on the first page*

These questions apply to wetlands of all HGM classes.

HABITAT FUNCTIONS - Indicators that site functions to provide important habitat

H 1.0. Does the site have the potential to provide habitat?

H 1.1. Structure of plant community: *Indicators are Cowardin classes and strata within the Forested class.* Check the Cowardin plant classes in the wetland. *Up to 10 patches may be combined for each class to meet the threshold of ¼ ac or more than 10% of the unit if it is smaller than 2.5 ac. Add the number of structures checked.*

☐ Aquatic bed	4 structures or more: points = 4
☐ Emergent	3 structures: points = 2
☐ Scrub-shrub (areas where shrubs have > 30% cover)	2 structures: points = 1
☒ Forested (areas where trees have > 30% cover)	1 structure: points = 0

If the unit has a Forested class, check if:

☒ The Forested class has 3 out of 5 strata (canopy, sub-canopy, shrubs, herbaceous, moss/ground-cover) that each cover 20% within the Forested polygon

Points: 1

H 1.2. Hydroperiods

Check the types of water regimes (hydroperiods) present within the wetland. The water regime has to cover more than 10% of the wetland or ¼ ac to count (*see text for descriptions of hydroperiods*).

☐ Permanently flooded or inundated	4 or more types present: points = 3
☐ Seasonally flooded or inundated	3 types present: points = 2
☒ Occasionally flooded or inundated	2 types present: points = 1
☒ Saturated only	1 type present: points = 0
☐ Permanently flowing stream or river in, or adjacent to, the wetland	
☐ Seasonally flowing stream in, or adjacent to, the wetland <u>**<10%**</u>	
☐ **Lake Fringe wetland**	**2 points**
☐ **Freshwater tidal wetland**	**2 points**

Points: 1

H 1.3. Richness of plant species

Count the number of plant species in the wetland that cover at least 10 ft^2.

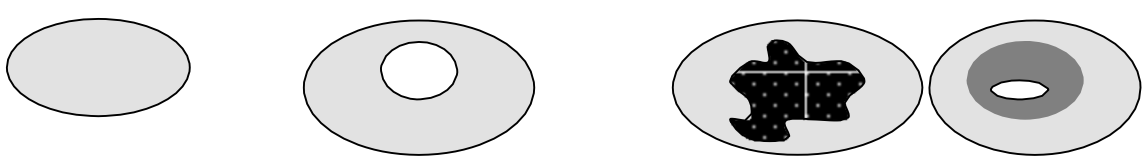
Different patches of the same species can be combined to meet the size threshold and you do not have to name the species. ***Do not include Eurasian milfoil, reed canarygrass, purple loosestrife, Canadian thistle***

If you counted: > 19 species	points = 2
5 - 19 species	points = 1
< 5 species	points = 0

Points: 2

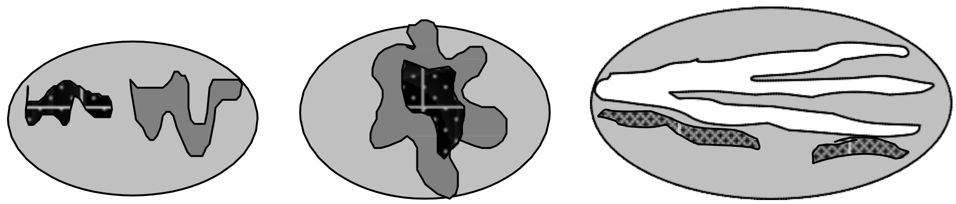
H 1.4. Interspersion of habitats

Decide from the diagrams below whether interspersion among Cowardin plants classes (described in H 1.1), or the classes and unvegetated areas (can include open water or mudflats) is high, moderate, low, or none. *If you have four or more plant classes or three classes and open water, the rating is always high.*



None = 0 points **Low** = 1 point **Moderate** = 2 points

All three diagrams in this row are **HIGH** = 3points



Points: 0

H 1.5. Special habitat features: Check the habitat features that are present in the wetland. *The number of checks is the number of points.* ☒ Large, downed, woody debris within the wetland (> 4 in diameter and 6 ft long). ☒ Standing snags (dbh > 4 in) within the wetland ☒ Undercut banks are present for at least 6.6 ft (2 m) **and/or** overhanging plants extends at least 3.3 ft (1 m) over a stream (or ditch) in, or contiguous with the wetland, for at least 33 ft (10 m) ☐ Stable steep banks of fine material that might be used by beaver or muskrat for denning (> 30 degree slope) OR signs of recent beaver activity are present *(cut shrubs or trees that have not yet weathered where wood is exposed)* ☐ At least ¼ ac of thin-stemmed persistent plants or woody branches are present in areas that are permanently or seasonally inundated *(structures for egg-laying by amphibians)* ☒ Invasive plants cover less than 25% of the wetland area in every stratum of plants (*see H 1.1 for list of strata*)	4
Total for H 1 — Add the points in the boxes above	8

Rating of Site Potential If score is: ☐**15-18 = H** ☒**7-14 = M** ☐**0-6 = L** *Record the rating on the first page*

H 2.0. Does the landscape have the potential to support the habitat functions of the site?	
H 2.1. Accessible habitat (include *only habitat that directly abuts wetland unit*). *Calculate:* % undisturbed habitat: **0+** [(% moderate and low intensity land uses)/2]: **0 =0%** If total accessible habitat is: > 1/3 (33.3%) of 1 km Polygon — points = 3 20-33% of 1 km Polygon — points = 2 10-19% of 1 km Polygon — points = 1 < 10% of 1 km Polygon — points = 0	0
H 2.2. Undisturbed habitat in 1 km Polygon around the wetland. *Calculate:* % undisturbed habitat: **4 +** [(% moderate and low intensity land uses)/2]: **0 = 4%** Undisturbed habitat > 50% of Polygon — points = 3 Undisturbed habitat 10-50% and in 1-3 patches — points = 2 Undisturbed habitat 10-50% and > 3 patches — points = 1 Undisturbed habitat < 10% of 1 km Polygon — points = 0	0
H 2.3. Land use intensity in 1 km Polygon: If > 50% of 1 km Polygon is high intensity land use — points = (- 2) ≤ 50% of 1 km Polygon is high intensity — points = 0	-2
Total for H 2 — Add the points in the boxes above	-2

Rating of Landscape Potential If score is: ☐**4-6 = H** ☐**1-3 = M** ☒**< 1 = L** *Record the rating on the first page*

H 3.0. Is the habitat provided by the site valuable to society?	
H 3.1. Does the site provide habitat for species valued in laws, regulations, or policies? *Choose only the highest score that applies to the wetland being rated.* Site meets ANY of the following criteria: — points = 2 ☒ It has 3 or more priority habitats within 100 m (see next page) ☐ It provides habitat for Threatened or Endangered species (any plant or animal on the state or federal lists) ☐ It is mapped as a location for an individual WDFW priority species ☐ It is a Wetland of High Conservation Value as determined by the Department of Natural Resources ☐ It has been categorized as an important habitat site in a local or regional comprehensive plan, in a Shoreline Master Plan, or in a watershed plan Site has 1 or 2 priority habitats (listed on next page) within 100 m — points = 1 Site does not meet any of the criteria above — points = 0	2

Rating of Value If score is: ☒**2 = H** ☐**1 = M** ☐**0 = L** *Record the rating on the first page*

WDFW Priority Habitats

Priority habitats listed by WDFW (see complete descriptions of WDFW priority habitats, and the counties in which they can be found, in: Washington Department of Fish and Wildlife. 2008. Priority Habitat and Species List. Olympia, Washington. 177 pp. http://wdfw.wa.gov/publications/00165/wdfw00165.pdf or access the list from here: http://wdfw.wa.gov/conservation/phs/list/)

Count how many of the following priority habitats are within 330 ft (100 m) of the wetland unit: ***NOTE:*** *This question is independent of the land use between the wetland unit and the priority habitat.*

☐ **Aspen Stands:** Pure or mixed stands of aspen greater than 1 ac (0.4 ha).

☐ **Biodiversity Areas and Corridors**: Areas of habitat that are relatively important to various species of native fish and wildlife (*full descriptions in WDFW PHS report*).

☐ **Herbaceous Balds:** Variable size patches of grass and forbs on shallow soils over bedrock.

☐ **Old-growth/Mature forests:** Old-growth west of Cascade crest – Stands of at least 2 tree species, forming a multi- layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) > 32 in (81 cm) dbh or > 200 years of age. Mature forests – Stands with average diameters exceeding 21 in (53 cm) dbh; crown cover may be less than 100%; decay, decadence, numbers of snags, and quantity of large downed material is generally less than that found in old-growth; 80-200 years old west of the Cascade crest.

☐ **Oregon White Oak:** Woodland stands of pure oak or oak/conifer associations where canopy coverage of the oak component is important (*full descriptions in WDFW PHS report p. 158 – see web link above*).

☒ **Riparian**: The area adjacent to aquatic systems with flowing water that contains elements of both aquatic and terrestrial ecosystems which mutually influence each other.

☐ **Westside Prairies:** Herbaceous, non-forested plant communities that can either take the form of a dry prairie or a wet prairie (*full descriptions in WDFW PHS report p. 161 – see web link above*).

☒ **Instream:** The combination of physical, biological, and chemical processes and conditions that interact to provide functional life history requirements for instream fish and wildlife resources.

☐ **Nearshore**: Relatively undisturbed nearshore habitats. These include Coastal Nearshore, Open Coast Nearshore, and Puget Sound Nearshore. (*full descriptions of habitats and the definition of relatively undisturbed are in WDFW report – see web link on previous page).*

☐ **Caves:** A naturally occurring cavity, recess, void, or system of interconnected passages under the earth in soils, rock, ice, or other geological formations and is large enough to contain a human.

☐ **Cliffs:** Greater than 25 ft (7.6 m) high and occurring below 5000 ft elevation.

☐ **Talus:** Homogenous areas of rock rubble ranging in average size 0.5 - 6.5 ft (0.15 - 2.0 m), composed of basalt, andesite, and/or sedimentary rock, including riprap slides and mine tailings. May be associated with cliffs.

☒ **Snags and Logs:** Trees are considered snags if they are dead or dying and exhibit sufficient decay characteristics to enable cavity excavation/use by wildlife. Priority snags have a diameter at breast height of > 20 in (51 cm) in western Washington and are > 6.5 ft (2 m) in height. Priority logs are > 12 in (30 cm) in diameter at the largest end, and > 20 ft (6 m) long.

Note: All vegetated wetlands are by definition a priority habitat but are not included in this list because they are addressed elsewhere.

CATEGORIZATION BASED ON SPECIAL CHARACTERISTICS

Wetland Type *Check off any criteria that apply to the wetland. Circle the category when the appropriate criteria are met.*	**Category**
SC 1.0. Estuarine wetlands Does the wetland meet the following criteria for Estuarine wetlands? ☐ The dominant water regime is tidal, ☐ Vegetated, and ☐ With a salinity greater than 0.5 ppt ☐Yes –Go to **SC 1.1** ☒No= **Not an estuarine wetland**	
SC 1.1. Is the wetland within a National Wildlife Refuge, National Park, National Estuary Reserve, Natural Area Preserve, State Park or Educational, Environmental, or Scientific Reserve designated under WAC 332-30-151? ☐Yes = **Category I** ☐No - Go to **SC 1.2**	**Cat. I**
SC 1.2. Is the wetland unit at least 1 ac in size and meets at least two of the following three conditions? ☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing, and has less than 10% cover of non-native plant species. (If non-native species are *Spartina*, see page 25) ☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un- mowed grassland. ☐ The wetland has at least two of the following features: tidal channels, depressions with open water, or contiguous freshwater wetlands. ☐Yes = **Category I** ☐No= **Category II**	**Cat. I** **Cat. II**
SC 2.0. Wetlands of High Conservation Value (WHCV) SC 2.1. Has the WA Department of Natural Resources updated their website to include the list of Wetlands of High Conservation Value? ☐Yes **–** Go to **SC 2.2** ☒No **–** Go to **SC 2.3** SC 2.2. Is the wetland listed on the WDNR database as a Wetland of High Conservation Value? ☐Yes **= Category** I ☐No **= Not a WHCV** SC 2.3. Is the wetland in a Section/Township/Range that contains a Natural Heritage wetland? http://www1.dnr.wa.gov/nhp/refdesk/datasearch/wnhpwetlands.pdf ☐Yes **– Contact WNHP/WDNR and go to SC 2.4** ☒No **= Not a WHCV** SC 2.4. Has WDNR identified the wetland within the S/T/R as a Wetland of High Conservation Value and listed it on their website? ☐Yes **= Category I** ☐No **= Not a WHCV**	**Cat. I**
SC 3.0. Bogs Does the wetland (or any part of the unit) meet both the criteria for soils and vegetation in bogs? *Use the key below.* ***If you answer YES you will still need to rate the wetland based on its functions.*** SC 3.1. Does an area within the wetland unit have organic soil horizons, either peats or mucks, that compose 16 in or more of the first 32 in of the soil profile? ☐Yes – Go to **SC 3.3** ☒No – Go to **SC 3.2** SC 3.2. Does an area within the wetland unit have organic soils, either peats or mucks, that are less than 16 in deep over bedrock, or an impermeable hardpan such as clay or volcanic ash, or that are floating on top of a lake or pond? ☐Yes – Go to **SC 3.3** ☒No = **Is not a bog** SC 3.3. Does an area with peats or mucks have more than 70% cover of mosses at ground level, AND at least a 30% cover of plant species listed in Table 4? ☐Yes = **Is a Category I bog** ☐No – Go to **SC 3.4** **NOTE:** If you are uncertain about the extent of mosses in the understory, you may substitute that criterion by measuring the pH of the water that seeps into a hole dug at least 16 in deep. If the pH is less than 5.0 and the plant species in Table 4 are present, the wetland is a bog. SC 3.4. Is an area with peats or mucks forested (> 30% cover) with Sitka spruce, subalpine fir, western red cedar, western hemlock, lodgepole pine, quaking aspen, Engelmann spruce, or western white pine, AND any of the species (or combination of species) listed in Table 4 provide more than 30% of the cover under the canopy? ☐Yes = **Is a Category I bog** ☐No = **Is not a bog**	**Cat. I**

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SC 4.0. Forested Wetlands

Does the wetland have at least <u>1 contiguous acre</u> of forest that meets one of these criteria for the WA Department of Fish and Wildlife's forests as priority habitats? ***If you answer YES you will still need to rate the wetland based on its functions.***

☐ **Old-growth forests** (west of Cascade crest): Stands of at least two tree species, forming a multi-layered canopy with occasional small openings; with at least 8 trees/ac (20 trees/ha) that are at least 200 years of age OR have a diameter at breast height (dbh) of 32 in (81 cm) or more.

☐ **Mature forests** (west of the Cascade Crest): Stands where the largest trees are 80- 200 years old OR the species that make up the canopy have an average diameter (dbh) exceeding 21 in (53 cm).

☐Yes = **Category I** ☒No **= Not a forested wetland for this section**

</td><td>**Cat. I**</td></tr>
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SC 5.0. Wetlands in Coastal Lagoons

Does the wetland meet all of the following criteria of a wetland in a coastal lagoon?

☐ The wetland lies in a depression adjacent to marine waters that is wholly or partially separated from marine waters by sandbanks, gravel banks, shingle, or, less frequently, rocks

☐ The lagoon in which the wetland is located contains ponded water that is saline or brackish (> 0.5 ppt) during most of the year in at least a portion of the lagoon *(needs to be measured near the bottom)*

☐Yes – Go to **SC 5.1** ☒No = **Not a wetland in a coastal lagoon**

SC 5.1. Does the wetland meet all of the following three conditions?

☐ The wetland is relatively undisturbed (has no diking, ditching, filling, cultivation, grazing), and has less than 20% cover of aggressive, opportunistic plant species (see list of species on p. 100).

☐ At least ¾ of the landward edge of the wetland has a 100 ft buffer of shrub, forest, or un-grazed or un- mowed grassland.

☐ The wetland is larger than $^{1}/_{10}$ ac (4350 ft^2)

☐Yes = **Category I** ☒No = **Category II**

</td><td>

Cat. I

Cat. II

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SC 6.0. Interdunal Wetlands

Is the wetland west of the 1889 line (also called the Western Boundary of Upland Ownership or WBUO)? ***If you answer yes you will still need to rate the wetland based on its habitat functions.***

In practical terms that means the following geographic areas:

☐ Long Beach Peninsula: Lands west of SR 103

☐ Grayland-Westport: Lands west of SR 105

☐ Ocean Shores-Copalis: Lands west of SR 115 and SR 109

☐Yes – Go to **SC 6.1** ☒No = **not an interdunal wetland for rating**

SC 6.1. Is the wetland 1 ac or larger and scores an 8 or 9 for the habitat functions on the form (rates H,H,H or H,H,M for the three aspects of function)? ☐Yes = **Category I** ☐No – Go to **SC 6.2**

SC 6.2. Is the wetland 1 ac or larger, or is it in a mosaic of wetlands that is 1 ac or larger?

☐Yes = **Category II** ☐No – Go to **SC 6.3**

SC 6.3. Is the unit between 0.1 and 1 ac, or is it in a mosaic of wetlands that is between 0.1 and 1 ac?

☐Yes = **Category III** ☐No = **Category IV**

</td><td>

Cat I

Cat. II

Cat. III

Cat. IV

</td></tr>
<tr><td>

Category of wetland based on Special Characteristics

If you answered No for all types, enter "Not Applicable" on Summary Form

</td><td>NA</td></tr>
</table>

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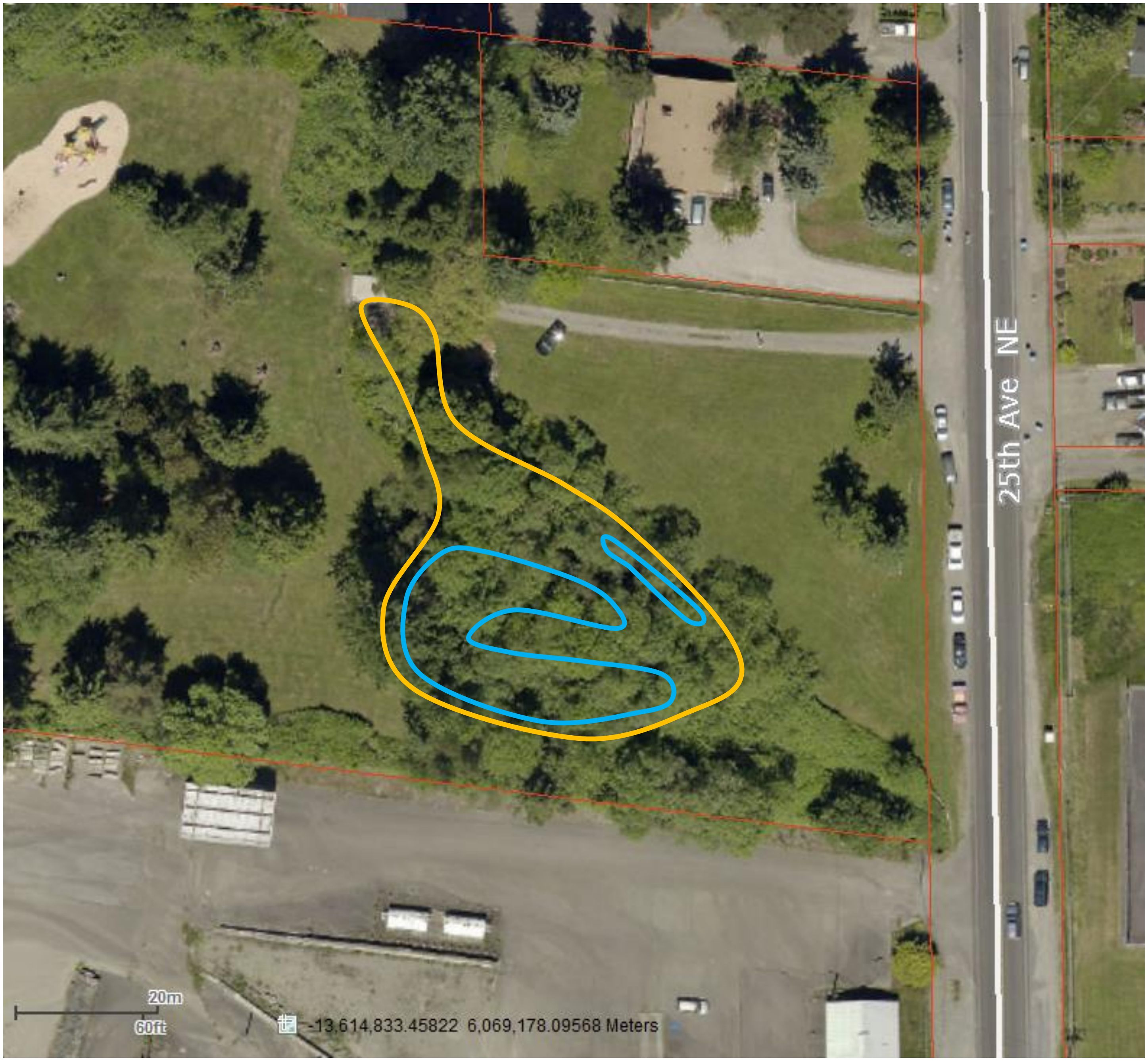


Figure 1: H1.1, H1.4, H1.2, H1.1

Forested / Saturated Only

Ponded Depressions / Occasionally flooded

Stream present but it comprises less than 10% of wetland.

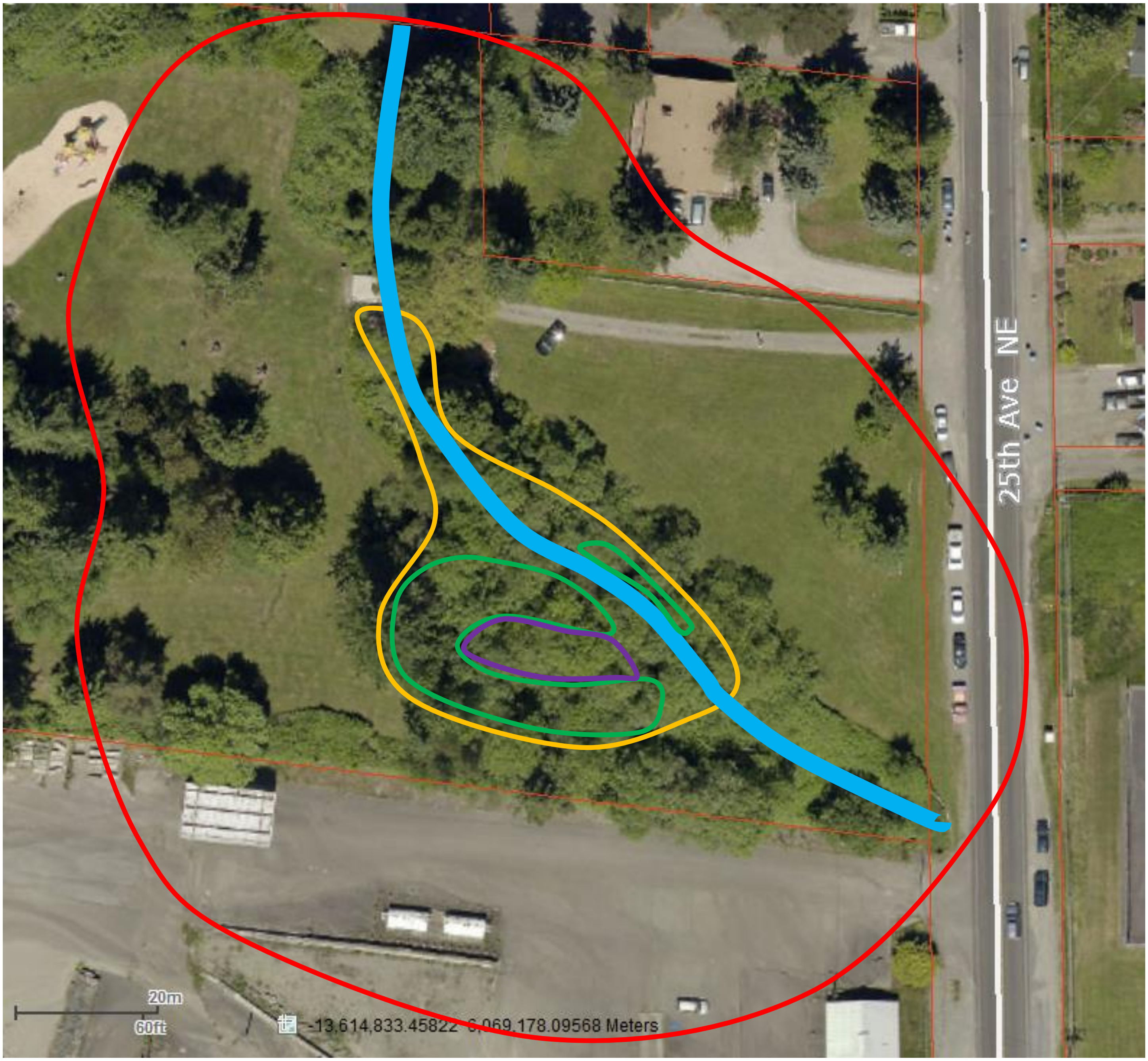


Figure 2: R2.4, R1.2, R4.2, R4.1

Areas of dense tree and shrub

Areas of dense emergent

150-foot buffer

Stream

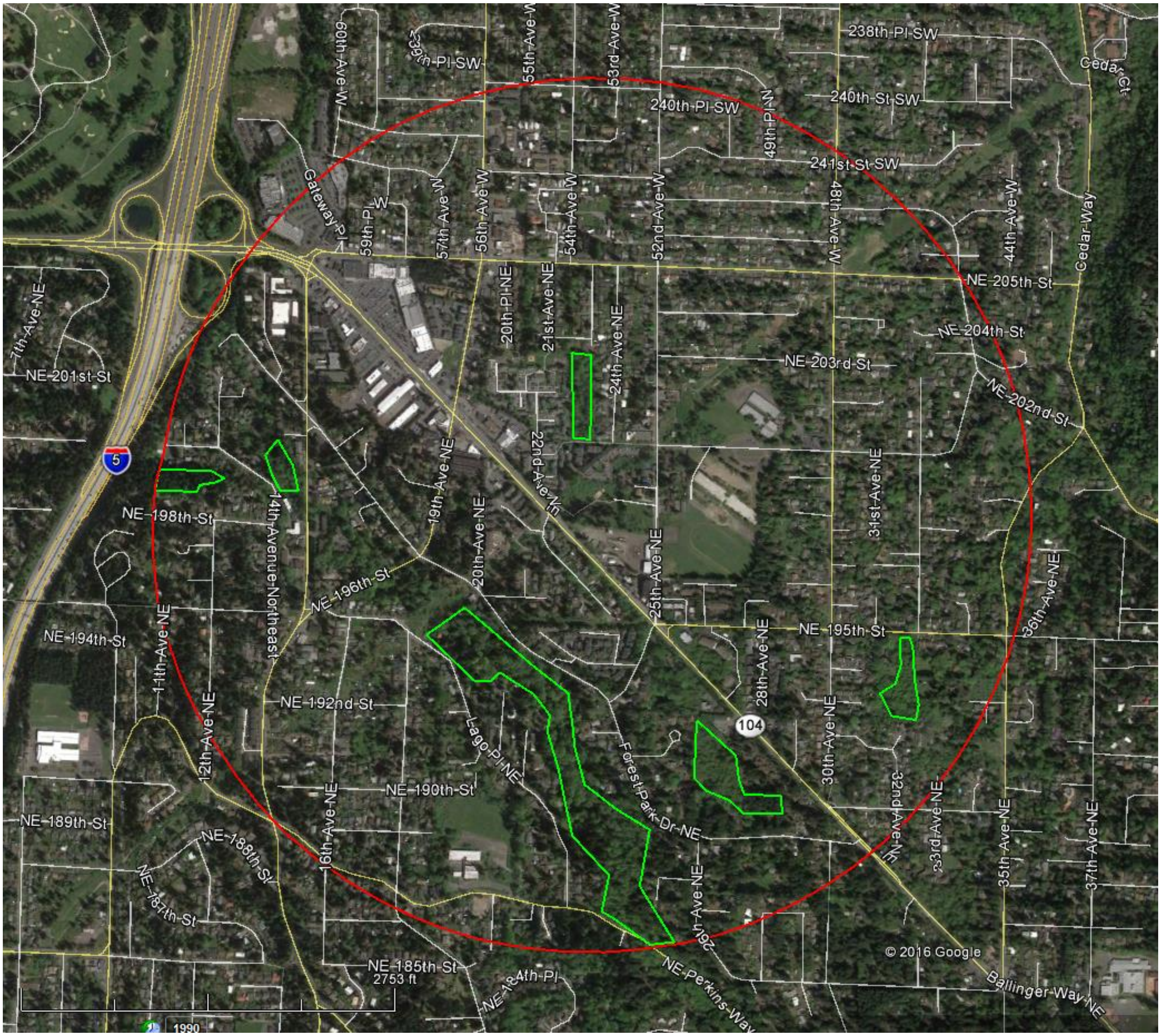


Figure 3: H2.1, H2.2

1km radius

Relatively undisturbed habitat

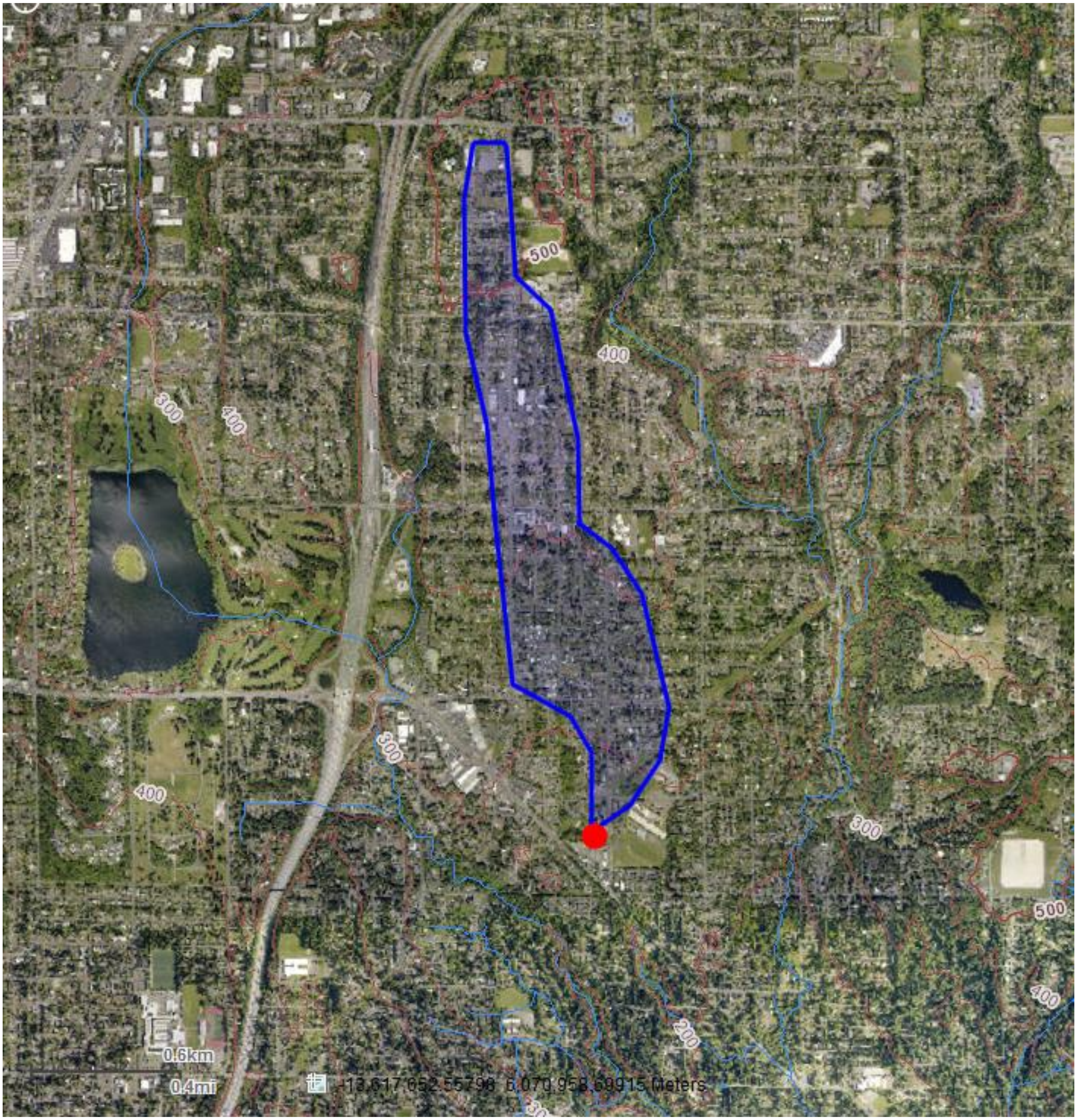
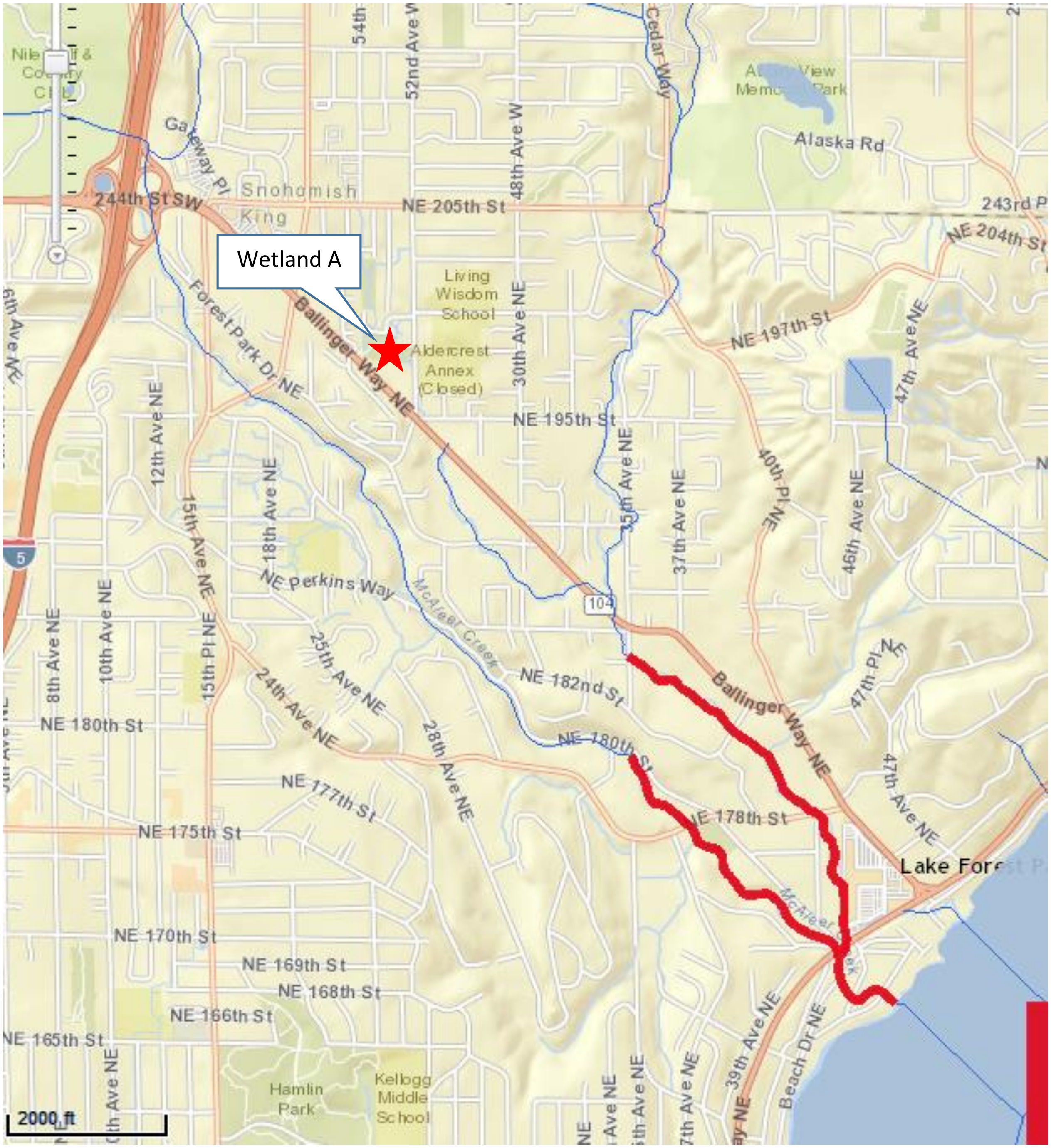


Figure 4: R2.2, R5.2

Contributing basin

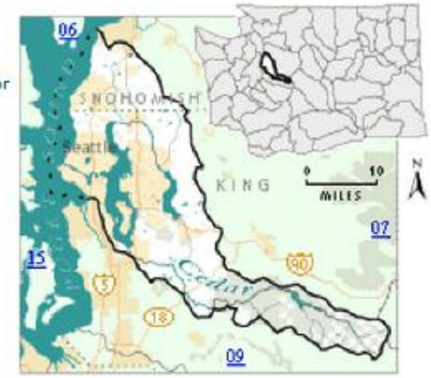


Wetland A
Ballinger Way NE
NE 205th St
244th St SW
Snohomish
King
Living Wisdom School
Aldercrest Annex (Closed)
Forest Park Dr NE
NE 195th St
NE Perkins Way
McAleer Creek
NE 182nd St
NE 180th St
NE 178th St
NE 177th St
NE 175th St
NE 170th St
NE 169th St
NE 168th St
NE 166th St
NE 165th St
NE 197th St
NE 204th St
243rd Pl
Alaska Rd
Cedar Way
Lake Forest Park
Hamlin Park
Kellogg Middle School
Beach Dr NE
2000 ft

Figure 5: R3.1

Water Quality Improvement Projects (TMDLs)

WRIA 8: Cedar-Sammamish



The following table lists overview information for water quality improvement projects (including total maximum daily loads, or TMDLs) for this water resource inventory area (WRIA). Please use links (where available) for more information on a project.

Counties

- King
- Snohomish

Waterbody Name	Pollutants	Status**	TMDL Lead
Ballinger Lake	Total Phosphorus	Approved by EPA	Tricia Shoblom 425-649-7288
Bear-Evans Creek Basin	Fecal Coliform Dissolved Oxygen Temperature	Approved by EPA Approved by EPA	Joan Nolan 425-649-4425
Cottage Lake	Total Phosphorus	Approved by EPA Has an implementation plan	Tricia Shoblom 425-649-7288
Issaquah Creek Basin	Fecal Coliform	Approved by EPA	Joan Nolan 425-649-4425
Little Bear Creek Tributaries: Trout Stream Great Dane Creek Cutthroat Creek	Fecal Coliform	Approved by EPA	Ralph Svrjcek 425-649-7036
North Creek	Fecal Coliform	Approved by EPA Has an implementation plan	Ralph Svrjcek 425-649-7036
Pipers Creek	Fecal Coliform	Approved by EPA	Joan Nolan 425-649-4425
Sammamish River	Dissolved Oxygen Temperature	Field work starts summer 2015	Ralph Svrjcek 425-649-7036
Swamp Creek	Fecal Coliform	Approved by EPA Has an implementation plan	Ralph Svrjcek 425-649-7036

*** **Status** will be listed as one of the following: Approved by EPA, Under Development or Implementation*

Figure 6: R3.2, 3.3

Appendix K
WSDOT Coordination

Appendix K.1
Gabion Wall Report

Foundations

DEPARTMENT OF TRANSPORTATION
INTRA-DEPARTMENTAL COMMUNICATION

DATE: May 28, 1980

FROM: R. V. LeClerc/A. P. Kilian
Phone:

SUBJECT: C.S. 1748, SR-104, L-5414
25th Ave. N.E. Vic. to Jct. SR-522
Gabion Walls #1, #2, and #3

To: C. S. Gloyd/G. T. Markich

Please find attached for your review Retaining Wall Data Sheets, wall plan and profile sheets, copies of District test hole logs, and transmittal IDC.

We concur with Mr. Whalen's recommendation for unsuitable removal at wall #1. The open excavation cavities for these walls should be inspected by District Materials prior to backfilling. Backfill material should be gravel borrow compacted to 95 percent of maximum density.

You will note the District requests an early review.

RVL:gmh
APK

Attach.

cc: K. E. Whalen
R. A. Arwine

HWY FORM 700-008 REVISED 3/72

DEPARTMENT OF HIGHWAYS

INTRA-DEPARTMENTAL COMMUNICATION

DATE: May 26, 1980

FROM: K.E. Whalen KEW

TO: R. V. LeClerc

SUBJECT: C.S. 1748 SR 104
25th Ave. N.E. Vic. to Jct. SR 522
Gabion Walls
L-5414

Attached for your review are Retaining Wall Data Sheets and test hole data for subject Gabion Walls. Our observations and recommendations for these walls are as follows.

Gabion # 1

Test holes with penetrometer tests and probes reveal a soft surface layer of Gravelly Clay and Silt over course silty sand. This clay was deposited by a stream to an average depth of 4.0'. We recommend removal of this soft material and backfilling the resulting void with Gravel Borrow to construct a base for the Gabions.

Gabion # 2

Probes and test holes in this area encountered stream bed gravel. Adjacent native materials also consist of Sand and Gravel indicating that dense foundation materials exist deeper then we were able to drill.

Gabion# 3

Foundation materials for this wall consist of slightly gravelly sand. Portable penetrometer information shows adequate bearing for the wall.

P S & E for this project is now being reviewed by headquarters. A review of the Gabion Walls is holding up the setting of the ad date. Your expeditious review would be appreciated.

Attachments
REA/bm
cc: R.A. Arwine

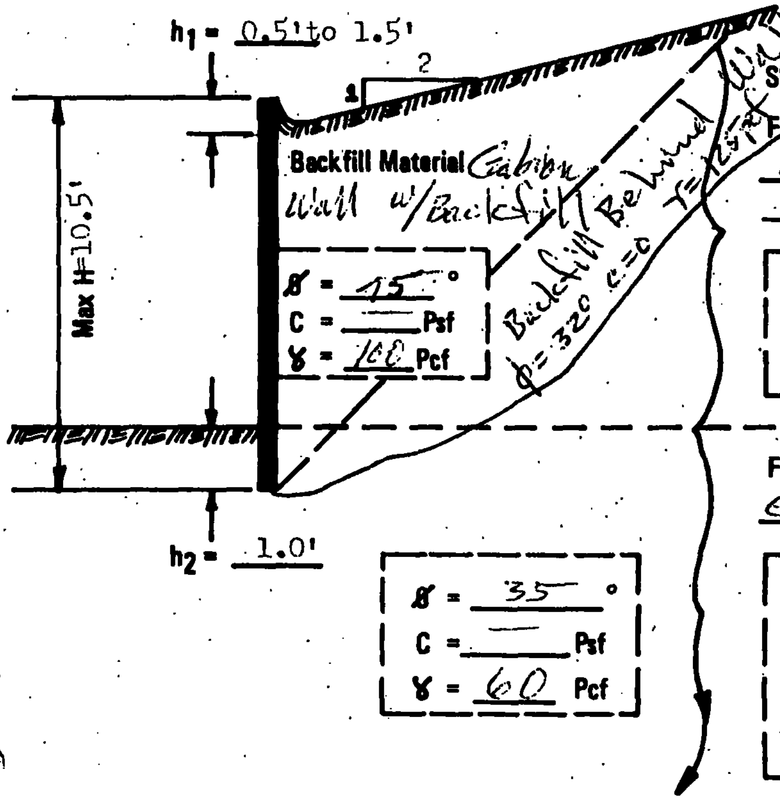
DEPARTMENT OF TRANSPORTATION

RETAINING WALL DATA SHEET

Dist. No. 1 **Control Section** 1748 **SR No.** 104 **Job No.** L-5414 **Date** May 21, 1980

Project 25th Ave. N.E. Vic. to Jct SR 522 **Prepared By** Arwine/IBI

Wall Type Planned Gabion No. 1



Show Location of Water Table: Native

Fill Material or Native Soil = Existing embankments constructed with Clay.

ϕ = 15 °
C = 300 Psf
γ = 120 Pcf

Foundation Soil Native Gravelly Sand OR Gravel Borrow Backfill

Allowable Bearing Value: 3.0 Tsf

Recommended Footing Elev. As Shown

Pile Support: Yes ____ No X

Pile Type: —

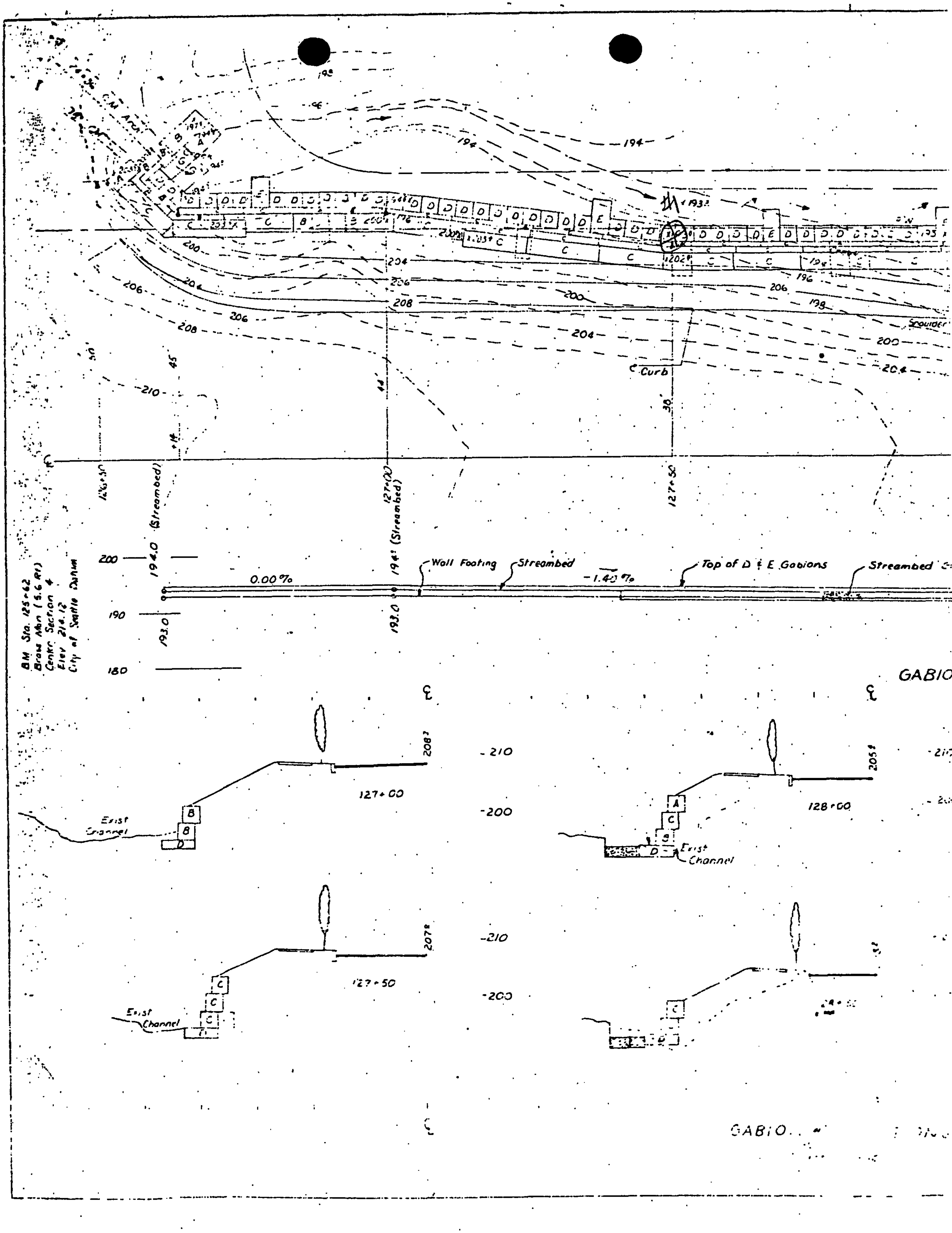
ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc.
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS-

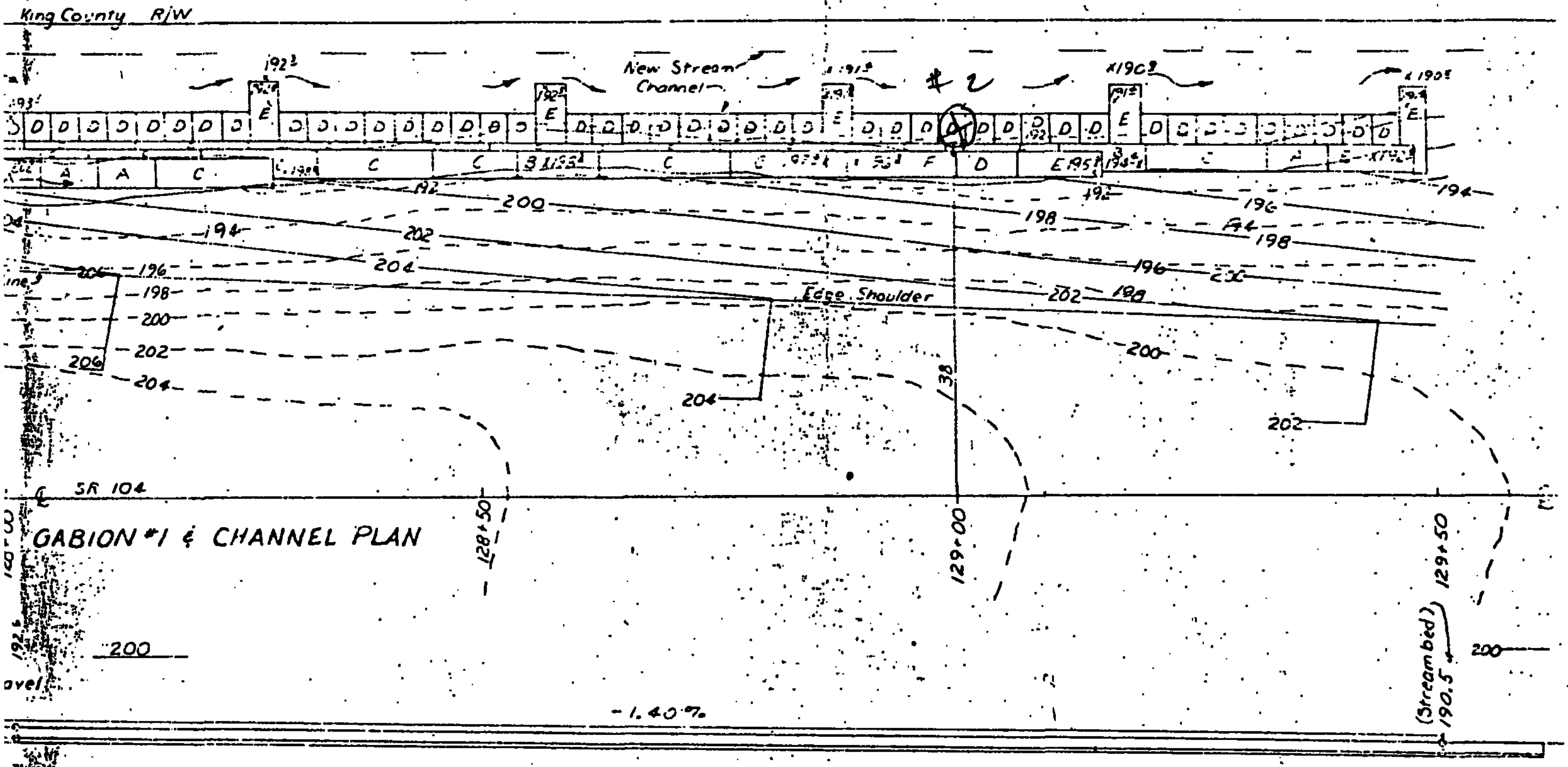
DOT FORM 351-009 REVISED 10/79

H.F. 26.99 1-66

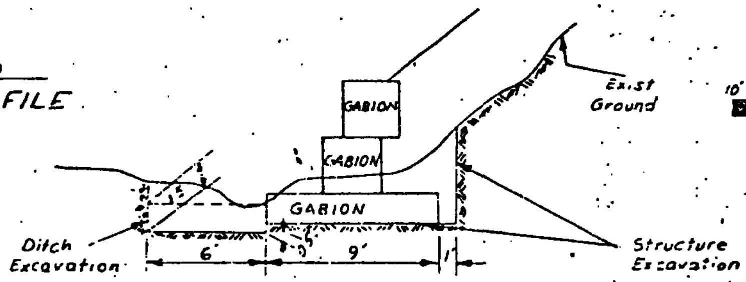


BM Sta. 125+62
Brass Mon (5.6 Rt)
Centre Section 4
Elev 214.12
City of Seattle Datum
Curb
Streambed
Wall Footing
Top of D & E Gabions
0.00 %
-1.40 %
194.0
193.0
194± (Streambed)
193.0
126+50
(Streambed)
127+00
127+50
200
190
180
210
200
Exist Channel
127+00
128+00
127+50
GABIO

REGION NO.	STATE	FEDERAL AID PROJECT NO.	SHEET NO.
10	WASH.		

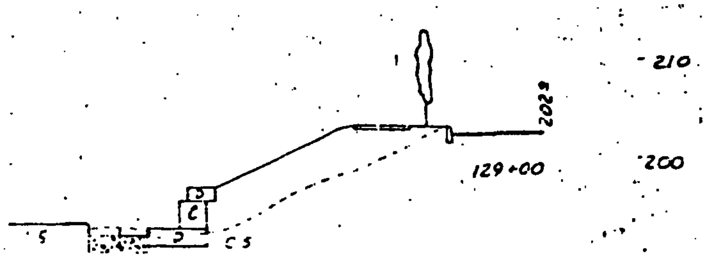


V #1 PROFILE



LIMITS OF DITCH EXCAVATION AND STRUCTURE EXCAVATION

GABIONS				
Type	L	W	D	Mark
A	6	3	3	2
B	9	3	3	8
C	12	3	3	1
D	6	3	1½	7
E	9	3	1½	4
F	12	3	1½	9
G	6	3	1	27
H	9'	3'	1'	24



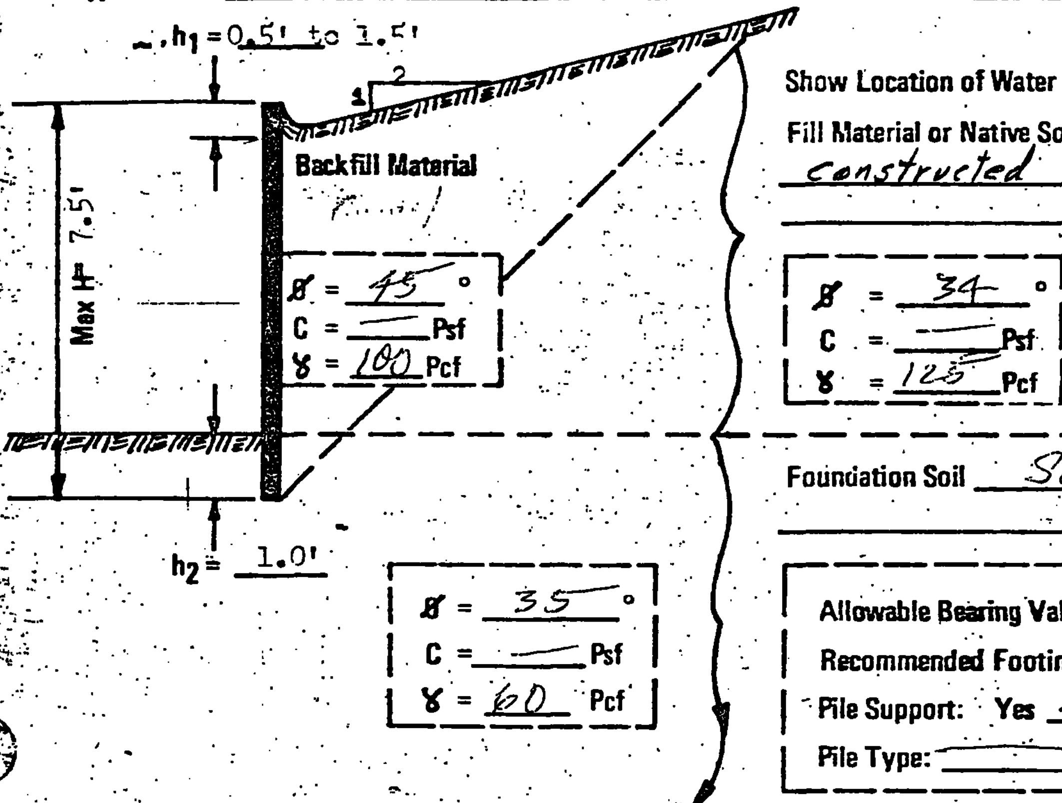
DEPARTMENT OF TRANSPORTATION

RETAINING WALL DATA SHEET

Dist. No. 1 Control Section 1748 SR No. 104 Job No. L-5414 Date May 21,80

Project 25th AveNE Vic to Jct SR 522 Prepared By Arwine/IBI

Wall Type Planned Gabion No. 2



Show Location of Water Table:

Fill Material or Native Soil = Existing embankments constructed with Gravel.

Foundation Soil Sandy Gravel

Allowable Bearing Value: 2.0 Tsf

Recommended Footing Elev. As Shown

Pile Support: Yes — No X

Pile Type: —

ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc.
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

REMARKS-

DOT FORM 351-009
REVISED 10/79

H.F. 26.99 1-66

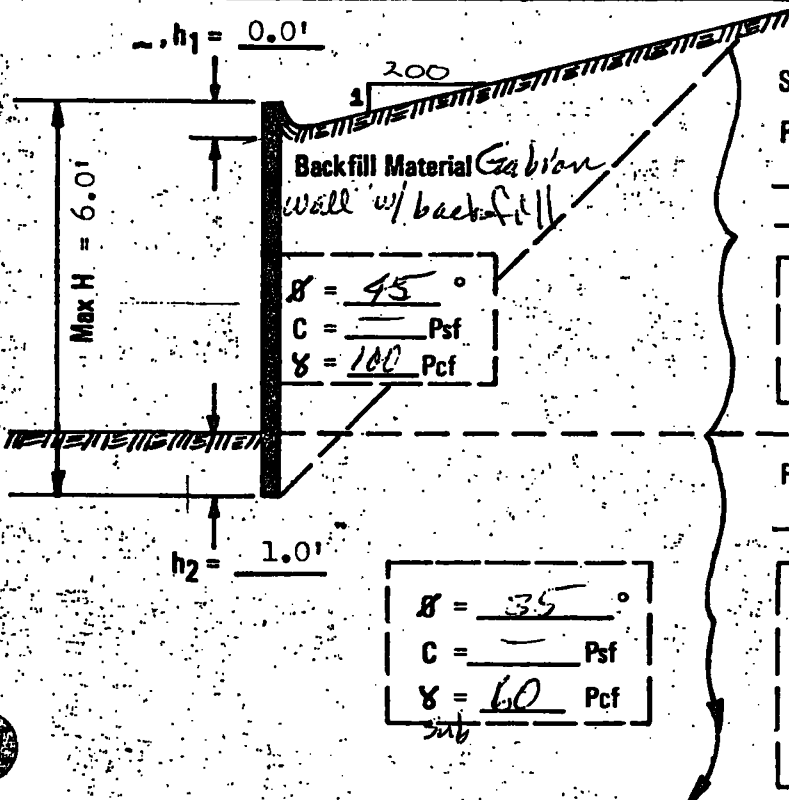
DEPARTMENT OF TRANSPORTATION

RETAINING WALL DATA SHEET

Dist. No.: 1 Control Section 1748 S.R No. 104 Job No. L-5414 Date 5/21/80

Project 25th Ave. N.E. to Jct SR-522 Prepared By Arwine/IBI

Wall Type Planned Gabion No. 3



Show Location of Water Table:

Fill Material or Native Soil = Existing embankments constructed with sand.

Foundation Soil Silty Gravelly Sand

Allowable Bearing Value: 1.0 Tsf

Recommended Footing Elev. As Shown

Pile Support: Yes — No X

Pile Type: —

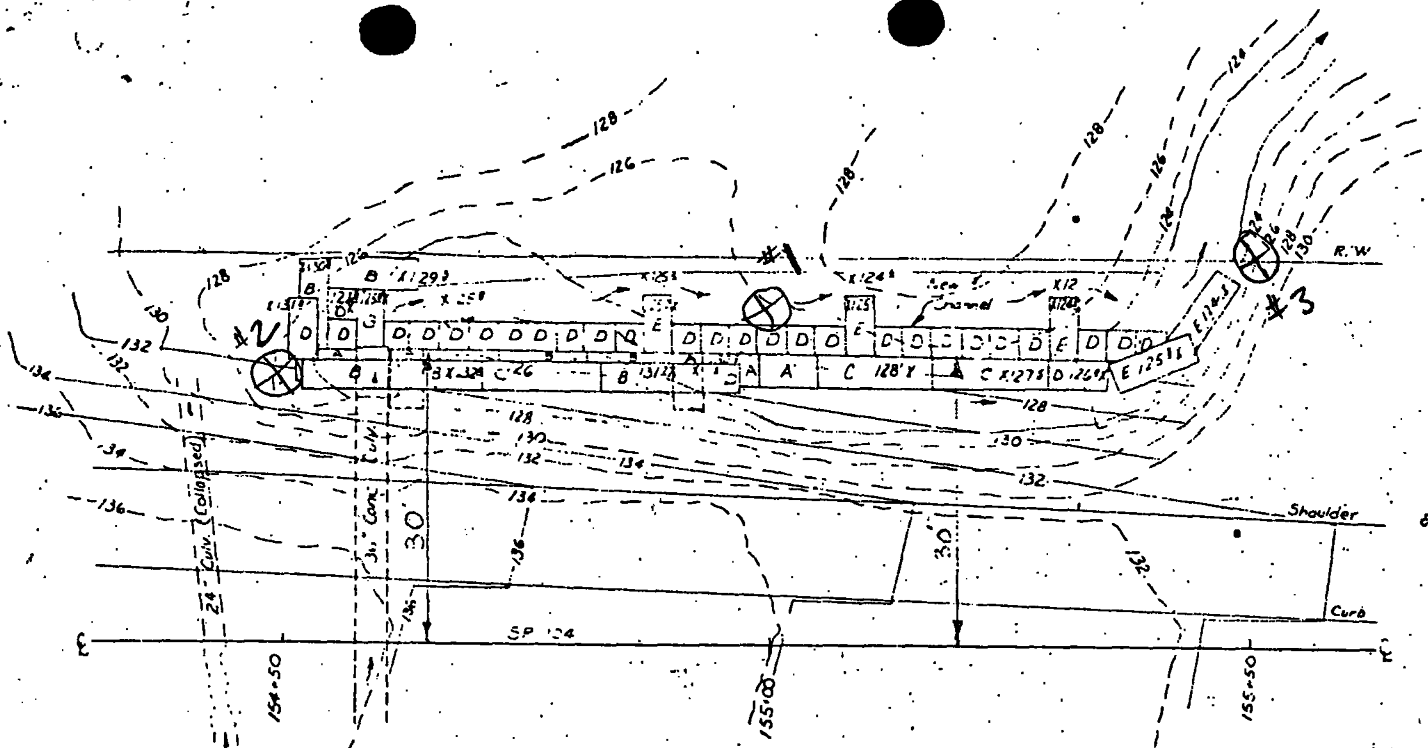
ADDITIONAL SKETCHES REQUIRED:

1. Profile of Complete Retaining Wall
2. Sketch showing location of sewer lines, water mains, etc.
3. Sketch showing type and location of all surcharges (buildings, bridge footings, streets, etc.) located above the proposed footing elevation of the wall within a horizontal distance equal to three times the wall height.
4. Sketch showing all planned drainage (applies to drainage behind wall) and how seepage and runoff are to be handled. Mention if areas of heavy seepage are anticipated.

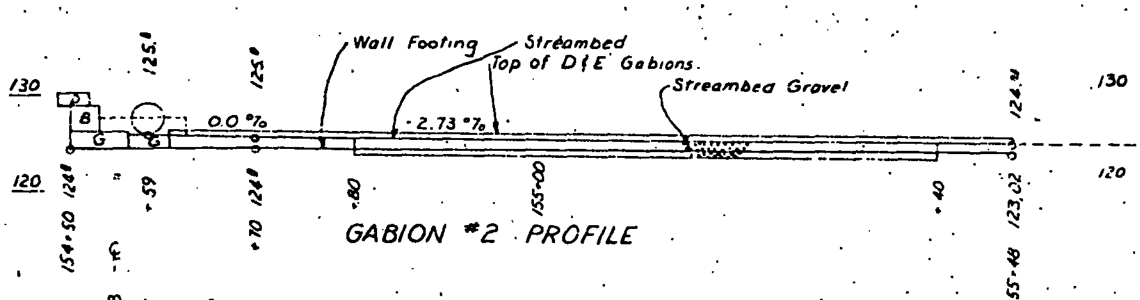
REMARKS-

DOT FORM 351-009 REVISED 10/79

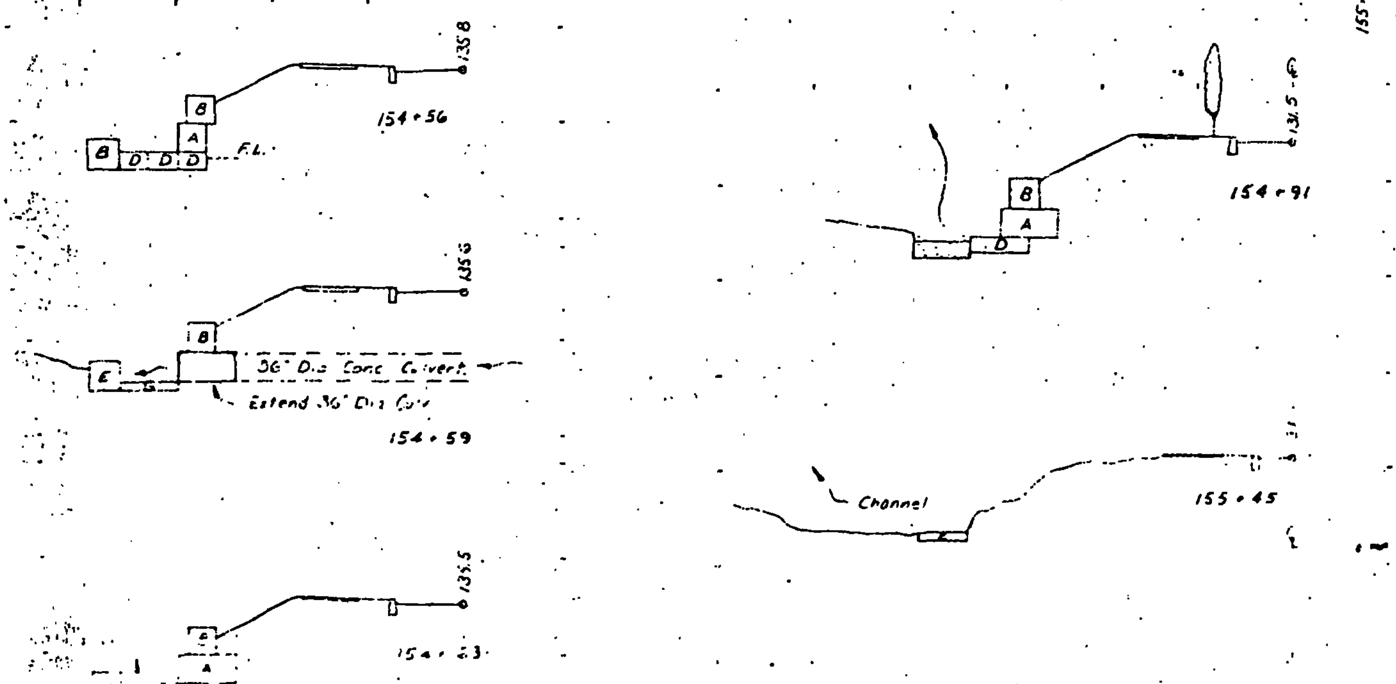
H.F. 26.99 1-66



GABION #2 & CHANNEL PLAN
Scale 1"=10'

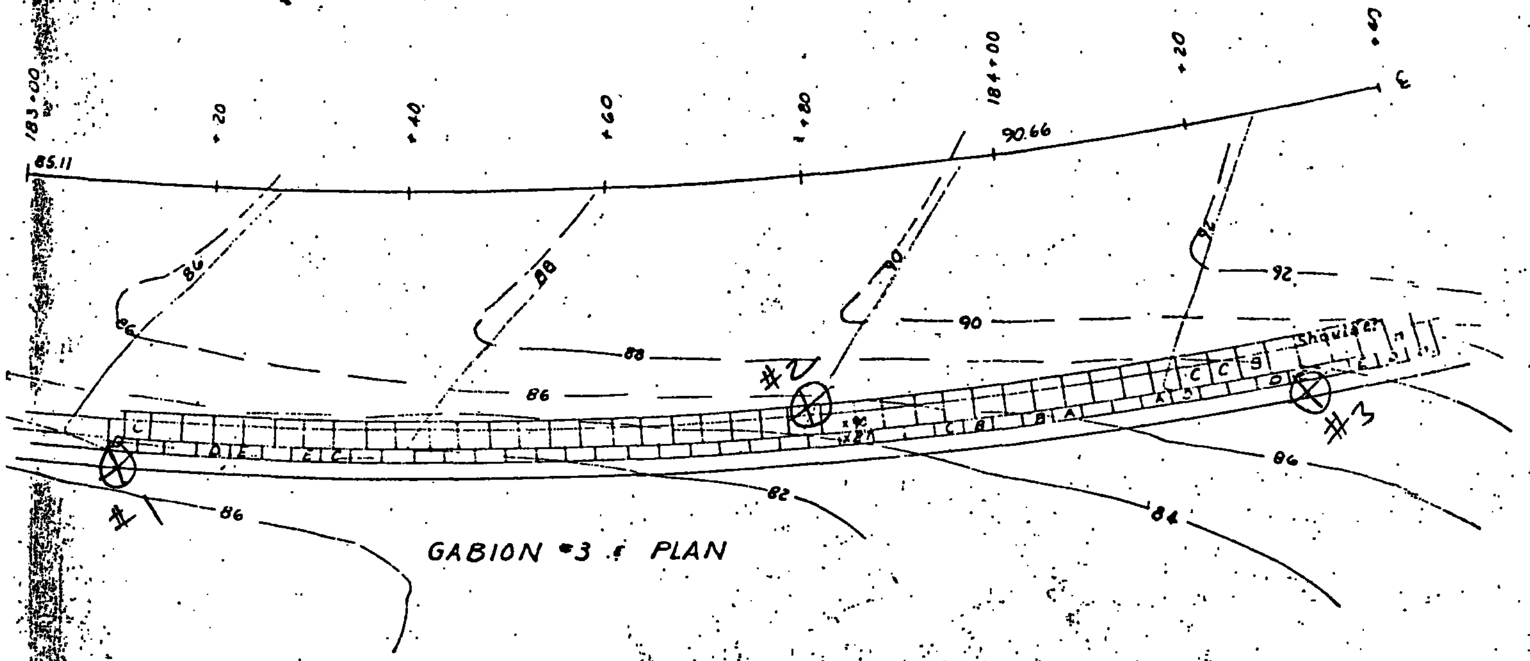


GABION #2 PROFILE

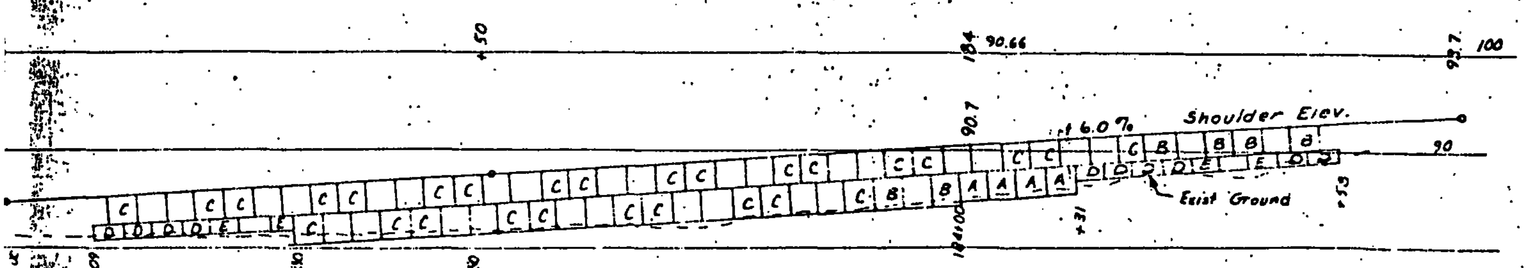


GABION #2 SECTIONS
SR-104

REGION NO.	STATE	FEDERAL AID PROJECT
10	WASH.	



GABION #3 & PLAN



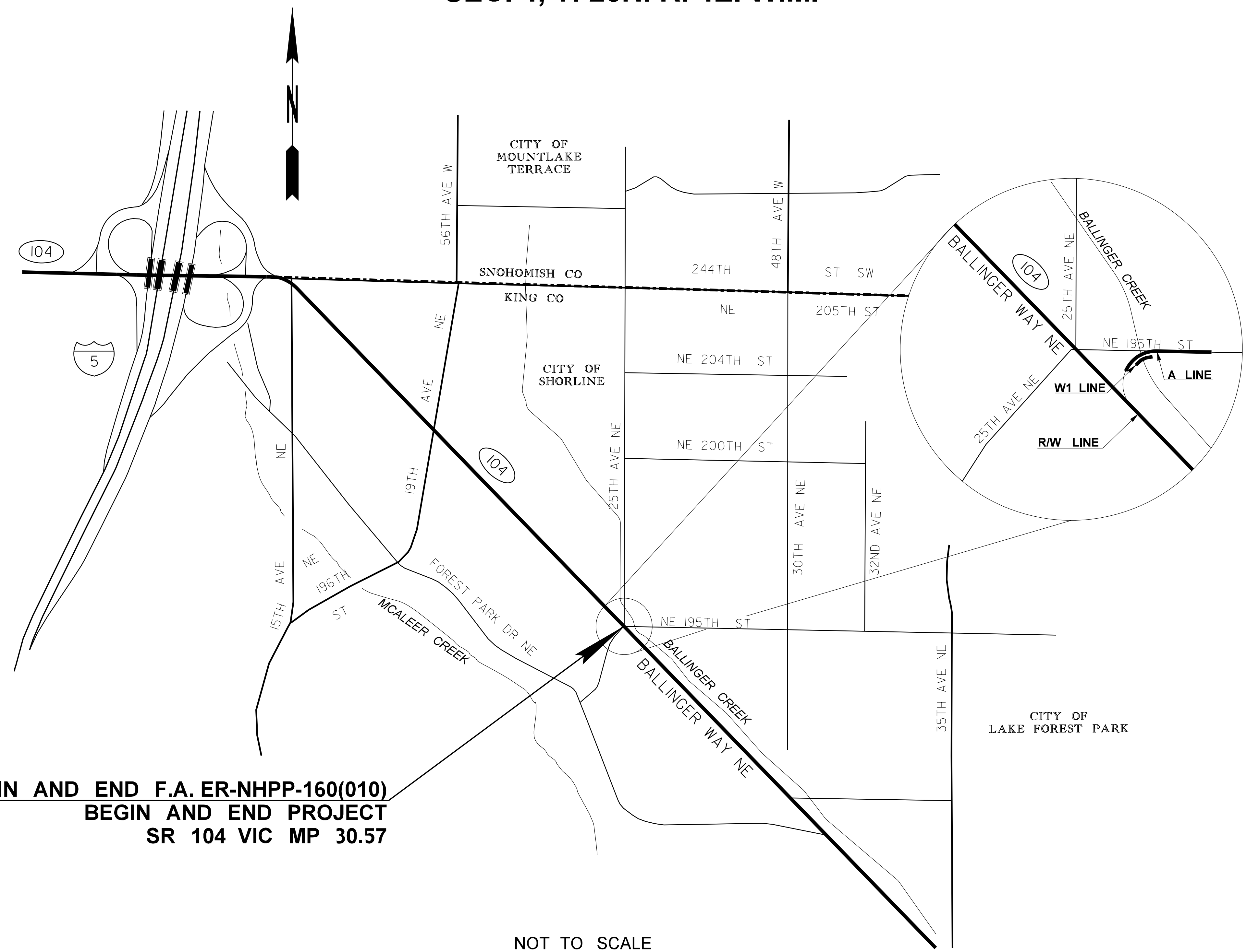
GABION #3 PROFILE

Appendix K.2
Final Design

INDEX

SHEET NO.	PLAN REFERENCE NO.	TITLE
1	VM1	INDEX / VICINITY MAP
2	SQ1	SUMMARY OF QUANTITIES
3	AL1	ALIGNMENT PLAN AND R/W PLAN
4	QTSP1	QUANTITY TABULATION - SITE PREPARATION
5	SP1	SITE PREPARATION PLAN
6	TSD1	TEMPORARY STREAM DIVERSION PLAN
7 - 7A	MD1 - MD2	MISCELLANEOUS DETAILS
8	SPP1	SOIL PREPARATION PLAN
9	SPP2	SOIL PREPARATION DETAILS
10	W1	LAYOUT
11	W2	SOLDIER WALL ELEVATION
12	W3	WALL DETAILS
13	W4	CULVERT LAGGING DETAILS
14	TC1	TRAFFIC CONTROL PLAN
15	DT1	DETOUR PLAN
16	PTC1	PEDESTRIAN TRAFFIC CONTOL PLAN

SEC. 4, T. 26N. R. 4E. W.M.



BEGIN AND END F.A. ER-NHPP-160(010)
BEGIN AND END PROJECT
SR 104 VIC MP 30.57

NOT TO SCALE

PLAN REFERENCE NO.
SHEET OF SHEETS

NOTE: ALL SHEET REFERENCES, FIRST NOS. OF STRUCTURE CODE DESIGNATIONS AND MATCH LINE SHEET REFERENCES, ETC., THROUGHOUT THE PLANS, REFER TO THE ENTRY IN THE PLAN REFERENCE NUMBER BOX.

NOTE:

1. FOR DETOURS, SEE SHEET DT1.

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DATE	6/23/2016			
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DESIGNED BY	K. PECHA			
ENTERED BY	K. PECHA			
CHECKED BY	S.N. WENDT			
PROJ. ENGR.	J. CHI			
REGIONAL ADM.	L. ENG	REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	ER-NHPP-160(010)
JOB NUMBER 16A009		
CONTRACT NO.		LOCATION NO.

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

INDEX / VICINITY MAP

Plot 1
PLAN REF. NO. VM1
SHEET 1 OF 16 SHEETS

SUMMARY OF QUANTITIES

ITEM NO	TOTAL QUANTITY	SUB-TOTAL * SECTION I-07.2(1) OF STANDARD SPECS	SUB-TOTAL ** SECTION I-07.2(2) OF STANDARD SPECS	STD. ITEM NO.	UNIT	ITEM	GROUP 1 A LINE 10+00.0 TO 11+75.0	GROUP 2 THIRD PARTY DAMAGE
						PREPARATION		
1	LUMP SUM	LUMP SUM		0001	L.S.	MOBILIZATION	L.S.	
2	LUMP SUM	LUMP SUM		0050	L.S.	REMOVAL OF STRUCTURE AND OBSTRUCTIONS	L.S.	
3	0.10	0.10		0025	ACRE	CLEARING AND GRUBBING	0.10	
4	2000.00	2000.00		0254	DOL	REMOVING SOLDIER PILE SHAFT OBSTRUCTIONS	2,000.00	
						GRADING		
5	30.00	30.00		0310	C.Y.	ROADWAY EXCAVATION INCL. HAUL	30.00	
						DRAINAGE		
6	5000.00	5000.00		3076	DOL	FISH EXCLUSION	5,000.00	
7	32000.00	32000.00			DOL	TEMPORARY STREAM DIVERSION	32,000.00	
						STRUCTURE		
8	LUMP SUM	LUMP SUM		4013	L.S.	SHORING OR EXTRA EXCAVATION CL. A	L.S.	
9	5.00	5.00		4025	C.Y.	GRAVEL BACKFILL FOR WALL	5.00	
10	180.00	180.00		4047	L.F.	SHAFT - 24 IN. DIAMETER	180.00	
11	178.00	178.00		4053	L.F.	FURNISHING SOLDIER PILE W12X106	178.00	
12	481.00	481.00		4299	S.F.	LAGGING	481.00	
						EROSION CONTROL AND ROADSIDE PLANTING		
13	5.00	5.00		6403	DAY	ESC LEAD	5.00	
14	1.00	1.00		6471	EACH	INLET PROTECTION	1.00	
15	68.00	68.00		6470	HR	STREET CLEANING	68.00	
16	84.00	84.00		6502	L.F.	COIR LOG	84.00	
17	20000.00	20000.00		6490	DOL	EROSION/WATER POLLUTION CONTROL	20,000.00	
18	0.10	0.10		6414	ACRE	SEEDING, FERTILIZING, AND MULCHING	0.10	
19	220.00	220.00		6630	L.F.	HIGH VISIBILITY FENCE	220.00	
20	123.00	123.00			S.Y.	SOIL AMENDMENT	123.00	
21	5.00	5.00			S.Y.	TOPSOIL TYPE A	5.00	
						TRAFFIC		
22	LUMP SUM	LUMP SUM		6971	L.S.	PROJECT TEMPORARY TRAFFIC CONTROL	L.S.	
23	LUMP SUM	LUMP SUM		6869	L.S.	PEDESTRIAN TRAFFIC CONTROL	L.S.	
						OTHER ITEMS		
24	10.00	10.00		7015	C.Y.	CONTROLLED DENSITY FILL	10.00	
25	LUMP SUM	LUMP SUM		7037	L.S.	STRUCTURE SURVEYING	L.S.	
26	LUMP SUM	LUMP SUM		7038	L.S.	ROADWAY SURVEYING	L.S.	
27	40.00	40.00		7086	L.F.	CHAIN LINK FENCE TYPE 6	40.00	
28	5000.00	5000.00		7480	DOL	ROADSIDE CLEANUP	5,000.00	
29	5.00	5.00		7725	DOL	REIMBURSEMENT FOR THIRD PARTY DAMAGE		5.00
30	-1.00	-1.00		7728	DOL	MINOR CHANGE	-1.00	
31	-1.00	-1.00		7732	DOL	AGGREGATE COMPLIANCE PRICE ADJUSTMENT	-1.00	
32	LUMP SUM	LUMP SUM		7736	L.S.	SPCC PLAN	L.S.	
33	45.00	45.00			L.F.	TEMPORARY CONSTRUCTION FENCE	45.00	

GROUP LEGEND :

GROUP NUMBER	SR	CONTROL SECTION	TAX SCHEDULE	FUND PARTICIPANTS
1	104	174801	*	FEDERAL,STATE
2	104	174801	*	STATE

DATE	REVISION	BY	REGION	STATE	FEDERAL AID PROJECT. NO.
			10	WA	ER-NHPP-1604(010)

JOB NUMBER 16A009/2

CONTRACT NO 000000

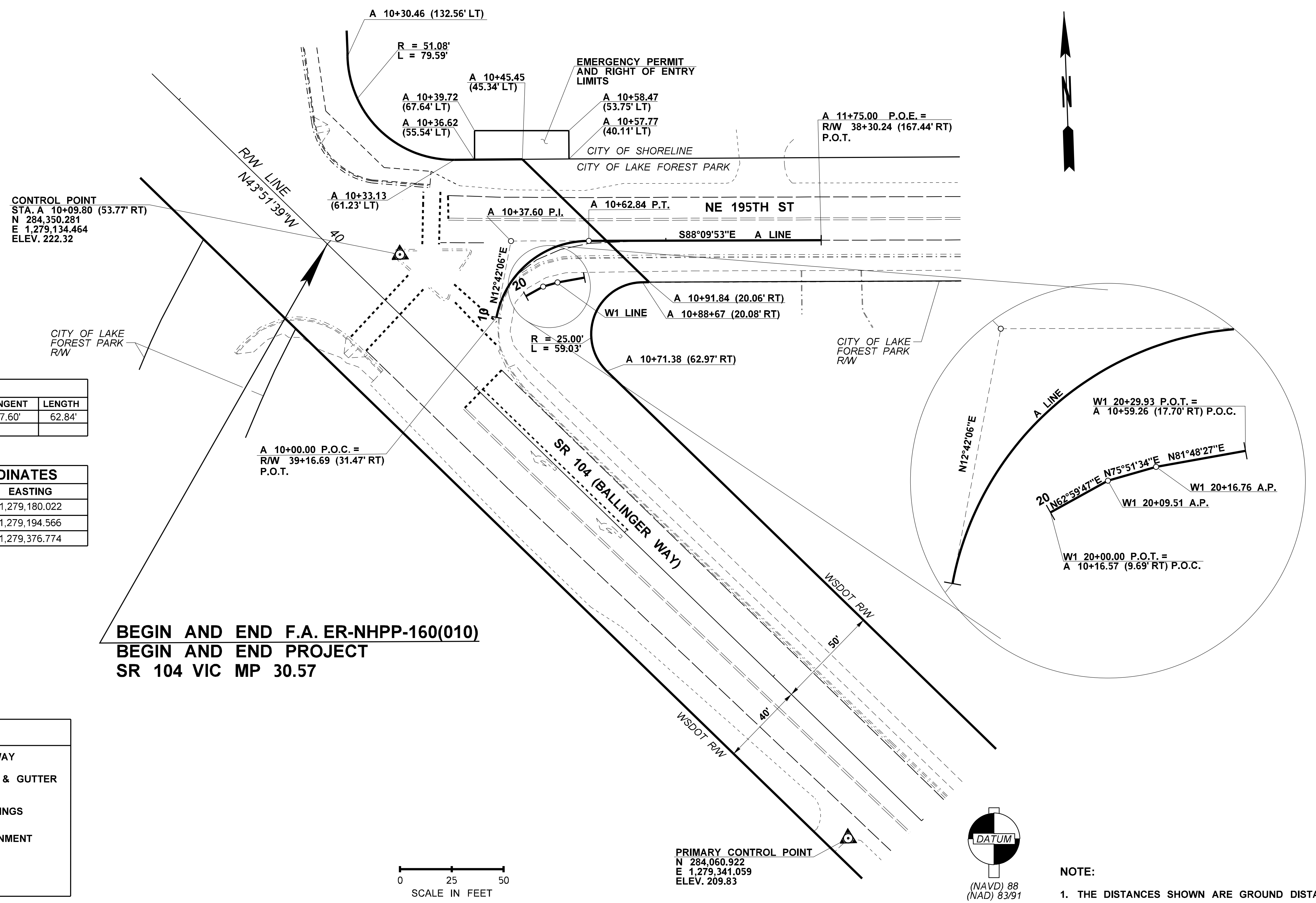
Washington State
Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

SUMMARY OF QUANTITIES

SQ1

SHEET 2 OF 16 SHEETS



CURVE DATA

P.I. STATION	DELTA	RADIUS	TANGENT	LENGTH
A 10+37.60	79°08'01" RT	45.50'	37.60'	62.84'

BEGINNING ALIGNMENT COORDINATES

STATION	NORTHING	EASTING
A 10+00.00	284,318.273	1,279,180.022
W1 20+00.00	284,328.072	1,279,194.566
R/W 36+00.00	284,068.125	1,279,376.774

LEGEND

- EXISTING EDGE OF ROADWAY
- EXISTING SIDEWALK, CURB & GUTTER
- EXISTING PAVEMENT MARKINGS
- 10 NEW CONSTRUCTION ALIGNMENT
- CONTROL POINT

NOTE:

1. THE DISTANCES SHOWN ARE GROUND DISTANCES.

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DATE	6/22/2016			
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DESIGNED BY	S.N. WENDT			
ENTERED BY	S.N. WENDT			
CHECKED BY	J. DAVIES			
PROJ. ENGR.	J. CHI			
REGIONAL ADM.	L. ENG	REVISION	DATE	BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 16A009

CONTRACT NO. | LOCATION NO.

JOHN MOC CHI, STATE OF WASHINGTON, 35642, REGISTERED PROFESSIONAL ENGINEER

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

ALIGNMENT AND R/W PLAN

Plot 1

PLAN REF NO AL1

SHEET 3 OF 16 SHEETS

QUANTITY TABULATION - SITE PREPARATION

NOTE:
THE FIRST NUMBER OF THE "CODE" BELOW REFERS TO THE SHEET NO. OR THE SHEET REFERENCE NO. SHOWING THE CONSTRUCTION FEATURE.

THE SECOND NUMBER REFERS TO THE CONSTRUCTION FEATURE FOUND ON THAT SHEET.

CODE	LOCATION \ UNIT OF MEASURE	REMOVING CHAIN LINK FENCE (FOR INFORMATION ONLY)	REMOVING EXISTING CULVERT PIPE (FOR INFORMATION ONLY)	REMOVING EXISTING CULVERT PIPE COLLAR (FOR INFORMATION ONLY)	REMOVING EXISITNG GABION ROCK WALL (FOR INFORMATION ONLY)		INLET PROTECTION	HIGH VISIBILITY FENCE		CHAIN LINK FENCE TYPE 6	TEMPORARY CONSTRUCTION FENCE						SEE GENERAL NOTES
		L.F.	L.F.	EACH	L.F.		EACH	L.F.		L.F.	L.F.						
SP1-1	A 10+09.9 (7.2' RT) TO A 10+61.4 (15.6' RT)	40								40							1,2
SP1-2	A 10+07.1 (7' RT) TO A 10+63.2 (14' RT)										45						5
SP1-3	A 10+18.4 (14.7' RT) TO A 10+34.0 (25.4' RT)				16												1,6
SP1-4	A 10+32.0 (15.7' RT)			1													1
SP1-5	A 10+32.0 (15.7' RT) TO A 10+25.1 (20.7' RT)		7														1
SP1-6	A 10+73.5 (45.2' RT) TO A 11+07.3 (15.2' RT)							70									4
SP1-7	A 11+60.3 (7' RT)						1										3
SP1-8	A 10+35.2 (41.3' LT) TO A 10+43.5 (57.9' LT)							30									4
SP1-9	A 10+50.1 (53.1' LT) TO A 11+30.7 (29.74' LT)							120									4
	SHEET TOTAL	40	7	1	16		1	220		40	45						
	PROJECT TOTAL	40	7	1	16		1	220		40	45						

GENERAL NOTES:

1. FOR INFORMATION ONLY. PAID FOR AS PART OF THE BID ITEM "REMOVAL OF STRUCTURES AND OBSTRUCTIONS. SEE THE SPECIAL PROVISIONS.
2. SEE SHEET MD1 FOR DETAILS.
3. SEE STD. PLAN I-40.20-00.
4. SEE STD. PLAN I-40.10-01.
5. SEE "CHAIN LINK FENCE AND WIRE FENCE" IN THE SPECIAL PROVISIONS FOR DETAILS.
6. STATIONING SHOWN IS AT THE FRONT FACE OF THE EXISTING WALL.

		DATE	DATE	REVISION	BY
DESIGNED BY	S.N. WENDT				
ENTERED BY	S.N. WENDT				
CHECKED BY	J. DAVIES				
PROJ. ENGR.	J.CHI				
REGION ADM.	L.ENG				

REGION NO.	STATE	FED. AID PROJ. NO.
10	WASH	

JOB NUMBER: 16A009

CONTRACT NO.

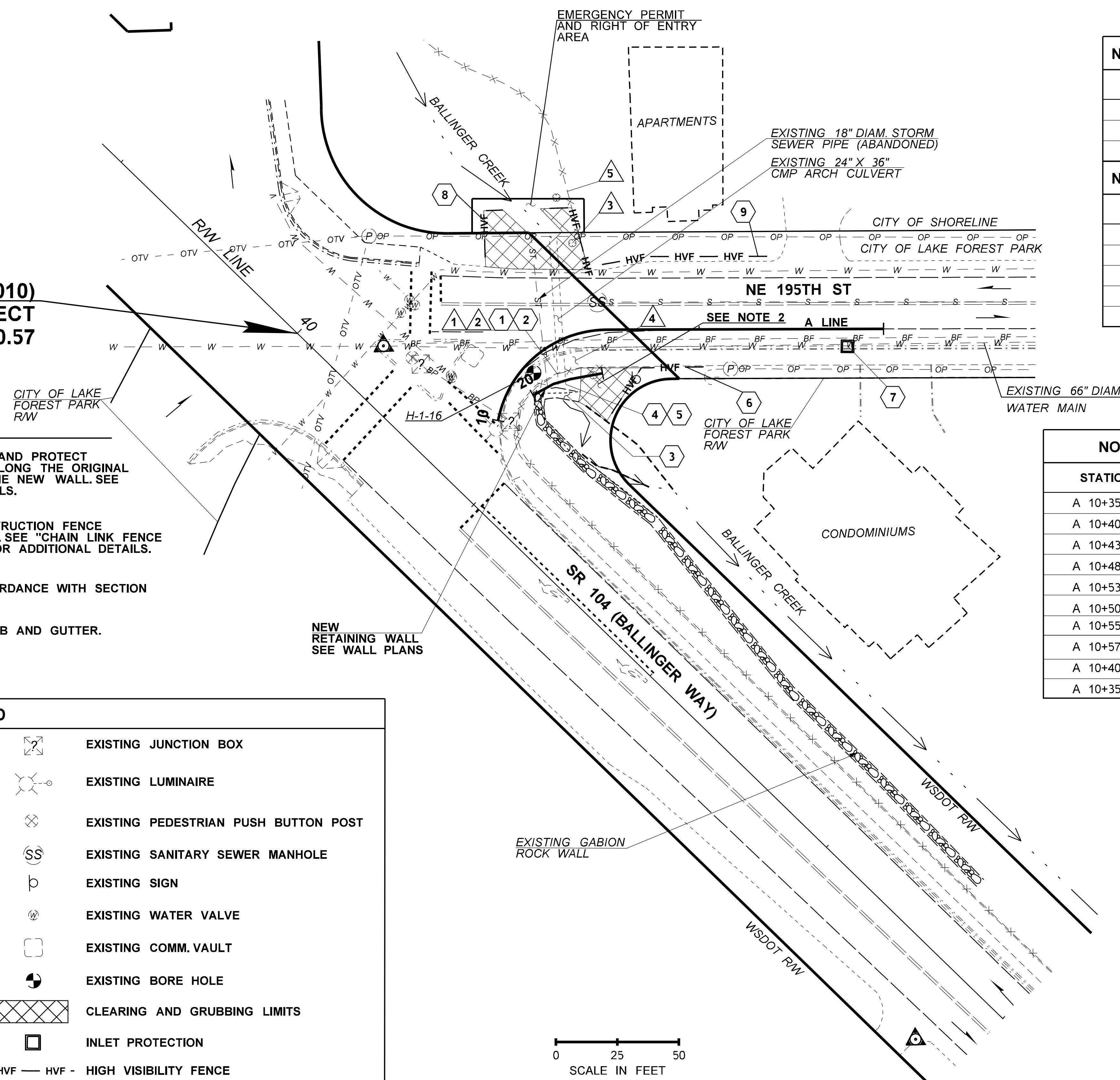
Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

QUANTITY TABULATION - SITE PREPARATION

QTSP 1

SHEET 4 OF 16 SHEETS



CONSTRUCTION NOTES

1. REMOVE EXISITING CHAIN LINK FENCE. PRESERVE AND PROTECT END POSTS. INSTALL CHAIN LINK FENCE TYPE 6 ALONG THE ORIGINAL FENCE ALIGNMENT AFTER THE COMPLETION OF THE NEW WALL. SEE SHEET MD1 FOR CHAIN LINK FENCE TYPE 6 DETAILS.
2. DURING NON-WORKING HOURS, TEMPORARY CONSTRUCTION FENCE SHALL BE INSTALLED TO PROTECT THE DROP-OFF. SEE "CHAIN LINK FENCE AND WIRE FENCE" IN THE SPECIAL PROVISIONS FOR ADDITIONAL DETAILS.
3. PRESERVE AND PROTECT EXISTING TREE IN ACCORDANCE WITH SECTION 1-07.16(2) OF THE STANDARD SPECIFICATIONS.
4. PRESERVE AND PROTECT EXISTING SIDEWALK, CURB AND GUTTER.
5. PRESERVE AND PROTECT EXISTING WOOD FENCE.

LEGEND

Symbol	Description	Symbol	Description
- BF — BF —	EXISTING BURIED FIBER		EXISTING JUNCTION BOX
- W — W —	EXISTING WATER LINE		EXISTING LUMINAIRE
- OTV — OTV -	EXISTING OVERHEAD TV		EXISTING PEDESTRIAN PUSH BUTTON POST
- OP — OP —	EXISTING POWER LINE	SS	EXISTING SANITARY SEWER MANHOLE
- S — S —	EXISTING SANITARY SEWER LINE		EXISTING SIGN
- BP — BP —	EXISTING SANITARY SEWER LINE	W	EXISTING WATER VALVE
	EXISTING STREAM		EXISTING COMM. VAULT
	EXISTING FENCE		EXISTING BORE HOLE
	EXISTING EDGE OF ROADWAY		CLEARING AND GRUBBING LIMITS
	EXISTING SIDEWALK, CURB & GUTTER		INLET PROTECTION
	EXISTING PAVEMENT MARKINGS	- HVF — HVF -	HIGH VISIBILITY FENCE
	EXISTING CATCH BASIN	1	QUANTITY TABULATION CODE
	CONTROL POINT		
P	EXISTING POWER POLE		

HVF LAYOUT SCHEDULE

NORTHWEST SIDE HVF

STATION	OFFSET
A 10+35.2	41.3' LT
A 10+40.4	61.1' LT
A 10+43.5	57.9' LT

SOUTH SIDE HVF

STATION	OFFSET
A 10+59.8	37.3' RT
A 10+76.4	15.6' RT
A 11+07.3	15.2' RT

NORTHEAST SIDE HVF

STATION	OFFSET
A 10+50.1	53.1' LT
A 10+55.9	50.7' LT
A 10+57.6	26.0' LT
A 10+79.4	29.6' LT
A 11+30.7	29.7' LT

CLEARING AND GRUBBING LIMITS

NORTH SIDE

STATION	OFFSET
A 10+35.2	41.3' LT
A 10+40.4	61.1' LT
A 10+43.5	57.9' LT
A 10+48.5	37.1' LT
A 10+53.2	41.9' LT
A 10+50.1	53.1' LT
A 10+55.9	50.7' LT
A 10+57.7	24.8' LT
A 10+40.4	34.3' LT
A 10+35.2	41.3' LT

SOUTHEAST SIDE

STATION	OFFSET
A 10+34.0	25.4' RT
A 10+39.8	22.5' RT
A 10+46.9	13.7' RT
A 10+76.4	15.6' RT
A 10+59.7	37.3' RT
A 10+37.6	28.4' RT
A 10+37.6	25.4' RT

NOTES:

1. FOR ALIGNMENT DETAILS, SEE SHEET AL1.
2. SEE SHEET MD1 FOR FRONT WALL FACE SLOPE DETAILS.

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DATE	6/22/2016
PLOTTED BY	wendts
DESIGNED BY	S.N. WENDT
ENTERED BY	S.N. WENDT
CHECKED BY	J. DAVIES
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 16A009

CONTRACT NO. | LOCATION NO.

JOHN MOC CHI — STATE OF WASHINGTON — 35642 REGISTERED PROFESSIONAL ENGINEER

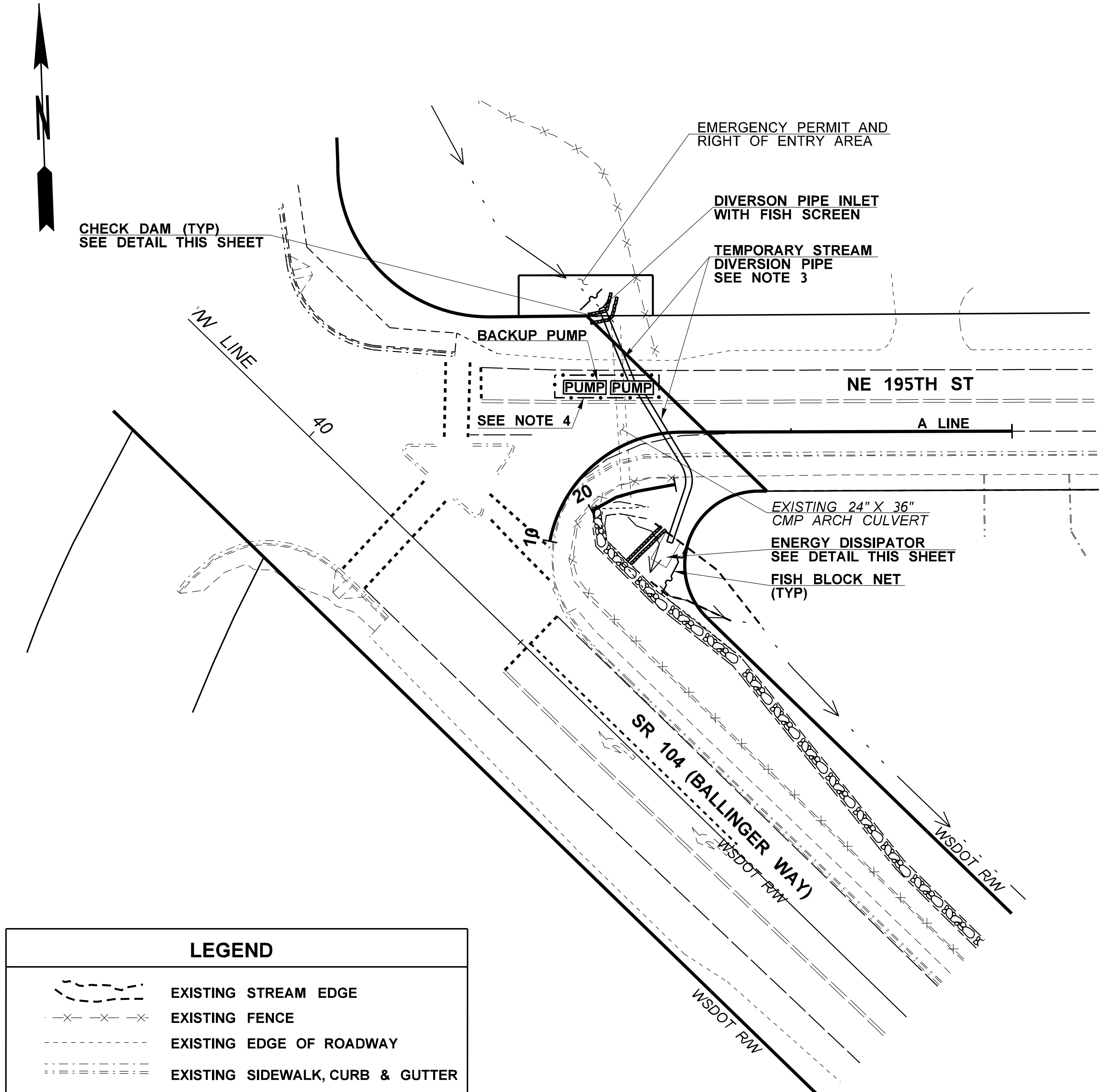
P.E. STAMP BOX — DATE | P.E. STAMP BOX — DATE

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

SITE PREPARATION PLAN

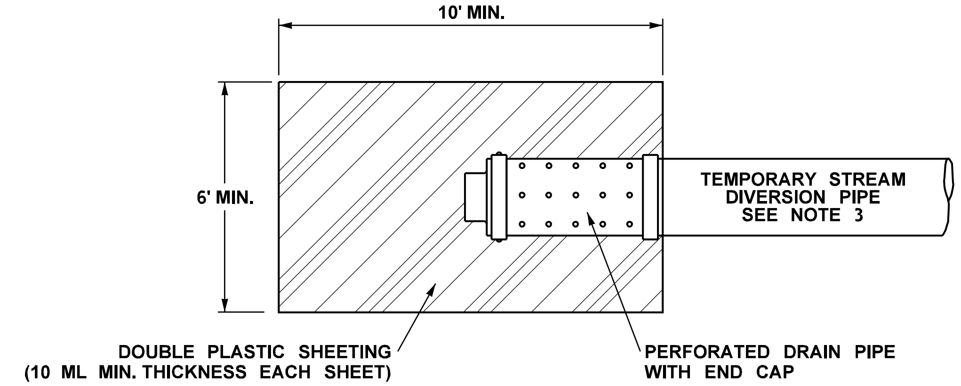
Plot 1 | PLAN REF NO SP1 | SHEET 5 OF 16 SHEETS



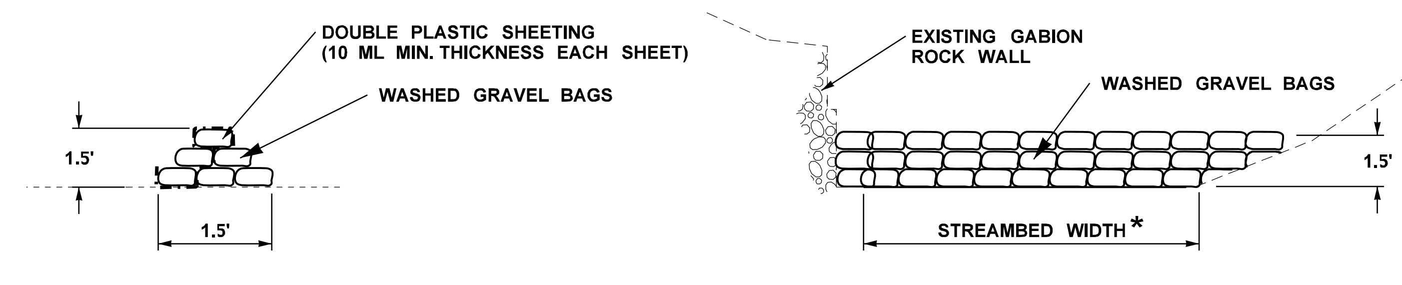
LEGEND

- EXISTING STREAM EDGE
- EXISTING FENCE
- EXISTING EDGE OF ROADWAY
- EXISTING SIDEWALK, CURB & GUTTER
- EXISTING PAVEMENT MARKINGS
- EXISTING STREAM
- CITY R/W
- EXISTING GABION ROCK WALL
- TEMPORARY NOISE SHIELD

0 25 50
SCALE IN FEET

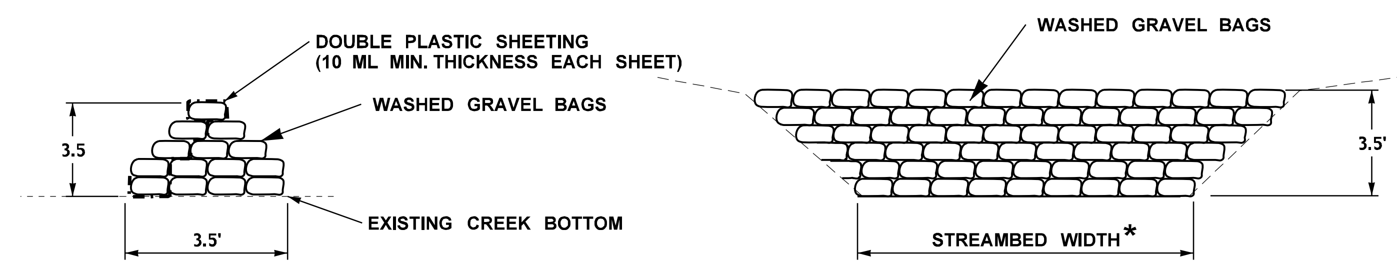


ENERGY DISSIPATOR DETAILS
NOT TO SCALE



* STREAMBED WIDTH TO BE FIELD VERIFIED

DOWNSTREAM CHECK DAM DETAILS
NOT TO SCALE



UPSTREAM CHECK DAM DETAILS
NOT TO SCALE

* STREAMBED WIDTH TO BE FIELD VERIFIED

NOTES:

1. CHECK DAMS SHALL NOT BE REMOVED UNTIL THERE WILL BE NO INCREASE IN TURBIDITY CAUSED BY THE RELEASED WATER. TURBID WATER CAUSED BY REWATERING THE THALWEG SHALL BE TREATED OR INFILTRATED UPLAND.
2. ALL TEMPORARY STREAM DIVERSION MATERIALS TO BE REMOVED FROM STREAM AT CONCLUSION OF WORK.
3. PUMPS AND STREAM DIVERSION PIPE SHALL BE ABLE TO ACCOMMODATE THE 2 YEAR STORM EVENT (57 CFS) FOR BALLINGER CREEK. SEE "TEMPORARY STREAM DIVERSION" IN THE SPECIAL PROVISIONS FOR ADDITIONAL DETAILS NOT SHOWN.
4. SEE SHEET MD2 FOR TEMPORARY NOISE SHIELD DETAILS. SEE "TEMPORARY NOISE SHIELDS' IN THE SPECIAL PROVISIONS FOR PLACEMENT TIMES.

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DATE	6/22/2016
PLOTTED BY	wendts
DESIGNED BY	S.N. WENDT
ENTERED BY	S.N. WENDT
CHECKED BY	J. DAVIES
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION	DATE	BY

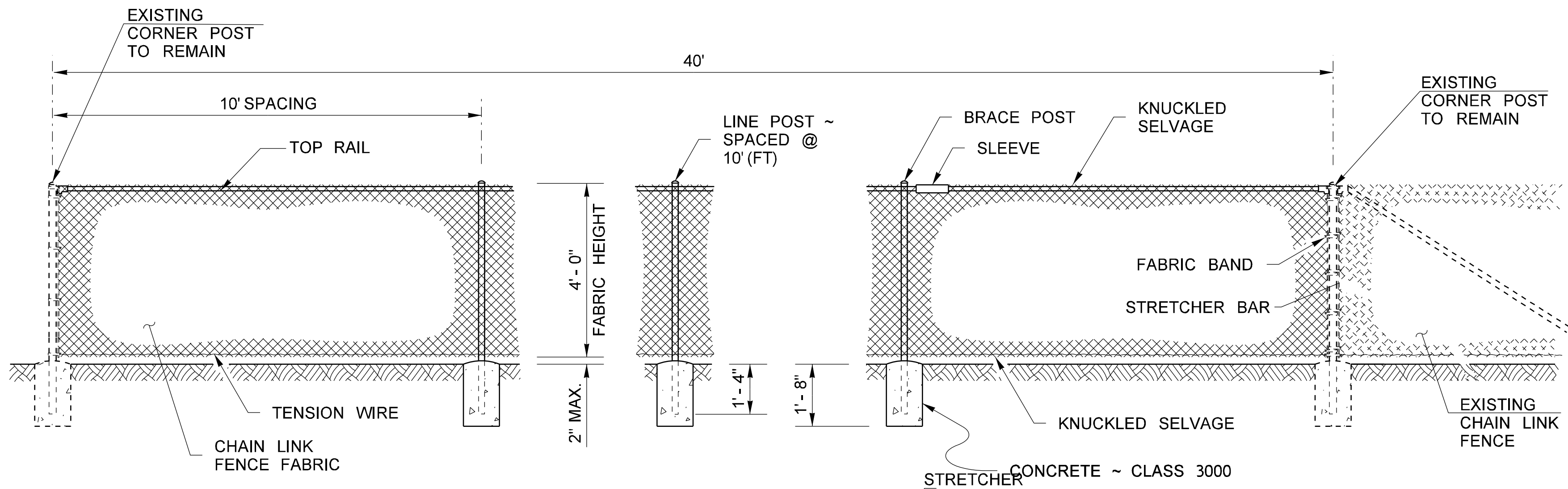
REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.
JOB NUMBER 16A009
CONTRACT NO. | LOCATION NO.

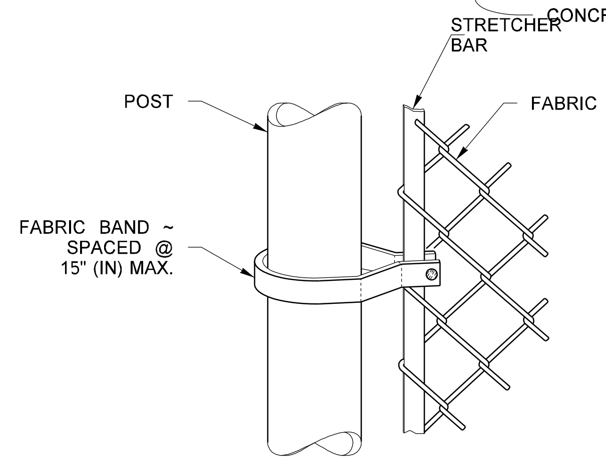
JOHN MOC CHI — STATE OF WASHINGTON — 35642 REGISTERED PROFESSIONAL ENGINEER
P.E. STAMP BOX — DATE
P.E. STAMP BOX — DATE

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR
TEMPORARY STREAM DIVERSION PLAN

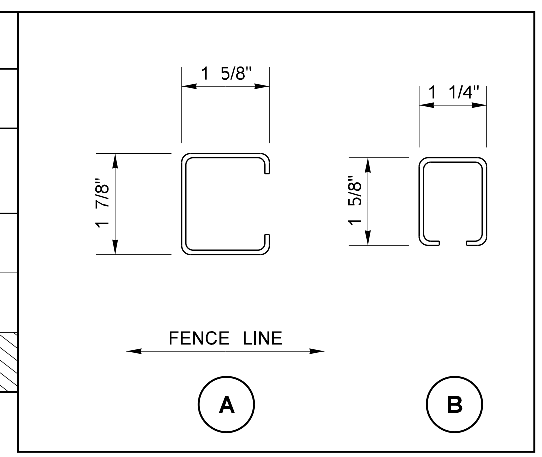
Plot 1
PLAN REF NO TSD1
SHEET 6 OF 16 SHEETS





METHOD OF FASTENING STRETCHER BAR TO POST
(SHOWN FOR ROUND POST)

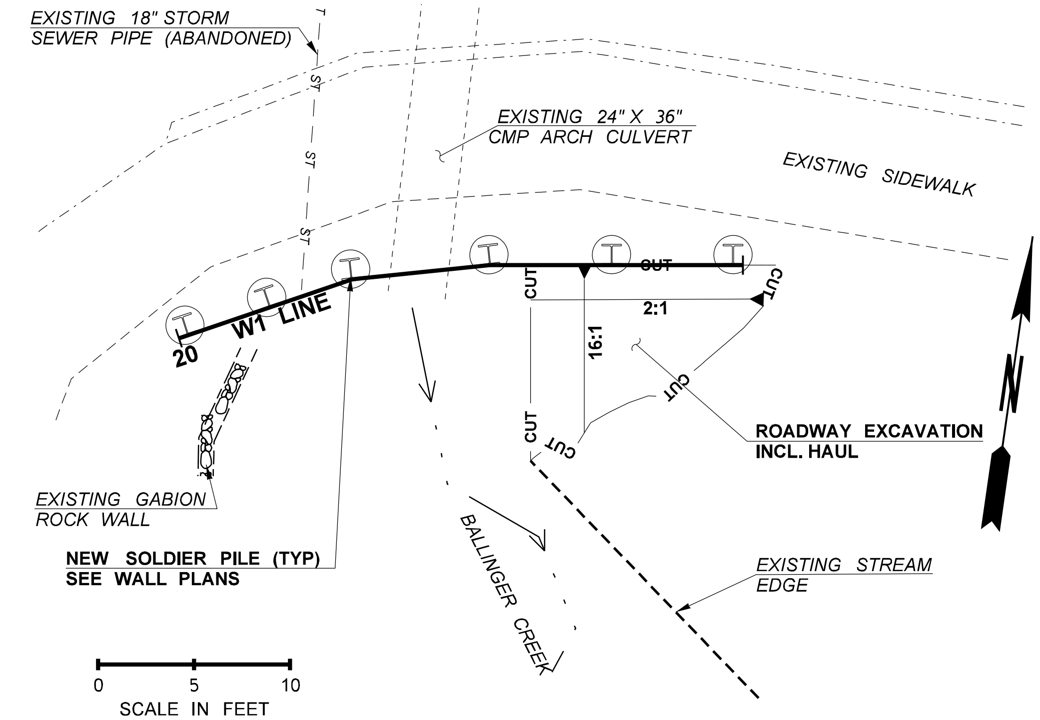
POST AND RAIL SPECIFICATIONS			
MEMBER	PIPE	CONC.	
	NOM. SIZE (SCH. 40)	SECTION	WEIGHT (LB./FT.)
LINE OR BRACE POST	2" DIAM.	A	2.40
BRACE OR TOP RAIL	1 1/4" DIAM.	B	1.35
GATE POST	3 1/2" DIAM.		



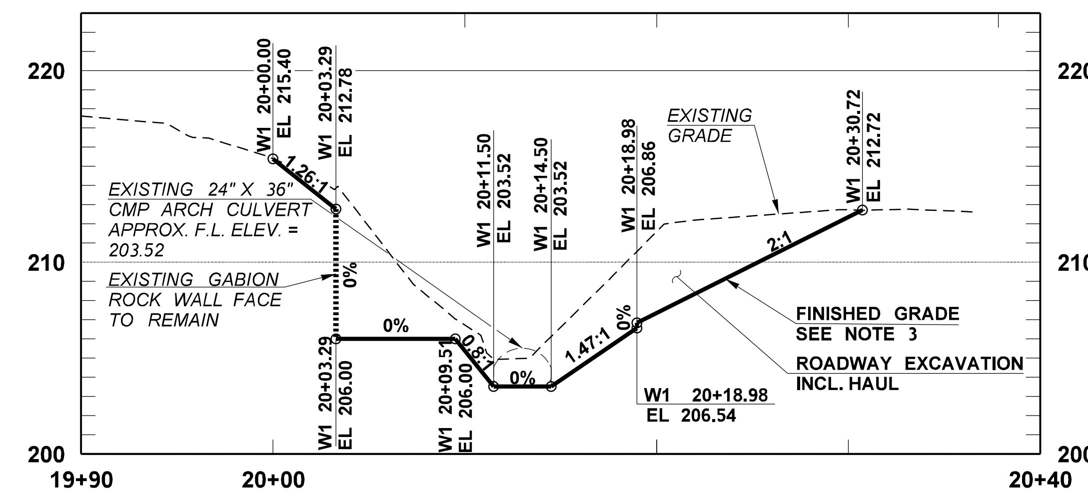
NOTES:

1. ALL CONCRETE POST BASES SHALL BE 10" (IN) MINIMUM DIAMETER.
2. TENSION WIRE SHALL BE PLACED WITHIN THE LIMITS OF THE FIRST FULL FABRIC WEAVE.
3. DETAILS ARE ILLUSTRATIVE AND SHALL NOT LIMIT HARDWARE DESIGN OR POST SELECTION OF ANY PARTICULAR FENCE TYPE.

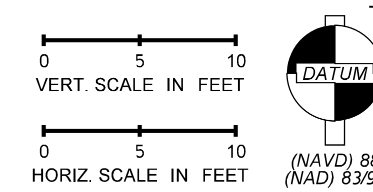
CHAIN LINK FENCE TYPE 6



PLAN



W1 LINE PROFILE



NOTES:

1. SEE WALL PLANS FOR ADDITIONAL DETAILS.
2. SEE SHEET AL1 FOR ALIGNMENT DETAILS.
3. FINISHED GRADE INCLUDES SOIL AMENDMENT DEPTH. SEE SHEETS SPP1-SPP2 FOR DETAILS.

WALL FACE GRADE DETAILS

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DATE	6/23/2016
PLOTTED BY	wendts
DESIGNED BY	S.N. WENDT
ENTERED BY	S.N. WENDT
CHECKED BY	J. DAVIES
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 16A009

CONTRACT NO. | LOCATION NO.

JOHN MOC CHI — STATE OF WASHINGTON — 35642 — REGISTERED PROFESSIONAL ENGINEER

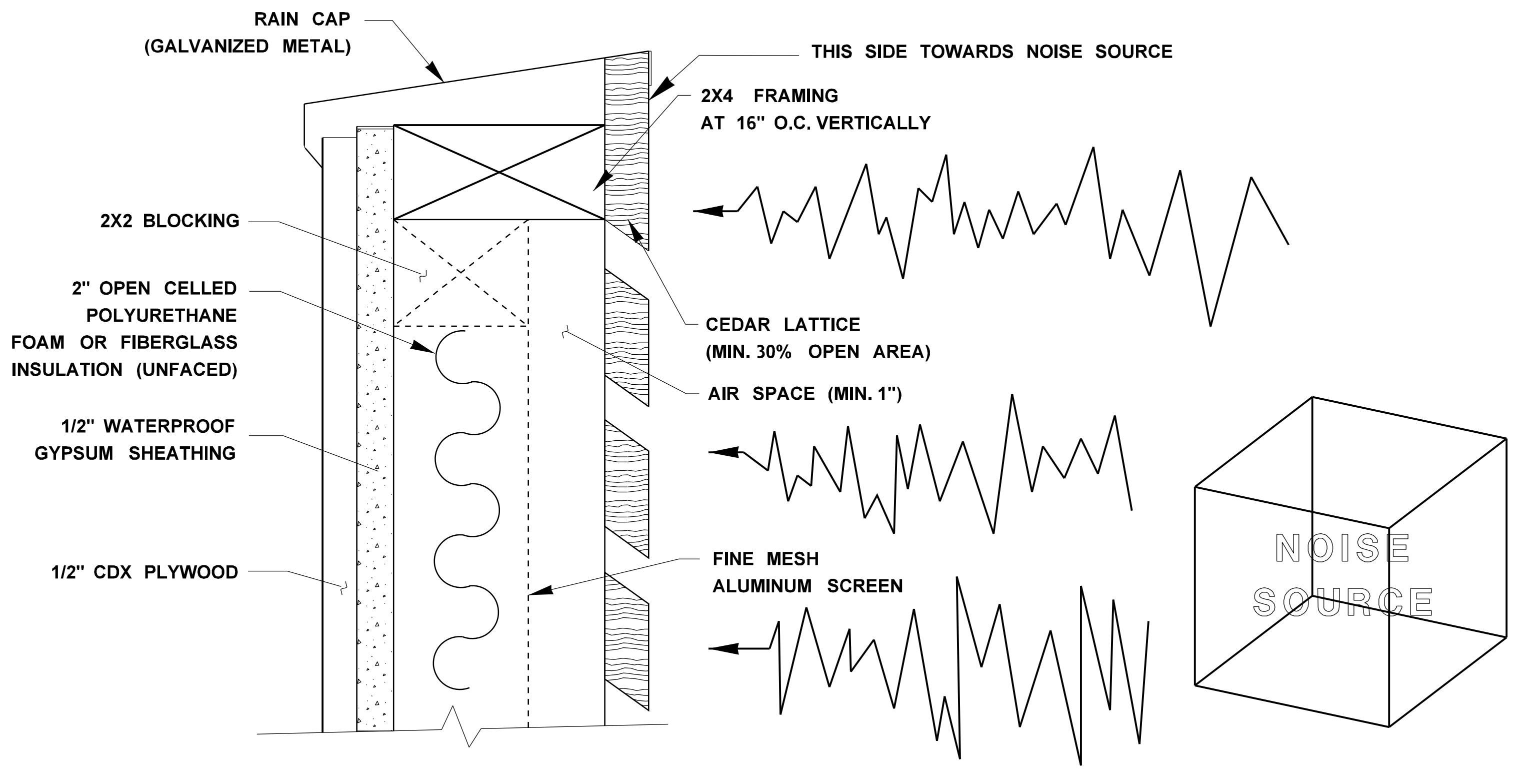
DATE — P.E. STAMP BOX — DATE — P.E. STAMP BOX

Washington State Department of Transportation

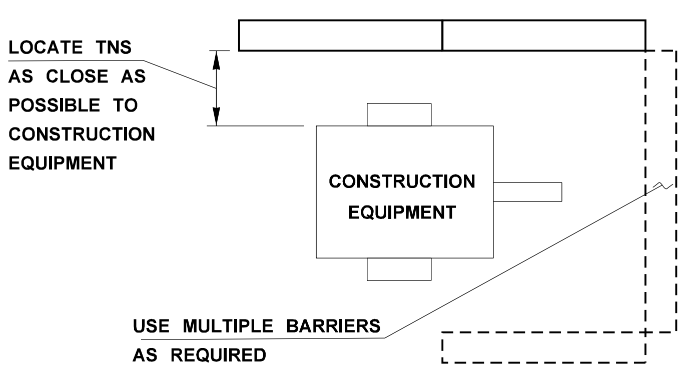
SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

MISCELLANEOUS DETAILS

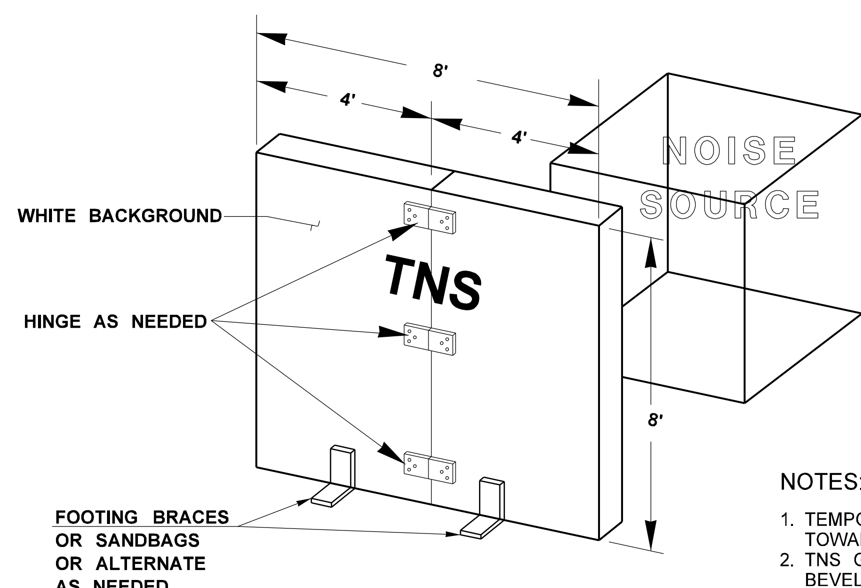
Plot 1
PLAN REF NO MD1
SHEET 7 OF 16 SHEETS



TEMPORARY NOISE SHIELD 8' X 8' (TNS)



PLAN VIEW



TEMPORARY NOISE SHIELDS

TEMPORARY NOISE SHIELD DETAILS

NOT TO SCALE

NOTES:

1. TEMPORARY NOISE SHIELD (TNS) SHALL FACE GRATED SURFACE TOWARD THE CONSTRUCTION EQUIPMENT OR NOISE SOURCE.
2. TNS GRATED SURFACE SHALL BE BUILT USING CEDAR LATTICE OR BEVELED CEDAR GRATING AT 45 DEGREE ANGLE. ALTERNATE MATERIAL SHALL BE APPROVED BY THE ENGINEER.
3. THE TNS SHALL BE CONSTRUCTED IN 8 ft. X 8 ft. UNITS OR AS APPROVED BY THE ENGINEER.
3. WITH APPROVAL OF THE ENGINEER, THE CONFIGURATION OF THE TNS MAY BE ALTERED TO SUIT DIFFERENT WORK ZONE CONDITIONS IF THE ATTENUATION THRESHOLD IS NOT COMPROMISED.
4. THE TNS SHALL BE PLACED AS CLOSE TO THE NOISE SOURCE OR CONSTRUCTION EQUIPMENT AS FEASIBLE.
5. THE TNS SHALL BLOCK THE LINE OF SIGHT BETWEEN THE CONSTRUCTION EQUIPMENT OR NOISE SOURCE AND THE RECEIVER.

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TIME	7:38:50 PM
DATE	6/23/2016
PLOTTED BY	wendts
DESIGNED BY	S.N. WENDT
ENTERED BY	S.N. WENDT
CHECKED BY	J. DAVIES
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION	DATE	BY

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER 16A009		
CONTRACT NO.		LOCATION NO.

JOHN MOC CHI
STATE OF WASHINGTON
35642
REGISTERED
PROFESSIONAL ENGINEER

DATE
P.E. STAMP BOX

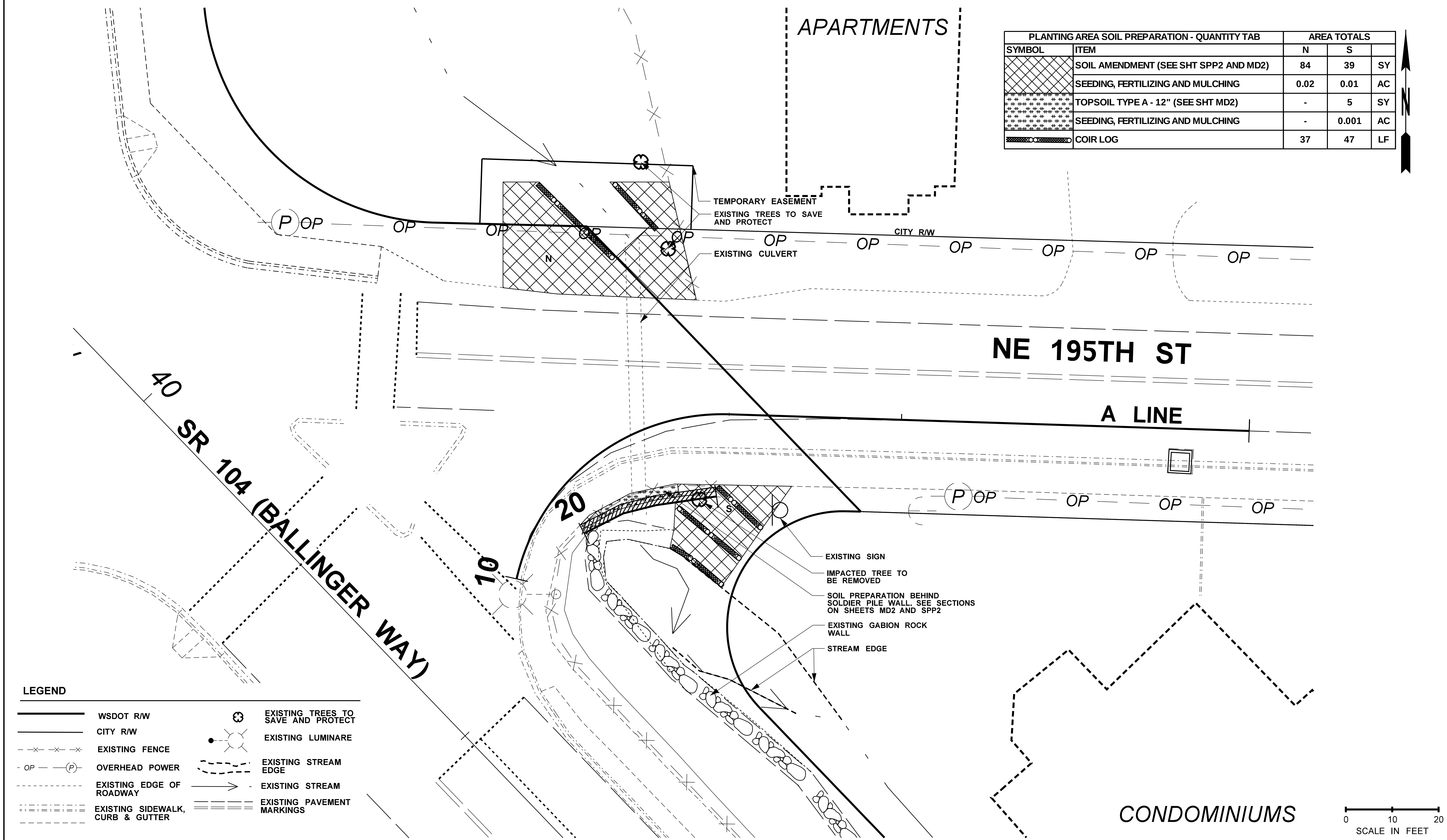
DATE
P.E. STAMP BOX

Washington State
Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

MISCELLANEOUS DETAILS

Plot 2
PLAN REF NO
MD2
SHEET
7A
OF
16
SHEETS



PLANTING AREA SOIL PREPARATION - QUANTITY TAB		AREA TOTALS		
SYMBOL	ITEM	N	S	
	SOIL AMENDMENT (SEE SHT SPP2 AND MD2)	84	39	SY
	SEEDING, FERTILIZING AND MULCHING	0.02	0.01	AC
	TOPSOIL TYPE A - 12" (SEE SHT MD2)	-	5	SY
	SEEDING, FERTILIZING AND MULCHING	-	0.001	AC
	COIR LOG	37	47	LF

FILE NAME	T:\412006\XL5249 SR 104 Gabion Wall CED\CAD\ContractPlans\XL5190_PS_SPP.dgn			
TIME	3:00:06 PM			
DATE	6/23/2016			
PLOTTED BY	floreac			
DESIGNED BY	C.FLOREANI			
ENTERED BY	C.FLOREANI			
CHECKED BY	L.JUNGBLUTH			
PROJ. ENGR.	J.CHI			
REGIONAL ADM.	L.ENG	REVISION	DATE	BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.
JOB NUMBER 164009
CONTRACT NO. | LOCATION NO.

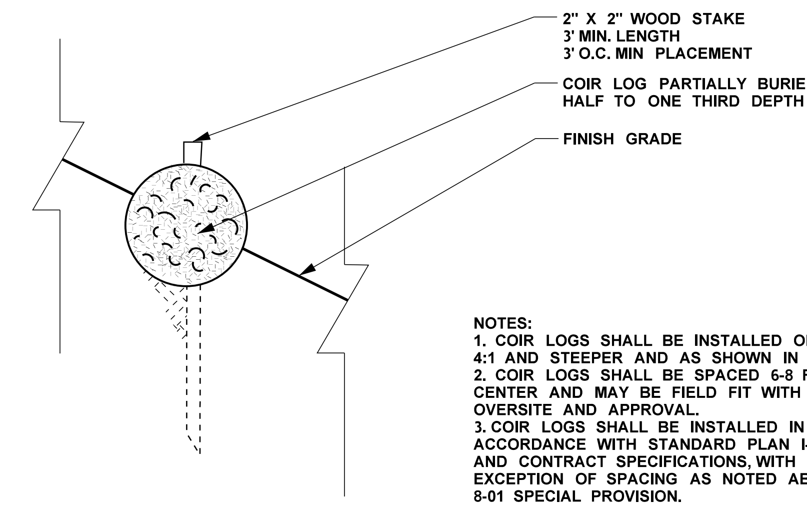
STATE OF WASHINGTON REGISTERED LANDSCAPE ARCHITECT
DAVID S. PETERSON
CERTIFICATE NO. 476
DATE:
EXPIRES: 02/04/2017

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

SOIL PREPARATION PLAN

Plot 1
SPP1
SHEET 8 OF 16 SHEETS

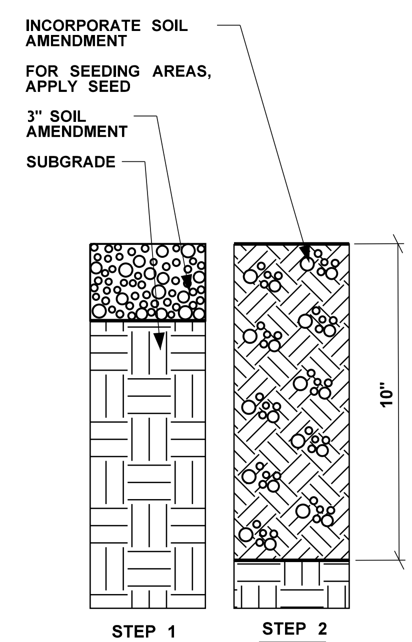


NOTES:
1. COIR LOGS SHALL BE INSTALLED ON SLOPES 4:1 AND STEEPER AND AS SHOWN IN PLANS.
2. COIR LOGS SHALL BE SPACED 6-8 FT ON CENTER AND MAY BE FIELD FIT WITH ENGINEER OVERSITE AND APPROVAL.
3. COIR LOGS SHALL BE INSTALLED IN ACCORDANCE WITH STANDARD PLAN I-30.40-01 AND CONTRACT SPECIFICATIONS, WITH THE EXCEPTION OF SPACING AS NOTED ABOVE. SEE 8-01 SPECIAL PROVISION.

COIR LOG

SECTION VIEW

NTS



PLANTING AREA PREPARATION (SEE SECTION 8-02.3(5) IN THE SPECIAL PROVISIONS)

STEP 1 — PLACE 3" SOIL AMENDMENT (SEE SPECIAL PROVISIONS)

STEP 2 — INCORPORATE SOIL AMENDMENT TO 10" DEPTH ACCORDING TO SECTION 8-02.3(6), SOIL AMENDMENT, IN THE SPECIAL PROVISIONS

PLANTING AREA SOIL PREPARATION - SEQUENCE OF WORK

SECTION VIEW

NOT TO SCALE

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DESIGNED BY	C.FLOREANI				
ENTERED BY	C.FLOREANI				
CHECKED BY	L.JUNGBLUTH				
PROJ. ENGR.	J.CHI				
REGIONAL ADM.	L.ENG	REVISION	DATE	BY	

REGION NO.	STATE	FED.AID PROJ.NO.
10	WASH	
JOB NUMBER 164009		
CONTRACT NO.		LOCATION NO.

STATE OF WASHINGTON
REGISTERED
LANDSCAPE ARCHITECT

DAVID S. PETERSON
CERTIFICATE NO. 476
DATE:
EXPIRES: 02/04/2017

Washington State
Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

SOIL PREPARATION DETAILS

Plot 2

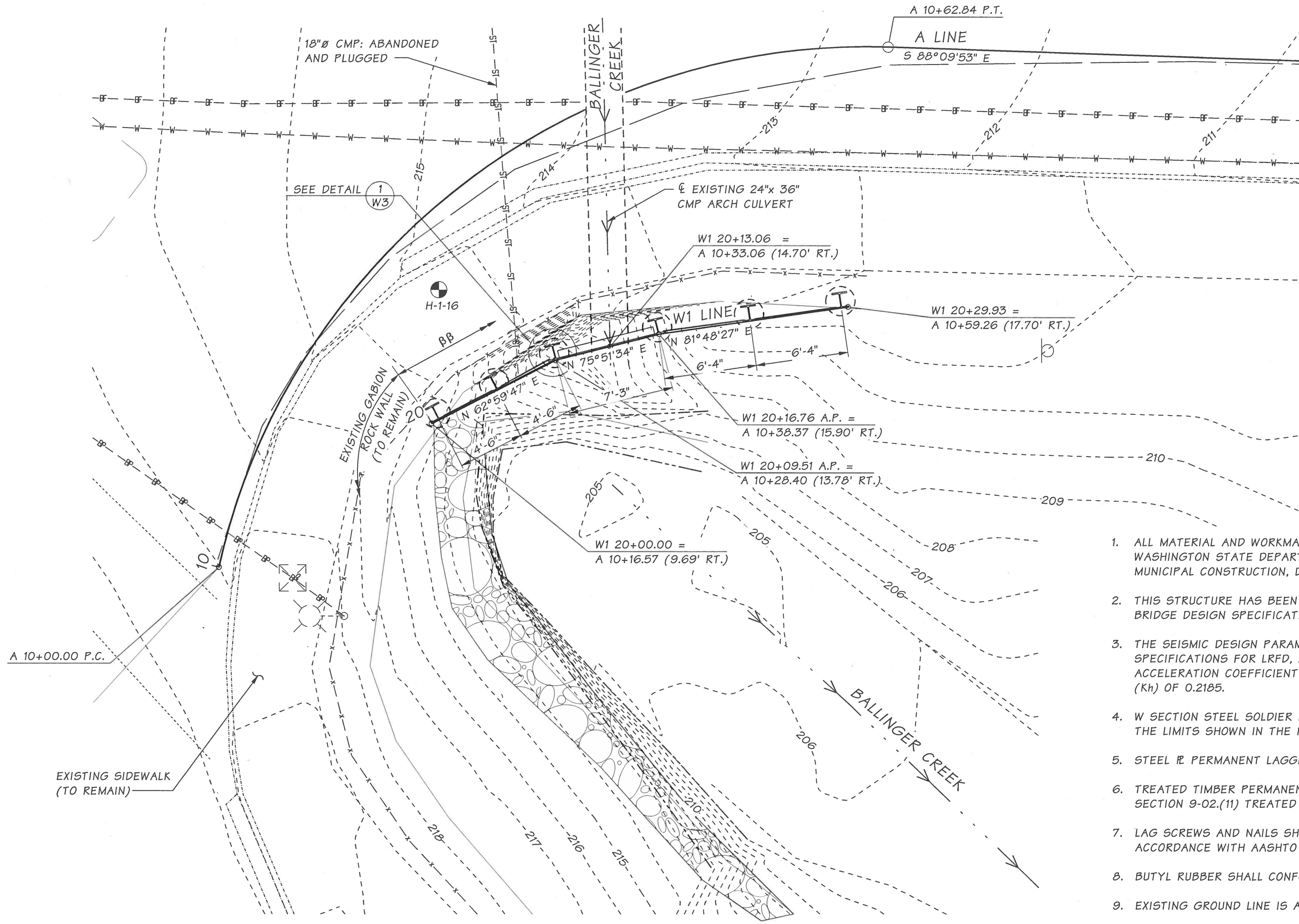
SPP2

SHEET 9 OF 16 SHEETS

CURVE DATA					
P.I. STA.	Δ	RADIUS	TANGENT	LENGTH	BACK TANGENT BEARING
A STA. 10+37.60	79°08'01" RT.	45.50'	37.60'	62.84'	N 12°42'06" E

SECTION 4, T. 26 N, R. 4 E, W. M.
CITY OF LAKE FOREST PARK

SR 104



LEGEND

- (B / W15) IDENTIFIES SECTION OR VIEW — TAKEN OR SHOWN ON BRIDGE SHEET W15
- (1 / —) IDENTIFIES DETAIL — TAKEN OR SHOWN ON THE SAME SHEET
- TEST BORING HOLE

GENERAL NOTES

1. ALL MATERIAL AND WORKMANSHIP SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE WASHINGTON STATE DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR ROAD, BRIDGE AND MUNICIPAL CONSTRUCTION, DATED 2016, AND AMENDMENTS.
2. THIS STRUCTURE HAS BEEN DESIGNED IN ACCORDANCE WITH THE REQUIREMENTS OF THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS - 7TH EDITION - 2014 WITH INTERIMS.
3. THE SEISMIC DESIGN PARAMETERS HAVE BEEN DETERMINED IN ACCORDANCE WITH THE AASHTO GUIDE SPECIFICATIONS FOR LRFD, 2ND EDITION 2011, USING SITE CLASS D, AN EFFECTIVE PEAK GROUND ACCELERATION COEFFICIENT (As) OF 0.437 AND A SEISMIC HORIZONTAL ACCELERATION COEFFICIENT (Kh) OF 0.2185.
4. W SECTION STEEL SOLDIER PILES SHALL CONFORM TO ASTM A992. SOLDIER PILES SHALL BE PAINTED TO THE LIMITS SHOWN IN THE PLANS IN ACCORDANCE WITH SECTION 6-16.3(4).
5. STEEL ℙ PERMANENT LAGGING SHALL CONFORM TO ASTM A 572 GRADE 50.
6. TREATED TIMBER PERMANENT LAGGING SHALL BE DOUGLAS FIR-LARCH GRADE NO. 2 CONFORMING TO SECTION 9-02.(11) TREATED IN ACCORDANCE WITH SECTION 9-09.3.
7. LAG SCREWS AND NAILS SHALL CONFORM TO SECTION 9-06.22, GALVANIZED AFTER FABRICATION IN ACCORDANCE WITH AASHTO M232.
8. BUTYL RUBBER SHALL CONFORM TO SECTION 9.04.10.
9. EXISTING GROUND LINE IS APPROXIMATE AND SHALL BE VERFIED BY THE CONTRACTOR IN THE FIELD.
10. SEE OTHER PLANS FOR FINISH GROUND ELEVATION AT FRONT AND BACK OF THE SOLDIER PILE WALL.

** CONTRACTOR TO FIELD MEASURE STATION AND ELEVATION.

ββ REMOVE DAMAGED GABION ROCK WALL WITH EXTREME CARE WITHOUT DAMAGING THE PORTION OF GABION WALL TO REMAIN.

DATUM

NAVD88

SOLDIER PILE WALL

SR ___ FILE NO. ___ SHEET W1

Bridge Design Engr.	Khaleghi, B		
Supervisor	Zeldenrust, RP		
Designed By	Bedi, G	05/16	
Checked By	O'Leary, M	06/16	
Detailed By	Avery, D	05/16	
Bridge Projects Engr.			
Prelim. Plan By			
Architect/Specialist			

M:\Z-Team\SR 104 GABION WALL REPAIR\window files\LAYOUT SR104 WALL.WND

DATE | REVISION | BY | APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			

JOB NUMBER 16A009

CONTRACT NO.

BRIDGE AND STRUCTURES OFFICE

BIJAN KHALEGHI STATE OF WASHINGTON 27695 STRUCTURAL PROFESSIONAL ENGINEER

Washington State Department of Transportation

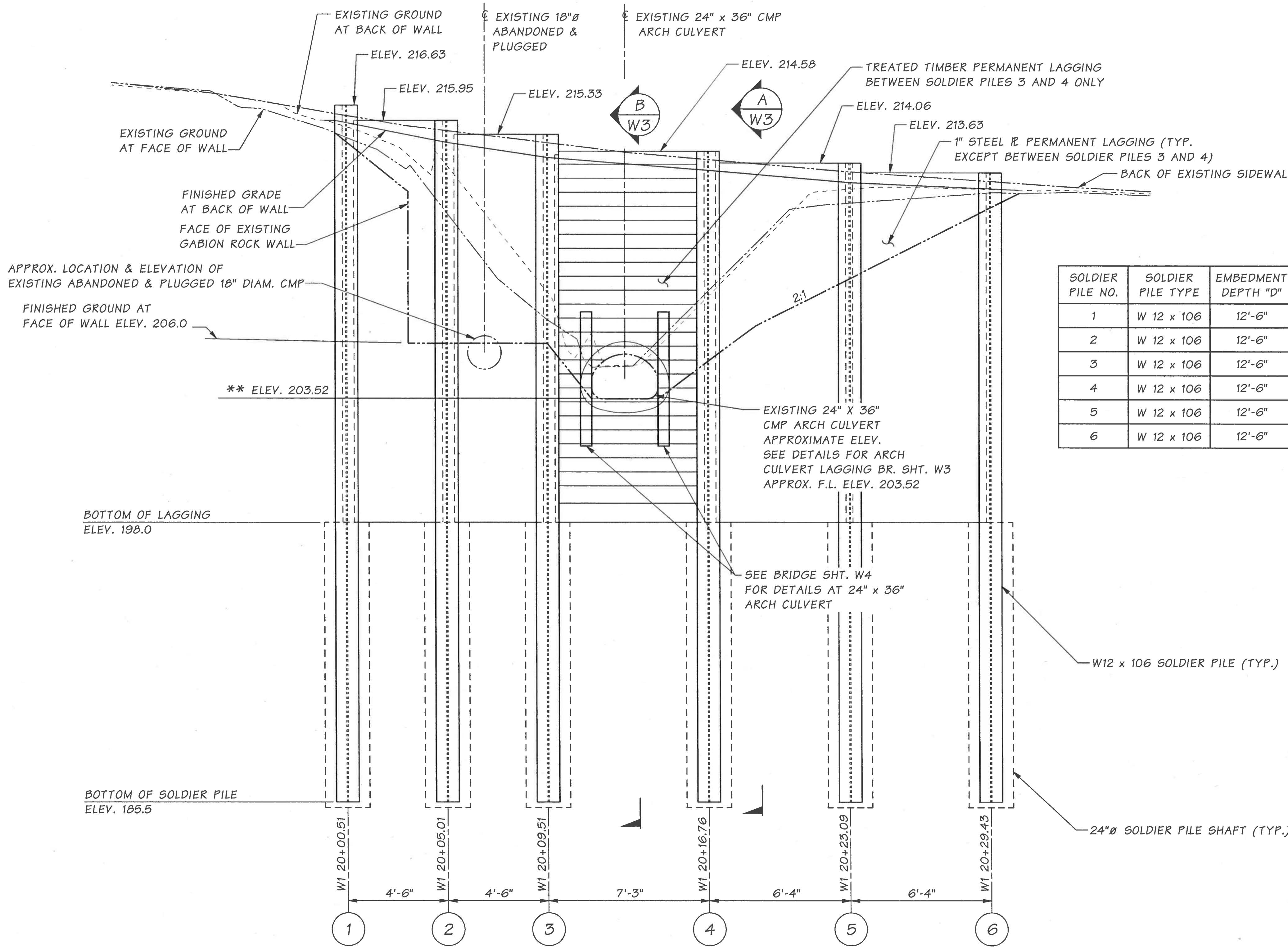
SR 104
NE 195TH ST GABION ROCK WALL EMERGENCY REPAIR

LAYOUT

BRIDGE SHEET NO. W1

SHEET 10 OF 16 SHEETS

Tue Jun 21 11:53:52 2016



SOLDIER PILE NO.	SOLDIER PILE TYPE	EMBEDMENT DEPTH "D"	TOTAL LENGTH OF SOLDIER PILE	SHAFT DIAMETER
1	W 12 x 106	12'-6"	31'-1½"	24"
2	W 12 x 106	12'-6"	30'-5⅜"	24"
3	W 12 x 106	12'-6"	29'-10"	24"
4	W 12 x 106	12'-6"	29'-1"	24"
5	W 12 x 106	12'-6"	28'-6¾"	24"
6	W 12 x 106	12'-6"	28'-1½"	24"

DEVELOPED ELEVATION

** CONTRACTOR TO FIELD MEASURE ELEVATION

SR ___ FILE NO. ___ SHEET W2

Bridge Design Engr.	Khaleghi, B	
Supervisor	Zeldenrust, RP	
Designed By	Bedi, G	05/16
Checked By	O'Leary, M	06/16
Detailed By	Avery, D	05/16
Bridge Projects Engr.		
Prelim. Plan By		
Architect/Specialist		

M:\Z-Team\SR 104 GABION WALL REPAIR\Window files\ELEVATION.WND

DATE | REVISION | BY | APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			

JOB NUMBER 16A009

CONTRACT NO.

GURBACHAN S. BEDI — STATE OF WASHINGTON — 22385 — REGISTERED PROFESSIONAL ENGINEER

BRIDGE AND STRUCTURES OFFICE

RICHARD P. ZELDENRUST — STATE OF WASHINGTON — 25470 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

Washington State Department of Transportation

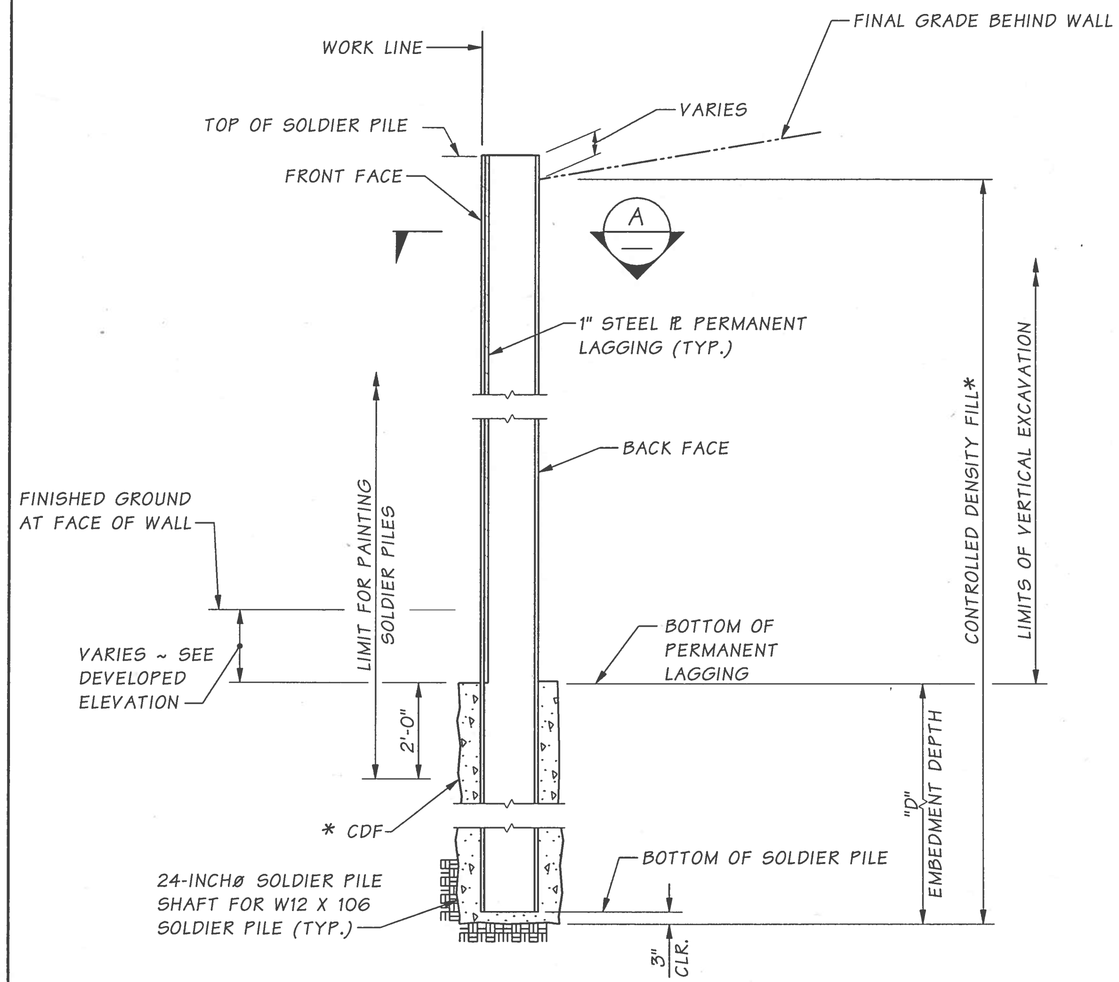
SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

SOLDIER WALL ELEVATION

BRIDGE SHEET NO. W2

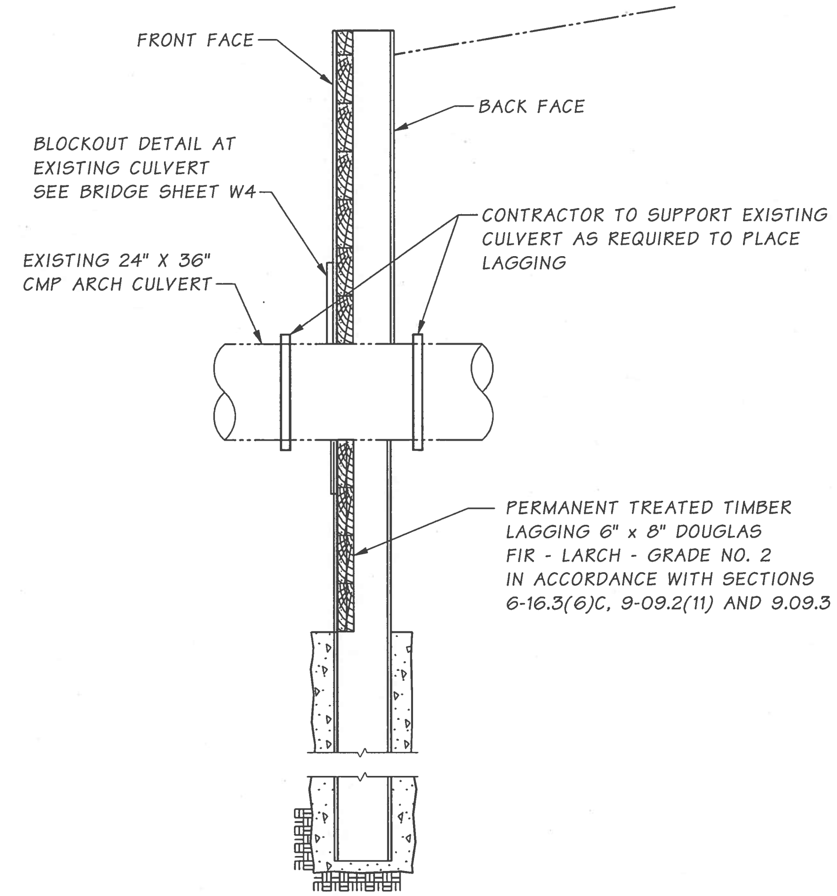
SHEET 11 OF 16 SHEETS

Tue Jun 21 11:53:48 2016



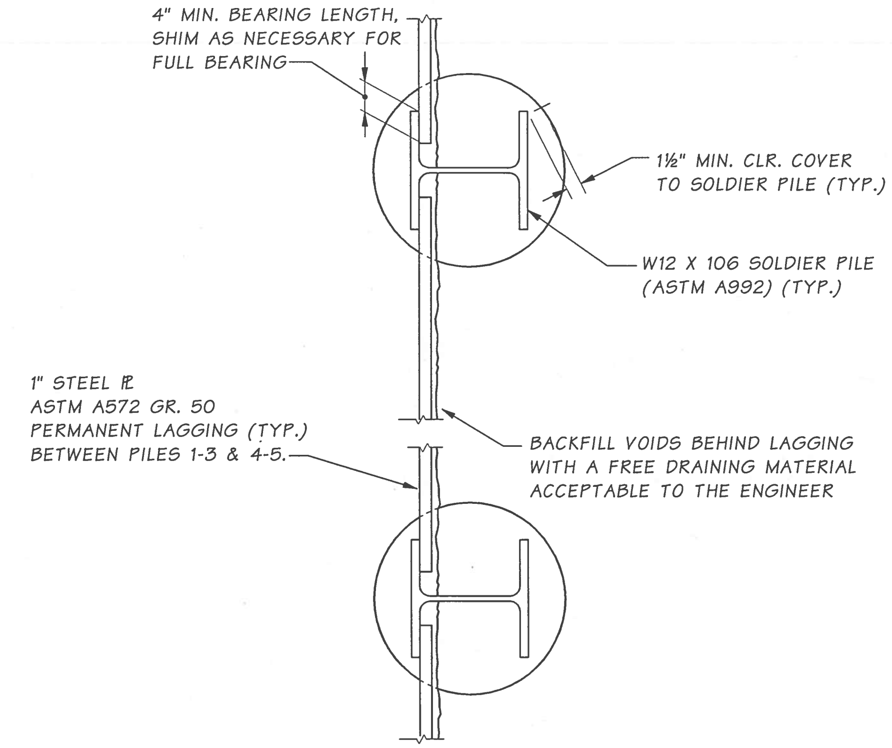
SECTION A/W2

* USE CONTROLLED DENSITY FILL WHEN PLACED IN THE DRY. USE PUMPABLE LEAN CONCRETE WHEN PLACED IN THE WET.

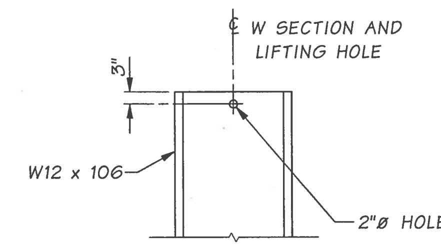


SECTION B/W2

SEE SECTION A FOR DETAILS NOT SHOWN.

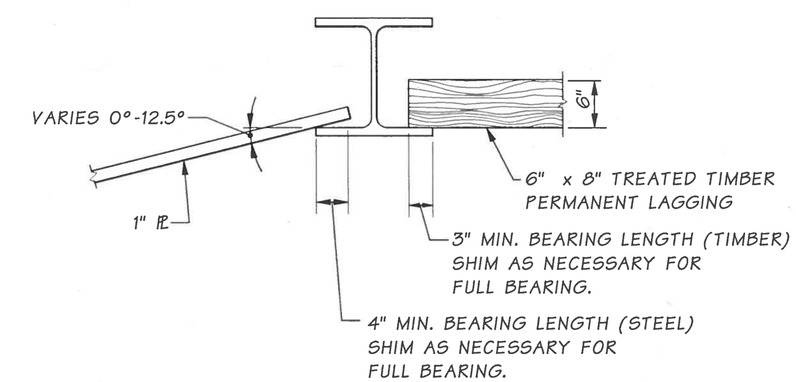


SECTION A



SOLDIER PILE LIFTING HOLE

LIFTING HOLD TO BE DRILLED IN THE SHOP PRIOR TO PAINTING THE PILE



DETAIL 1/W1

SR ___ FILE NO. ___ SHEET W3

Bridge Design Engr.	Khaleghi, B		
Supervisor	Zeldenrust, RP		
Designed By	Bedi, G	05/16	
Checked By	O'Leary, M	06/16	
Detailed By	Avery, D	05/16	
Bridge Projects Engr.			
Prelim. Plan By			
Architect/Specialist			

M:\Z-Team\SR 104 GABION WALL REPAIR\Window files\DETAILS.WND

DATE	REVISION	BY	APP'D

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			

JOB NUMBER 16A009

CONTRACT NO.

GURBACHAN S. BEDI, STATE OF WASHINGTON, 22385, REGISTERED PROFESSIONAL ENGINEER

BRIDGE AND STRUCTURES OFFICE

RICHARD P. ZELDENRUST, STATE OF WASHINGTON, 25470, STRUCTURAL ENGINEER, PROFESSIONAL ENGINEER

Washington State Department of Transportation

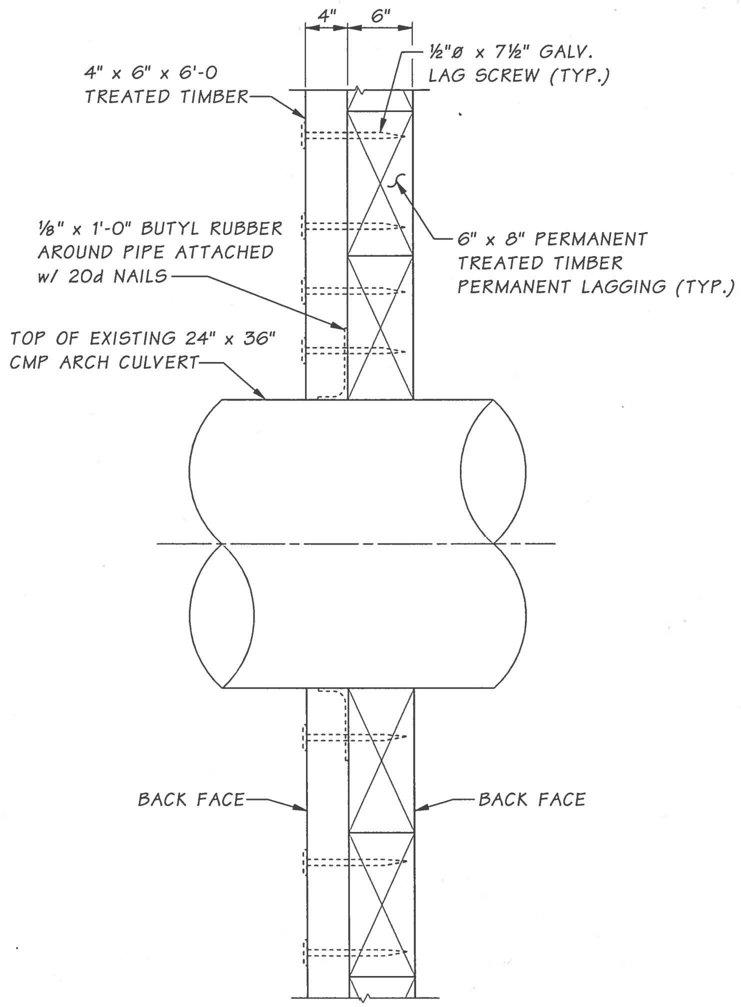
SR 104
NE 195TH ST GABION ROCK WALL EMERGENCY REPAIR

WALL DETAILS

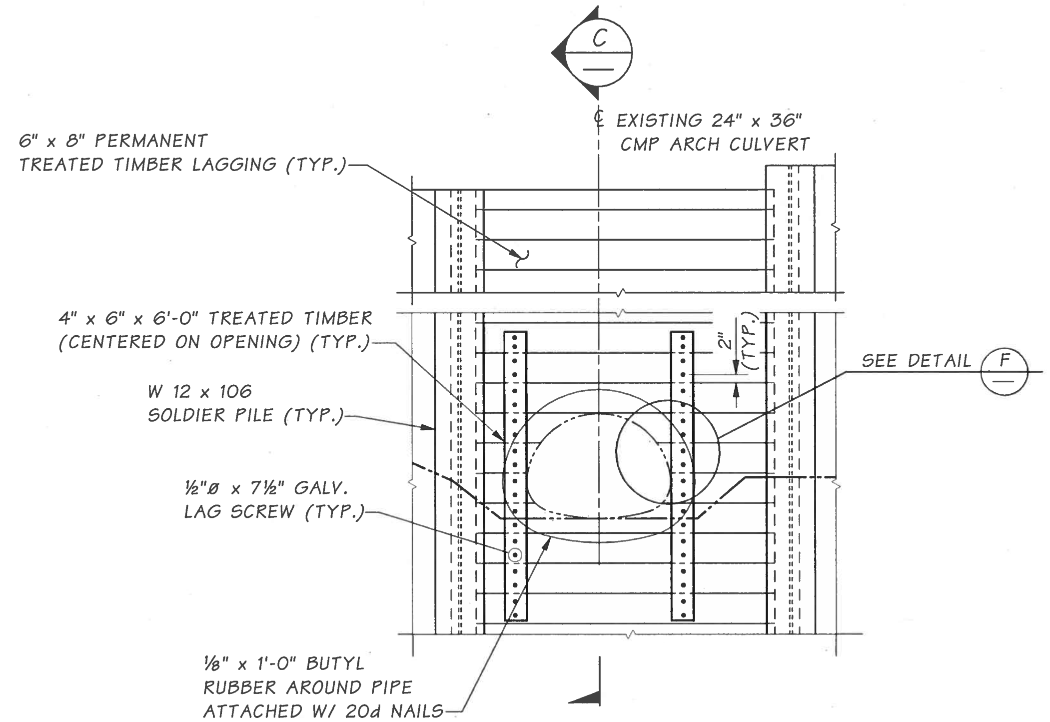
BRIDGE SHEET NO. W3

SHEET 12 OF 16 SHEETS

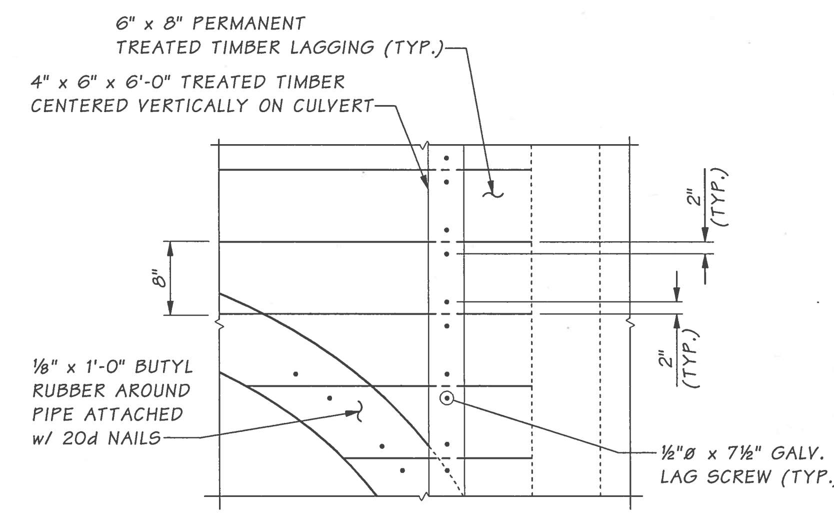
Tue Jun 21 11:53:44 2016



SECTION C



BLOCKOUT DETAIL
AT 24" x 36" CMP ARCH CULVERT
LOOKING AT FRONT OF WALL



DETAIL F

SR ___ FILE NO. ___ SHEET W4

Bridge Design Engr.	Khaleghi, B						
Supervisor	Zeldenrust, RP						
Designed By	Bedi, G	05/16					
Checked By	O'Leary, M	06/16					
Detailed By	Avery, D	05/16					
Bridge Projects Engr.							
Prelim. Plan By							
Architect/Specialist			DATE	REVISION	BY	APP'D	

M:\Z-Team\SR 104 GABION WALL REPAIR\Window files\CULVERT DETAILS.WND

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.	TOTAL SHEETS
10	WASH.			
JOB NUMBER 16A009				
CONTRACT NO.				

GURBACHAN S. BEDI — STATE OF WASHINGTON — 22385 — REGISTERED PROFESSIONAL ENGINEER

BRIDGE AND STRUCTURES OFFICE

RICHARD P. ZELDENRUST — STATE OF WASHINGTON — 25470 — STRUCTURAL ENGINEER — PROFESSIONAL ENGINEER

Washington State Department of Transportation

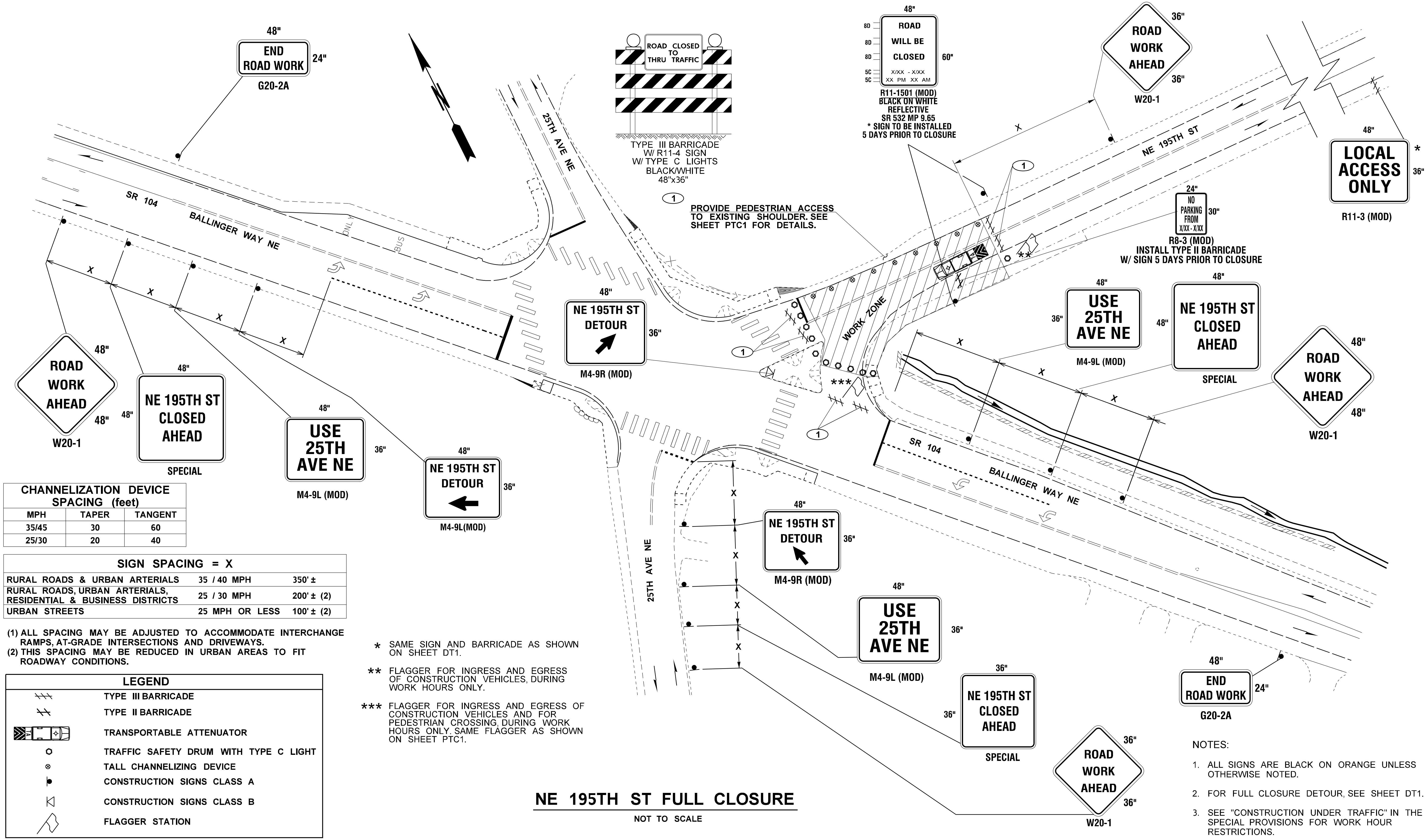
SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

CULVERT LAGGING DETAILS

BRIDGE SHEET NO. W4

SHEET 13 OF 16 SHEETS

Tue Jun 21 11:53:42 2016



CHANNELIZATION DEVICE SPACING (feet)		
MPH	TAPER	TANGENT
35/45	30	60
25/30	20	40

SIGN SPACING = X		
RURAL ROADS & URBAN ARTERIALS	35 / 40 MPH	350' ±
RURAL ROADS, URBAN ARTERIALS, RESIDENTIAL & BUSINESS DISTRICTS	25 / 30 MPH	200' ± (2)
URBAN STREETS	25 MPH OR LESS	100' ± (2)

(1) ALL SPACING MAY BE ADJUSTED TO ACCOMMODATE INTERCHANGE RAMPS, AT-GRADE INTERSECTIONS AND DRIVEWAYS.
(2) THIS SPACING MAY BE REDUCED IN URBAN AREAS TO FIT ROADWAY CONDITIONS.

LEGEND	
	TYPE III BARRICADE
	TYPE II BARRICADE
	TRANSPORTABLE ATTENUATOR
	TRAFFIC SAFETY DRUM WITH TYPE C LIGHT
	TALL CHANNELIZING DEVICE
	CONSTRUCTION SIGNS CLASS A
	CONSTRUCTION SIGNS CLASS B
	FLAGGER STATION

* SAME SIGN AND BARRICADE AS SHOWN ON SHEET DT1.

** FLAGGER FOR INGRESS AND EGRESS OF CONSTRUCTION VEHICLES, DURING WORK HOURS ONLY.

*** FLAGGER FOR INGRESS AND EGRESS OF CONSTRUCTION VEHICLES AND FOR PEDESTRIAN CROSSING, DURING WORK HOURS ONLY. SAME FLAGGER AS SHOWN ON SHEET PTC1.

NE 195TH ST FULL CLOSURE

NOT TO SCALE

NOTES:

1. ALL SIGNS ARE BLACK ON ORANGE UNLESS OTHERWISE NOTED.
2. FOR FULL CLOSURE DETOUR, SEE SHEET DT1.
3. SEE "CONSTRUCTION UNDER TRAFFIC" IN THE SPECIAL PROVISIONS FOR WORK HOUR RESTRICTIONS.

FILE NAME	T:\412350\XL5249_SR 104_195th St Gabion Rock Wall\CAD_SheetFiles\XL-5190_PS_TC.dgn
TIME	6:11:50 PM
DATE	6/22/2016
PLOTTED BY	wendts
DESIGNED BY	K. PECHA
ENTERED BY	K. PECHA
CHECKED BY	S.N. WENDT
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 16A009

CONTRACT NO. | LOCATION NO.

P.E. STAMP BOX DATE | P.E. STAMP BOX DATE

Washington State Department of Transportation

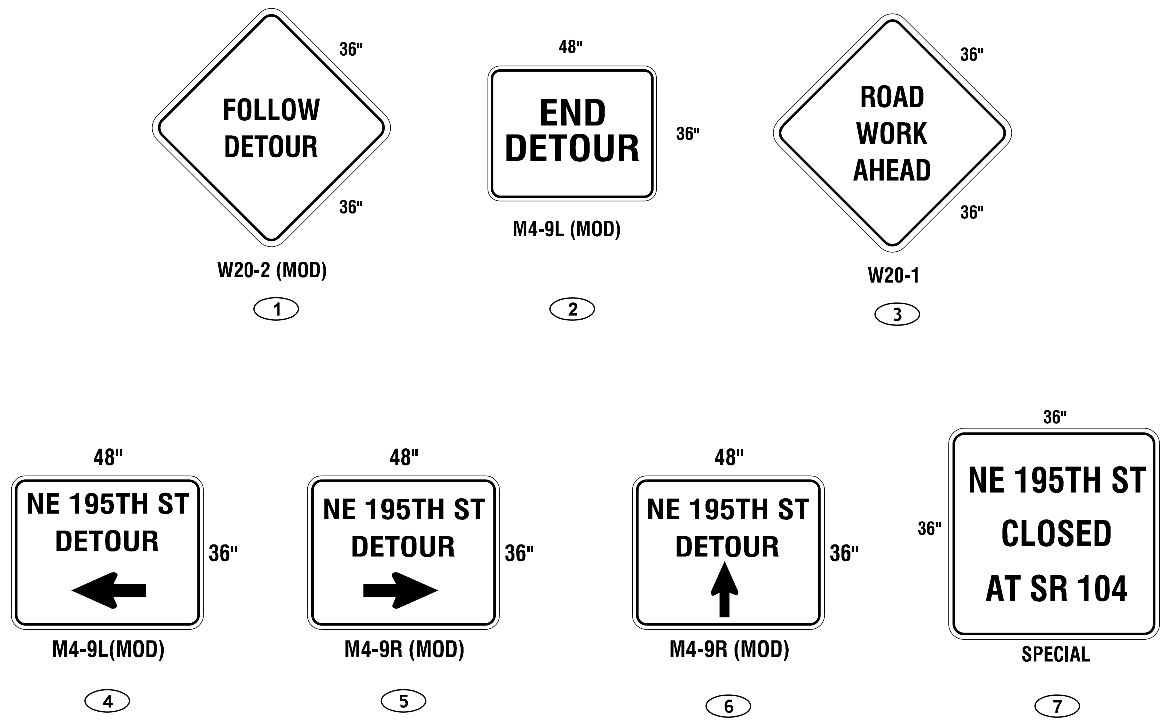
SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

TRAFFIC CONTROL PLAN

Plot 3

PLAN REF NO TC1

SHEET 14 OF 16 SHEETS



PCMS MESSAGE #1	
PHASE 1	PHASE 2
195TH ST WILL BE CLOSED	XX DATE TO XX DATE
1.5 SEC	1.5 SEC

FIELD LOCATE ½ MILE (+-) IN ADVANCE OF LANE CLOSURE, 5 DAYS IN ADVANCE OF CLOSURE

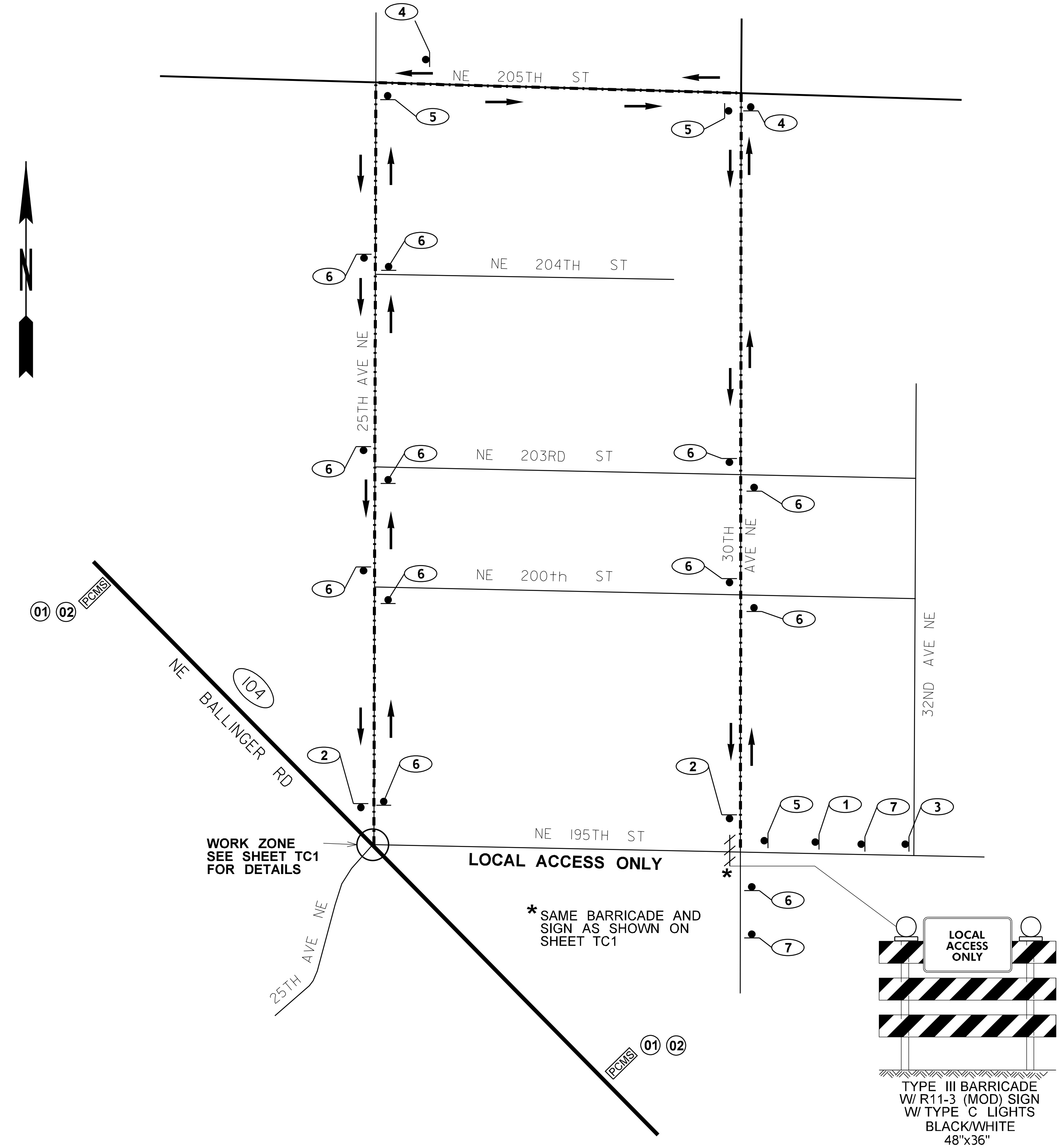
PCMS 01

PCMS MESSAGE #2	
PHASE 1	PHASE 2
195TH ST CLOSED AHEAD	FOLLOW DETOUR
1.5 SEC	1.5 SEC

FIELD LOCATE ½ MILE (+-) IN ADVANCE OF LANE CLOSURE, DURING ROADWAY CLOSURE

PCMS 02

DETOUR SIGNING DETAILS



NE 195TH ST FULL CLOSURE DETOUR

NOT TO SCALE

LEGEND	
	TYPE III BARRICADE
	CONSTRUCTION SIGNS CLASS A
	DETOUR ROUTE
7	DETOUR SIGN NOTE

NOTES:

1. ALL SIGNS ARE BLACK ON ORANGE UNLESS OTHERWISE NOTED.
2. SEE SHEET TC1 FOR CLOSURE DETAILS.

FILE NAME	T:\412350\XL5249_SR 104_195th St Gabion Rock Wall\CAD_SheetFiles\XL-5190_PS_DT.dgn
TIME	6:05:49 PM
DATE	6/22/2016
PLOTTED BY	wendts
DESIGNED BY	K. PECHA
ENTERED BY	K. PECHA
CHECKED BY	S.N. WENDT
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 16A009

CONTRACT NO. | LOCATION NO.

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

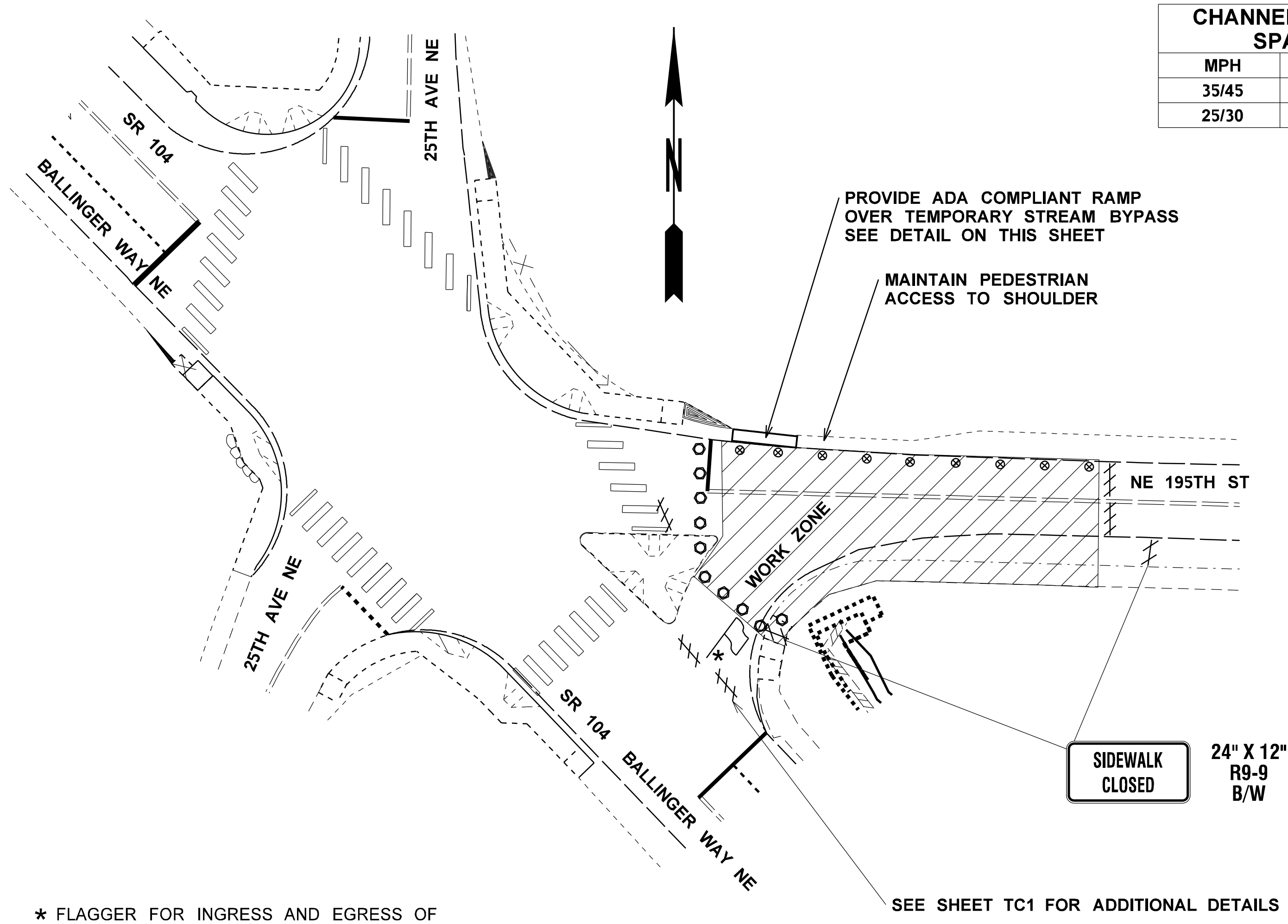
DETOUR PLAN

Plot 1

PLAN REF NO DT1

SHEET 15 OF 16 SHEETS

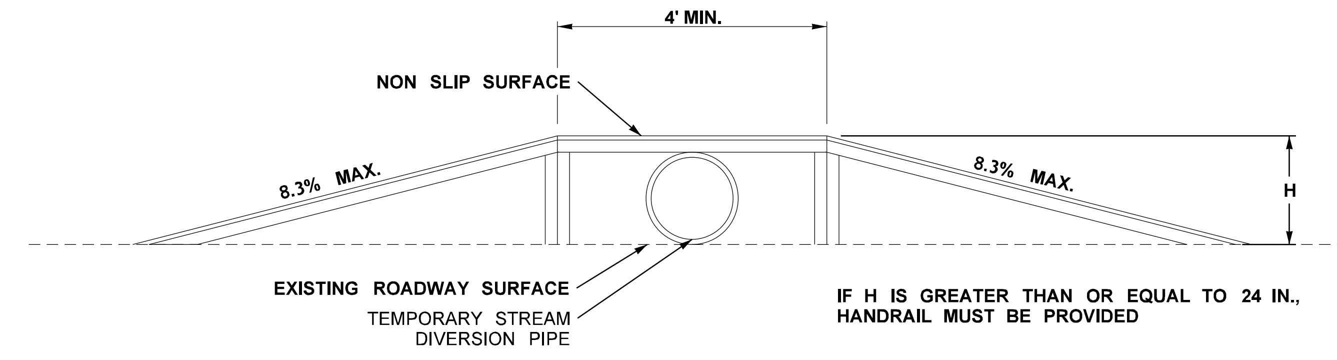
CHANNELIZATION DEVICE SPACING (feet)		
MPH	TAPER	TANGENT
35/45	30	60
25/30	20	40



* FLAGGER FOR INGRESS AND EGRESS OF CONSTRUCTION VEHICLES AND PEDESTRIAN CROSSING, DURING WORK HOURS ONLY. SAME FLAGGER AS SHOWN ON SHEET TC1.

FULL NE 195TH ST CLOSURE PEDESTRIAN TRAFFIC CONTROL PLAN

NOT TO SCALE



CONCEPTUAL ADA RAMP OVER TEMPORARY STREAM BYPASS

NOT TO SCALE

LEGEND

- TYPE III BARRICADE
- TYPE II BARRICADE
- TALL CHANNELIZING DEVICE
- TRAFFIC SAFETY DRUM WITH TYPE C LIGHT
- FLAGGER STATION

FILE NAME	T:\412350\XL5249_SR 104_195th St Gabion Rock Wall\CAD_SheetFiles\XL-5190_PS_TC.dgn
TIME	7:50:05 PM
DATE	6/23/2016
PLOTTED BY	wendts
DESIGNED BY	K. PECHA
ENTERED BY	K. PECHA
CHECKED BY	S. WENDT
PROJ. ENGR.	J. CHI
REGIONAL ADM.	L. ENG

REVISION | DATE | BY

REGION NO. 10 | STATE WASH | FED.AID PROJ.NO.

JOB NUMBER 16A009

CONTRACT NO. | LOCATION NO.

P.E. STAMP BOX DATE

P.E. STAMP BOX DATE

Washington State Department of Transportation

SR 104
NE 195TH ST GABION ROCK WALL
EMERGENCY REPAIR

PEDESTRIAN TRAFFIC CONTROL PLAN

Plot 1

PLAN REF NO PTC1

SHEET 16 OF 16 SHEETS

Appendix K.3
Fish Exclusion Report

WSDOT

PROJECT: SR 104 NE 195th ST GABION WALL REPAIR PG. 1 OF 1

DATE: 9/10/16	WEATHER: PARTLY CLOUDY
LOCATION/WATERBODY: BALLINGER CREEK	AIR TEMPERATURE: 60 °F
CREW: GROSS, MC GOVERN, KAPANTAIS	WATER TEMPERATURE: 12°C
DATA RECORDER: KAPANTAIS, GROSS	CAPTURE METHODS: E-FISH / DIP NET

ELECTROFISHING DATA[1]:

ELECTROFISHER MODEL:	LR 24
WATER CONDUCTIVITY:	
PULSE RATE:	30 HZ
VOLTAGE SETTING:	300
PASSES (INCLUDE # AND DURATION):	3

FISH COLLECTION/EXCLUSION DATA:

#	TIME	SPECIES	FORK LENGTH	CONDITION	SAMPLE (Y/N)	TECHNIQUES/ METHODS	COMMENTS/ NOTES
1	9:00AM	CO		GOOD	N	E-FISH	ALL RELEASED
2		CT		GOOD	N	E-FISH	DOWNSTREAM
3		CT		GOOD	N	E-FISH	
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Fish Species Codes:

BH: Bullhead
BK: Brook Trout
BR: Brown Trout
BT: Bull Trout[2]
CH: Chum
CO: Coho

CK: Chinook[2]
CT: Cutthroat Trout
LAM: Lamprey spp.
MI: Minnow
PI: Pink
PK: Pumpkinseed

RT: Rainbow/steelhead Trout
SC: Sculpin spp.
SM: Smelt
SO: Sockeye
ST: Three-spined stickleback
SU: Sucker

UNK: Unknown
WH: Whitefish
X: Other (i.e. forage fish, amphibians, etc.) I.D. in COMMENTS.

[1,2]Report to Federal Services pursuant to Section 10 Permits

Form: F-1
Revised Feb 2005

From:	John Featherstone
To:	Giseburt, Michael S
Cc:	Shelby Petro (spetro@herrerainc.com) (spetro@herrerainc.com)
Subject:	FW: Fish exclusion report for SR 104 NE 195th St Gabion Rock Wall Emergency Project
Date:	Tuesday, November 29, 2016 10:45:08 AM

FYI

From: Gross, Andrew [mailto:GrossA@wsdot.wa.gov]
Sent: Tuesday, November 29, 2016 10:44 AM
To: John Featherstone; Woeck, Robert
Cc: Chi, John; Maas, John
Subject: RE: Fish exclusion report for SR 104 NE 195th St Gabion Rock Wall Emergency Project

Hi John,

Fish were not formally measured. However, they were visually estimated at the following:
Coho 70mm
cutthroat 70mm
cutthroat 110 mm

Thanks,

Andrew Gross
Regional Maintenance Environmental Coordinator
WSDOT NW Region Environmental
Hours: Mon-Thur, 6:30- 5:00
Office: 206-440-4951
Cell: 206-406-8074
Fax: 206-440-4805

From: John Featherstone [mailto:jfeatherstone@shorelinewa.gov]
Sent: Tuesday, November 29, 2016 9:55 AM
To: Woeck, Robert <WoeckRo@wsdot.wa.gov>
Cc: Chi, John <ChiJ@wsdot.wa.gov>; Maas, John <MaasJA@wsdot.wa.gov>; Gross, Andrew <GrossA@wsdot.wa.gov>
Subject: RE: Fish exclusion report for SR 104 NE 195th St Gabion Rock Wall Emergency Project

Hi Robert,

Just wanted to follow up on this request – is there any documentation of the size of the Coho and cutthroat? We'd like to include this information in the flood reduction project pre-design report currently in development.

Thanks,

Subject: Fish exclusion report for SR 104 NE 195th St Gabion Rock Wall Emergency Project

Hi John and Dave,

I was also wondering if I might ask you for contact information for whoever would have the fish exclusion report for the recent SR 104 NE 195th St Gabion Rock Wall Emergency Project. We heard that they found cutthroat trout and Coho salmon upstream of NE 195th St, which is of major interest to the City of Shoreline 25th Ave NE Flood Reduction project. Your assistance is greatly appreciated.

Thanks!

John Featherstone, P.E.
Surface Water Engineer
City of Shoreline
Desk: 206 801 2478
Cell: 206 681 6443

"Working together, protecting our resources, making a difference"
- City of Shoreline Public Works Mission

Appendix K.4
Input on Replacement Culvert and Stream Improvements

Memorandum

DATE: Thursday, November 3, 2016

TO: WSDOT Representatives

FROM: John Featherstone, City of Shoreline

CC: Mike Giseburt, Louis Berger

RE: WSDOT Input on Key Topics for 25th Ave NE Flood Reduction Project

---

This memorandum presents two priority topics for which the City of Shoreline (City) requests WSDOT input related to the 25th Avenue NE Flood Reduction Project: (1) NE 195th Street Culvert Replacement, and (2) the SR 104 Gabion Wall south of NE 195th St (the portion not recently repaired).

The City's project team is currently preparing a predesign study to assess options to reduce flooding of Ballinger (West Lyon) Creek in the vicinity of NE 195th St, 25th Avenue NE, and Ballinger Way NE/SR 104. One likely project element will be to replace the existing culvert underneath NE 195th Street just east of Ballinger Way NE/SR 104. The culvert is actually owned and located within the City of Lake Forest Park (with the corporate limits being on the north edge of the NE 195th Street right-of-way), and also within WSDOT right of way. The City of Shoreline is leading the project (rather than Lake Forest Park) because the existing culvert is undersized and contributes to upstream flooding within the City of Shoreline.

During our preliminary alternative analysis, we identified several important questions where we need WSDOT input. The responses to the questions will help inform the future design of the proposed culvert replacement and related stream channel work.

The City's project team includes Louis Berger as the lead engineering design consultant and Herrera Environmental Consultants as the team's environmental and permitting specialists. We have already had a fair amount of coordination with WSDOT related to the recently-completed SR 104 NE 195th St Gabion Rock Wall Emergency Project. The extents of the WSDOT gabion repair project overlap with the 25th Avenue NE Flood Reduction Project extents.

Description of 25th Avenue NE Flood Reduction Project

Since 2001 the City has received reports of Ballinger Creek flooding areas along 25th Avenue NE between Brugger's Bog Park and NE 195th Street on at least 15 separate occasions. Nearby public and private properties have flooded, including multifamily residences, public rights-of-way, and the City's North Maintenance Facility (NMF) site.

The 25th Avenue NE Flood Reduction Project, which was recommended as a high priority in the City's recently-completed Lyon Creek Basin Plan, is currently evaluating flood reduction approaches potentially affecting a reach of Ballinger Creek extending 2,000 feet from Brugger's Bog Park downstream to the culvert crossing Ballinger Way NE approximately 450 feet south of NE 195th Street.

Hydrologic and hydraulic modeling efforts have confirmed historical and anecdotal observations that this system floods at an approximate 2-year frequency. Modeling determined that the existing piped system – which generally ranges in size from 24 to 36 inches in diameter -- is far below needed capacity.

The portions of the project north of NE 195th St are located within the City of Shoreline, for which local permitting will be coordinated internally with the City of Shoreline Planning and Community Development department. The portions of the project within and south of NE 195th Street are located within City of Lake Forest Park (LFP) and WSDOT rights-of-way (ROW); the project team has already begun and will continue to coordinate with LFP and WSDOT for their regulations and permitting requirements within this area.

Early outreach has also been started with Muckleshoot Indian Tribe Fisheries Division, Washington State Department of Fish and Wildlife (WDFW), Washington State Department of Ecology, and US Army Corps of Engineers seeking permit-related input on project concepts related to stream and wetland critical areas.

The project team has recently completed initial investigations including hydrologic and hydraulic modeling, survey, environmental, and geotechnical. Design alternatives are currently in development to allow the City to consider an array of potential feasible approaches to resolve the existing flooding issue with minimal downstream impacts while complying with critical stakeholder needs and accounting for various constraints, such as spatial/physical and cost limitations.

NE 195th Culvert and SPU Water Line

The existing NE 195th St culvert is a 24” high x 36” wide corrugated metal arch (CMP) which crosses directly below a Seattle Public Utilities 66-inch-diameter water distribution main (Tolt Pipeline). There is little to no clearance between the existing 66” pipe and the 24x36 culvert (see Figure 1 below) – as confirmed by potholing.

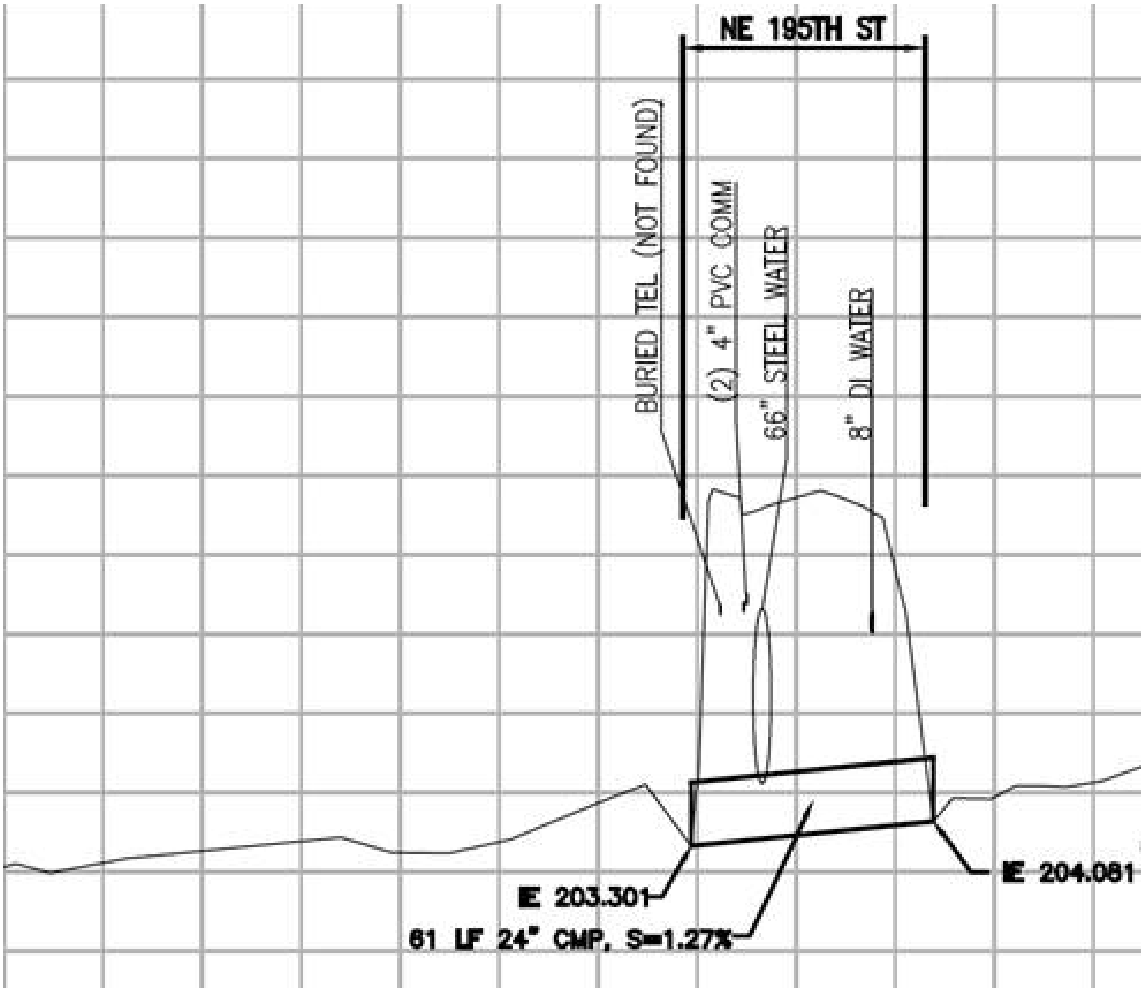


Figure 1- Existing NE 195th St culvert crossing profile, showing SPU 66" dia. water pipe

A replacement culvert will need to be fish passable (per WDFW and other permit requirements), which would be an approximately 10-ft wide concrete box culvert partially filled with fish-friendly spawning gravels. Our understanding is that once the NE 195th St culvert is replaced, ownership will transfer from Lake Forest Park to WSDOT (based on a size threshold of a 60-inch diameter or equivalent, the minimum size at which WSDOT is typically responsible for culverts within rights-of-way WSDOT shares with local jurisdictions). As such, we understand that as the future culvert owner, WSDOT will need to review and approve this culvert replacement design.

We have coordinated with Seattle Public Utilities regarding the project and they have indicated that the new culvert must have a minimum clearance 0.5-ft of between the bottom of the 66" pipeline and the top of the new culvert.   With this added clearance (where there is no clearance under current conditions) and the thickness of a concrete box culvert (roughly one foot), the soffit (or top) of the new culvert will be approximately 1.5-feet lower than the top of existing culvert.

Lowered culvert depth at NE 195th St will present some major challenges to the City's project because the channel immediately downstream of the culvert has aggraded (raised the creek bed), and also because the downstream channel runs a significant length alongside the failing WSDOT SR 104 gabion basket wall (further described below). If the open vertical height between the top of stream bed gravel and the soffit of the replacement culvert could be designed to match the existing culvert open height (i.e., 2 feet), the new grade of the downstream channel would need to be deepened and re-graded for an approximate two hundred foot length downstream of the culvert (as needed for channel slope).   A required open height of the culvert greater than 2 feet would lead to deeper re-grading for an even longer downstream stretch of channel – complicated by the failing gabion wall (see next section). Another concern about lowering the channel is that it's already flat. The invert of the next downstream culvert which crosses Ballinger Way approximately 500 feet downstream, is only 4.3 feet lower than the existing NE 195th culvert.

One culvert design criterion taken from 2015 WSDOT Hydraulics Manual (Section 3-3.2.2) specifies that the 25-year flow depth should not exceed 1.25 x diameter (height) of culvert. Using this criterion the new culvert would have to have a minimum open height of 2.5 feet, which is 0.5 feet greater than the existing opening. A 2.5 foot open height would require lowering the channel elevation by approximately 2 feet from the existing channel elevation, and by more than 2 feet deeper where the channel is aggraded.

The Hydraulics Manual does indicate that exceptions can be made to allow 25-year flow depth to exceed 1.25 x diameter (height) of culvert. Could such an exception apply to this case, and if so what would the City need to provide in order for WSDOT to allow this? Would this memorandum be of sufficient justification to exceed the criteria, provided that the HW/D ratio is less than 3 to5 and upstream properties are not impacted?

Downstream Channel and WSDOT Gabion Wall along Ballinger Way

Downstream from NE 195th Street, a gabion basket wall is located along NE 195th and running approximately 300 feet to southeast along Ballinger Way NE/SR 104.   WSDOT recently replaced the failed gabion wall at the south side of NE 195th Street at the culvert outlet under an emergency contract. Downstream of the emergency repair project extents, Ballinger Creek runs directly along the base of this gabion wall, which is in failing condition. The wire fabric of the lower gabion baskets in the flow line of the creek has corroded away completely and some of the rocks from within the gabion baskets have spilled out into the creek. This condition exists along most of the visible gabion wall toe.

We have had some earlier discussions with WSDOT about the failing wall during our discussions on the emergency gabion wall repair. A major concern for the City's project is that lowering creek alongside the wall (as described in the previous section) could worsen the failing conditions observed at the toe of the wall.

Figure 2 below shows a preliminary cross section which overlays the potential deeper channel section (due to replacing the NE 195th St culvert) with existing conditions including the existing ground and gabion wall structure (also provided as a standalone PDF email attachment). This cross section was developed based upon 2016 field survey of the channel (conducted by the City's project team) combined with information from the May 1980 Gabion Wall Memorandum, which WSDOT previously provided to the team. The 1980 memorandum does not indicate that the gabion wall design shown is "as-built" so this representation should be considered approximate. This cross section is cut approximately 80-ft downstream of the NE 195th St culvert outlet. Proposed channel deepening shown assumes that the channel invert at the culvert outlet will need to be 1.5 feet below the existing culvert and that the existing 2' open vertical height is allowable (i.e., not meeting the 25-year flow requirement, but matching existing open height as requested in previous section). This section illustrates how requiring a greater minimum open vertical height for the replacement culvert would further lower the channel, be more problematic, and even potentially undermine the toe of the wall.

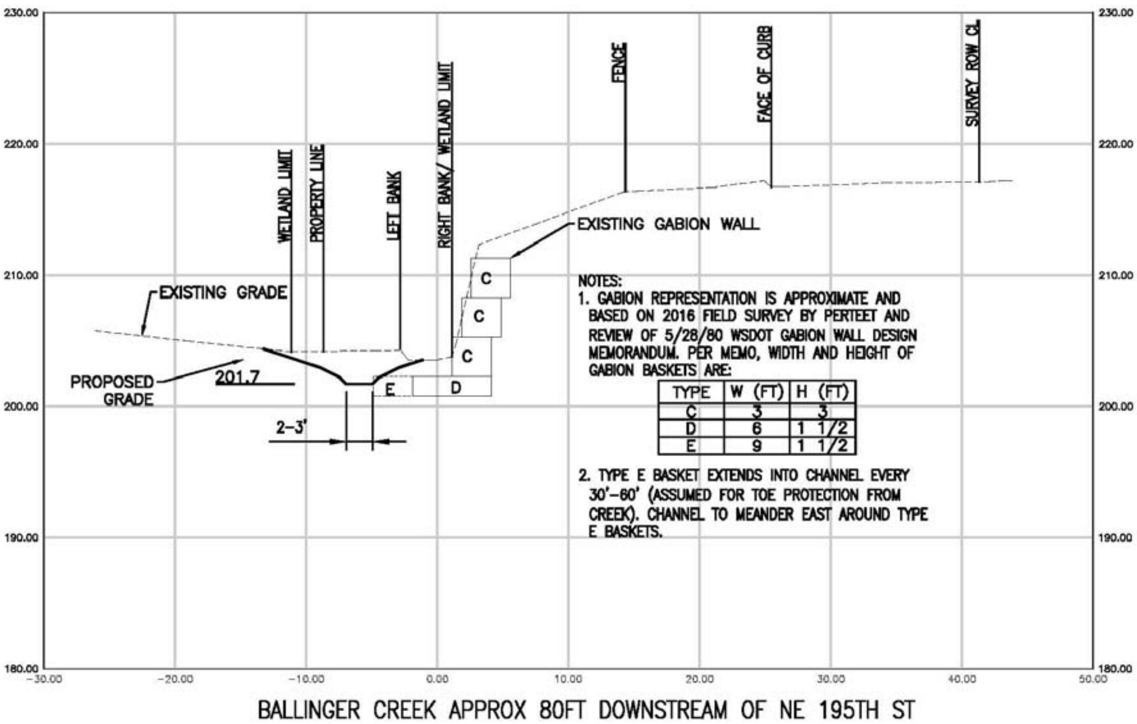


Figure 2- Proposed channel section relative to existing grade and gabion wall

We have also confirmed that there is very little available width of right of way in the narrow corridor shared by Ballinger Creek and the toe of the gabion wall. The City of Shoreline will likely need to coordinate with the City of Lake Forest Park to obtain a new surface water easement to the northeast to provide additional width for stream improvements.

WSDOT Input

We request WSDOT input on these key questions related to the channel improvements and gabion wall. Getting WSDOT input at this point during pre-design is important for the City to know what to expect for future design of required improvements – such as re-grading of the stream -- and associated WSDOT permitting expectations.

Questions:

1. What minimum open height for new NE 195th culvert would WSDOT allow? As discussed above, allowing the replacement culvert open height to match the existing culvert open height of 2.0 feet would help to minimize some of the complicating issues downstream. Section 3-3.2.2 of the Hydraulics Manual does indicate that exceptions can be made to allow 25-year flow depth to exceed 1.25 x diameter (height) of culvert. Could such an exception apply to this case, and if so what would the City need to provide in order for WSDOT to allow this? Would this memorandum be of sufficient justification to exceed the criteria, provided that the HW/D ratio is less than 3 to 5 and upstream properties are not impacted?

2. If WSDOT is unable to accommodate the City's request to allow a culvert open height of 2.0 feet, our team wanted to get some clarification on how WSDOT applies this criteria for fish passable culverts. Figure 3 below shows a 10'x3.6' box culvert with 1.1'-deep spawning gravels placed in the bottom and a low flow thalweg in the spawning channel. In this case, is the height of the culvert to be used in the 25-year flow criteria 2.5' (thus allowing a headwater depth of 3.1 ft. – with both depths measured from the thalweg elevation)? Or would culvert height be considered 3.6' (with an allowable 4.5' headwater depth), both as measured from the invert elevation of the box culvert?

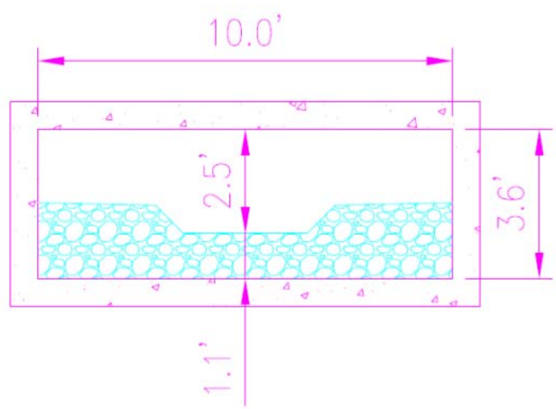


Figure 3- NE 195th St Replacement Culvert conceptual dimensions

3. It could potentially be mutually beneficial to coordinate repair of the failing gabion wall along SR 104 with the directly adjacent potential stream channel work for the City's project. Does WSDOT have any near term plans to repair/replace this gabion wall such that we can coordinate with you on the timing of improvements? If not, what would the long term plan for the wall?

4. If the City needs to move forward with the flood reduction project and needs to lower the channel prior to the timeframe for the WSDOT repair of the failing gabion wall, what measures would WSDOT require for the protection of the wall along the City's project extents for lowering the creek?

Responses to Memo from the Bridge & Structures Office.

Wendt, Shawn

From:	Zeldenrust, Richard
Sent:	Tuesday, November 08, 2016 8:29 AM
To:	Wendt, Shawn; Pittman, Heather; Cuthbertson, Jim; Johnson, Chris J.
Cc:	Chi, John; Heilman, Julie; Frye, Mark; Bedi, Gary
Subject:	RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo
Attachments:	25th Ave - 2 Ballinger Creek Section location.pdf; 25th Ave - 1 Ballinger Creek Section.pdf; 25th Ave - 4 WSDOT 1980 gabion wall report.pdf; Shoreline 25th Ave NE WSDOT coordination memo 2016-11-03.pdf; 25th Ave - 3 Survey project extents.pdf

Shawn,

I looked over all the attachments, and found the four questions at the end of the Coordination Memo. I can offer the following:

1. This question may be best answered by WSDOT Hydraulics Staff.
2. This question may be best answered by a combination of WSDOT Hydraulics and Environmental Staff, possibly with input from WDFW Staff.
3. This is really a question for NW Region Staff.

Resonse to Question #4

4. Figure 2 in the Coordination Memo shows the proposed lowered stream bottom elevation to be very close to the bottom of the gabion wall. Any further incision or scour of the stream could undermine the wall, causing failure. Also, as described in the Memo, the existing gabion baskets have begun to fail, due to corrosion, and rock is beginning to spill out of the baskets, into the creek. Total wall replacement could solve both problems. Perhaps a cantilevered sheet pile wall or cantilevered soldier pile wall could be installed immediately behind the existing gabion wall, containing the existing fill and allowing the gabion wall to be removed from the front side (stream side). A new wall, extended deeply enough, would alleviate any scour concerns, would allow removal of the failing gabion baskets, and would provide additional space for routing of the stream. I understand that the 66" water main is buried in the fill beneath Ballinger Way, and that any wall type requiring anchorage back into the fill would not be allowed. Ideas for repairing or retrofitting the existing gabion basket wall in-place include driving sheet pile at the toe of the wall to protect against scour, and/or forming the exposed face of the gabion baskets and pumping some sort of a thin grout into the rock matrix, to try to cement all the rock together into a cohesive unit. These retrofit ideas were discussed, but practicality/constructability was not determined. As well, there may be additional retrofit ideas.

Richard Zeldenrust
Structural Design Unit Supervisor
WSDOT Bridge and Structures Office
360-705-7196
zeldenr@wsdot.wa.gov

From: Wendt, Shawn
Sent: Monday, November 07, 2016 8:56 AM

Responses to Memo from Geotechnical Office

Wendt, Shawn

From: Frye, Mark
Sent: Wednesday, November 09, 2016 4:23 PM
To: Wendt, Shawn
Cc: Cuthbertson, Jim
Subject: FW: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Shawn,

None of the questions were really geotechnical in nature. Rich did a good job of summarizing the concerns regarding the existing gabion basket wall.

Thanks,

Mark A. Frye
WSDOT Geotechnical Office
360-709-5469 (Office)
360-951-7267 (cell)

From: Zeldenrust, Richard
Sent: Tuesday, November 08, 2016 08:29
To: Wendt, Shawn <WendtS@wsdot.wa.gov>; Pittman, Heather <PittmaH@wsdot.wa.gov>; Cuthbertson, Jim <CuthbeJ@wsdot.wa.gov>; Johnson, Chris J. <JohnsoC@wsdot.wa.gov>
Cc: Chi, John <ChiJ@wsdot.wa.gov>; Heilman, Julie <HeilmaJ@wsdot.wa.gov>; Frye, Mark <FryeM@wsdot.wa.gov>; Bedi, Gary <BediG@wsdot.wa.gov>
Subject: RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Shawn,

I looked over all the attachments, and found the four questions at the end of the Coordination Memo. I can offer the following:

1. This question may be best answered by WSDOT Hydraulics Staff.
2. This question may be best answered by a combination of WSDOT Hydraulics and Environmental Staff, possibly with input from WDFW Staff.
3. This is really a question for NW Region Staff.
4. Figure 2 in the Coordination Memo shows the proposed lowered stream bottom elevation to be very close to the bottom of the gabion wall. Any further incision or scour of the stream could undermine the wall, causing failure. Also, as described in the Memo, the existing gabion baskets have begun to fail, due to corrosion, and rock is beginning to spill out of the baskets, into the creek. Total wall replacement could solve both problems. Perhaps a cantilevered sheet pile wall or cantilevered soldier pile wall could be installed immediately behind the existing gabion wall, containing the existing fill and allowing the gabion wall to be removed from the front side (stream side). A new wall, extended deeply enough, would alleviate any scour concerns, would allow removal of the failing gabion baskets, and would provide additional space for routing of the stream. I understand that the 66" water main is buried in the fill beneath Ballinger Way, and that any wall type requiring anchorage back into the fill would not be allowed. Ideas for repairing or retrofitting the existing gabion basket wall in-place include

Responses to Memo from HQ Hydraulics

Wendt, Shawn

From: Pittman, Heather
Sent: Wednesday, November 09, 2016 10:10 AM
To: Zeldenrust, Richard; Wendt, Shawn; Cuthbertson, Jim; Johnson, Chris J.
Cc: Chi, John; Heilman, Julie; Frye, Mark; Bedi, Gary
Subject: RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Shawn,

The new crossing would need to meet stream simulation standards unless otherwise approved by WDFW, the Tribes, and WSDOT. Has Anyone confirmed whether the structure will in fact be transferred to WSDOT for ownership as stated in the memo?

Response to Question #1

1. We do not have enough information to answer question 1. The headwater criteria cited in the memo is not applicable for stream simulation crossings and the project would not likely meet the stream simulation criteria in the WAC or in the 2013 Water Crossing Design Guidelines (WCDG) by doing so. The memorandum is not sufficient justification for exceeding the criteria and WSDOT would not be the only approving authority on this. Given the complications of this site, I think that this might be an iterative process and it might be good to get all stakeholders together at the table to discuss what the options are. At a minimum, the city would need to prove that they are meeting the WAC and WCDG or have approval from WSDOT, WDFW and likely the Tribes to deviate.
2. WSDOT typically designs fish passage structures to meet the WCDG which recommends a minimum freeboard above the 100-year. Freeboard is measured above the streambed material inside the culvert, regardless of embedment depth. The structure should be designed to maintain a bed within the channel under the expected scour conditions.
3. This is a NWR staff question
4. I believe Rich answered this question below.

Response to Question #2

Heather Pittman, P.E.
Assistant State Hydraulic Engineer
WSDOT HQ Hydraulics Office
360.705.7495

From: Zeldenrust, Richard
Sent: Tuesday, November 08, 2016 8:29 AM
To: Wendt, Shawn <WendtS@wsdot.wa.gov>; Pittman, Heather <PittmaH@wsdot.wa.gov>; Cuthbertson, Jim <CuthbeJ@wsdot.wa.gov>; Johnson, Chris J. <JohnsoC@wsdot.wa.gov>
Cc: Chi, John <ChiJ@wsdot.wa.gov>; Heilman, Julie <HeilmaJ@wsdot.wa.gov>; Frye, Mark <FryeM@wsdot.wa.gov>; Bedi, Gary <BediG@wsdot.wa.gov>
Subject: RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Shawn,

I looked over all the attachments, and found the four questions at the end of the Coordination Memo. I can offer the following:

1. This question may be best answered by WSDOT Hydraulics Staff.

From:	Wendt, Shawn
To:	John Featherstone
Cc:	Chi, John
Subject:	Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo
Date:	Thursday, November 17, 2016 10:01:46 AM
Attachments:	Shoreline 25th Ave NE WSDOT coordination memo 2016-11-03.pdf WSDOT Responses to Memo.pdf

John,

Response to Question #3

I have solicited responses from various support groups to answer your questions within the memo. In regards to question #3; There are no long term Plans at this point to repair or replace the existing remaining gabion rock wall. Our Maintenance will most likely monitor this wall in the interim.

I hope this answers the questions in the memo. Let me know if need any additional information.

Thanks,

Shawn Neil Wendt, P.E.

Transportation Engineer 3 – Design Team Leader

Schedule: M-TH 8:00 AM- 5:30 PM

Alt Friday 8:00 AM - 4:30 PM

Office Phone: (206) 440-4614

WSDOT, NW Region

wendts@wsdot.wa.gov

Appendix K.5
City Cost Estimate of Ballinger Way NE
Gabion Wall Replacement

Note that the cost estimate for replacing the existing failing gabion wall along Ballinger Way NE was prepared by ABAM/Louis Berger for the City of Shoreline at the request of WSDOT. The cost estimate assumes a standalone project not related to other creek improvements.

Table 1. Planning Level Design, Permitting, and Construction Cost Estimate for WSDOT Ballinger Way Wall						
Spec Section	Bid Item Description	Quantity	Unit	Unit Cost	Amount	Assumptions/Notes
1	MOBILIZATION (10%)	1	LS	$158,000	$158,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (5%)	1	LS	$58,000	$58,000	
3	SURVEYING	1	LS	$20,000	$10,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$5,000	$5,000	
7	REMOVING SOLDIER PILE SHAFT OBSTRUCTIONS	1	LS	$32,300	$32,300	
8	SHAFT-30 IN DIAMETER	1290	LF	$250	$322,500	
9	FURNISHINGS SOLDER PILE W12X190	1290	LF	$175	$225,750	
10	LAGGING	4200	SF	$75	$315,000	
11	GUARDRAIL	330	LF	$30	$9,900	
12	CHAIN LINK FENCE TYPE 6	280	LF	$33	$9,240	
13	GABION EXCAVATION INCL. HAUL	610	CY	$60	$36,600	
14	STRUCTURE EXCAVATION CLASS A INCL. HAUL	780	CY	$35	$27,300	
15	CHANNEL EXCAVATION	232	CY	$25	$5,797	
16	EMBANKMENT COMPACTION	73	CY	$4	$293	
17	STREAMBED SEDIMENT	229	TN	$40	$9,158	
18	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	618	EA	$10.00	$6,180	
19	TOPSOIL	317	CY	$50.00	$15,864	
20	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$20,000	$20,000	
21	LARGE WOODY DEBRIS	7	EA	$1,200	$7,827	
22	EARTH ANCHORS	13	EA	$800	$10,437	
23	HABITAT BOULDERS	13	TN	$85	$1,063	
24	EROSION/WATER POLLUTION CONTROL	1	LS	$45,000	$45,000	
25	TEMPORARY STREAM ACCESS ROAD	185	TN	$35	$6,475	
26	DEWATERING	1	LS	$20,000	$20,000	
27	RECORD DRAWINGS	1	LS	$5,000	$5,000	
SUBTOTAL CONSTRUCTION COST					$1,372,684	
CONSTRUCTION CONTINGENCY				30%	$411,805	
TOTAL CONSTRUCTION COST WITH CONTINGENCY					$1,785,000	
SALES TAX				9.5%	$169,580	
TOTAL CONSTRUCTION COST WITH TAX					**$1,954,600**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$196,000	
DESIGN AND PERMITTING				15%	$293,190	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$294,000	
TEMPORARY EASEMENT					$5,000	
SPECIAL TESTING AND INSPECTIONS				2%	$40,000	
TOTAL CONSTRUCTION COST					**$2,783,000**	

Cost Estimate Assumptions:

1. Wall would tie into the recently repaired wall at NE 195th St. and extend approximately 330 feet to the South.
2. Wall construction would be similar type wall as NE 195th St. repair. The bid results for the WSDOT wall repair was reviewed to help develop estimates for unit costs.
3. It is assumed that the wall would be installed behind the existing gabion wall and the existing gabion wall would be removed.
4. It was assumed this would be a “stand-alone” project for the wall replacement, but because it would affect the creek would require permits and creek restoration, which was assumed to be part of the project.
5. The cost estimate includes a 30% construction contingency and soft costs (administration, design and permitting, construction management, and special testing and inspections).
6. The estimate includes a bid item break down similar to the alternative cost estimates for the 25th Ave. NE Flood Reduction Project.
7. The estimate does not include the assumption of lowering the creek profile south of 195th Street NE (which ultimately would be necessary when the 195th Street NE culvert is replaced).

From:	Trowbridge, Amity
To:	John Featherstone
Subject:	RE: [EXTERNAL] Shoreline 25th Ave NE Flood Reduction Project
Date:	Thursday, November 02, 2017 5:09:15 PM

Thanks John. Sounds like the segment adjacent to SR 104 with the wall will likely be constructed sometime after 2023. This is good news from the perspective that we'll have plenty of time to coordinate should WSDOT fund the wall replacement. I've sent an inquiry to our HQ programming office regarding when the wall might receive funding and will contact you when I get a response.

Thanks,

Amity Trowbridge, P.E.
WSDOT NWR Program Development
Tue – Fri, 7:00 AM – 5:30 PM
206.440.4749

From: John Featherstone [mailto:jfeatherstone@shorelinewa.gov]
Sent: Monday, October 30, 2017 2:34 PM
To: Trowbridge, Amity <AmityT@wsdot.wa.gov>
Cc: Crawford, John P. (NW Region) <CrawfJP@wsdot.wa.gov>; Wendt, Shawn <WendtS@wsdot.wa.gov>
Subject: RE: [EXTERNAL] Shoreline 25th Ave NE Flood Reduction Project

Hi Amity,

The City of Shoreline's plan is to phase construction of the 25th Ave NE Flood Reduction project. Currently, construction of floodplain storage within an upstream portion of the site (at the City's North Maintenance Facility Site just south of Brugger's Bog Park) is tentatively scheduled for 2023. We don't currently have a near-term construction schedule for any downstream areas (including NE 195th St culvert replacement and channel deepening along the base of the SR-104 gabion wall). The culvert at this location belongs to the City of Lake Forest Park and Shoreline wants to further determine source of funding and lead party for replacement of this culvert. If WSDOT is potentially interested in a combined construction effort, that could help to move things along and would certainly be useful context for discussions with Lake Forest Park.

Let me know if you'd like to talk over any of these topics.

Thanks,

John Featherstone, P.E.
Surface Water Engineer
City of Shoreline
Desk: 206 801 2478
Cell: 206 681 6443

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and natural environment."
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From: Trowbridge, Amity [mailto:AmityT@wsdot.wa.gov]
Sent: Friday, October 20, 2017 3:40 PM
To: John Featherstone <jfeatherstone@shorelinewa.gov>
Cc: Crawford, John P. (NW Region) <CrawfJP@wsdot.wa.gov>; Wendt, Shawn <WendtS@wsdot.wa.gov>
Subject: [EXTERNAL] Shoreline 25th Ave NE Flood Reduction Project

John – My office is developing a scoping level estimate for the replacement of the remaining gabion wall on State Route 104 in the vicinity of your flood reduction project. As noted in email correspondence with Shawn Wendt, WSDOT doesn't have a project programmed for the wall replacement, but your project might be an opportunity to coordinate construction efforts should the gabion wall replacement be programmed in the near future. Your project webpage indicated having 60% design by the end of 2018 – but doesn't have any other proposed schedule information.

When is Shoreline hoping to advertise for construction bids on the 25th Ave NE Flood Reduction project? Do you have construction funding secured?

Thanks for your help!

Thanks,
Amity Trowbridge, P.E.
Washington State Department of Transportation
NWR Program Development
Tue – Fri, 7:00 AM – 5:30 PM
206.440.4749 - amityt@wsdot.wa.gov

From:	Chi, John
To:	John Featherstone
Cc:	Wendt, Shawn
Subject:	RE: [EXTERNAL] RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo
Date:	Monday, June 19, 2017 12:00:01 PM

John,

Our HQ would like to know the replacement cost so they can make an informed decision. Let me know if you are able to provide the cost estimate for the wall replacement work.

Thanks,

John Chi, PE
WSDOT Project Engineer
(206) 440-4612

From: John Featherstone [mailto:jfeatherstone@shorelinewa.gov]
Sent: Monday, June 19, 2017 11:24 AM
To: Chi, John <ChiJ@wsdot.wa.gov>
Cc: Wendt, Shawn <WendtS@wsdot.wa.gov>
Subject: RE: [EXTERNAL] RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Hi John,

We have not estimated any costs for wall repair. The concepts we've developed to date generally moved the creek as far from the base of the wall as feasible to attempt to minimize any impacts to the wall.

Thanks,

John Featherstone, P.E.
Surface Water Engineer
City of Shoreline
Desk: 206 801 2478
Cell: 206 681 6443

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- City of Shoreline Public Works Mission

From: Chi, John [mailto:ChiJ@wsdot.wa.gov]

Sent: Monday, June 19, 2017 6:23 AM
To: John Featherstone
Cc: Wendt, Shawn
Subject: [EXTERNAL] RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

John,

Do you know the estimated cost for the wall repair work?

Thanks,

John Chi, PE
WSDOT Project Engineer
(206) 440-4612

From: Chi, John
Sent: Thursday, June 15, 2017 9:52 AM
To: 'John Featherstone' <jfeatherstone@shorelinewa.gov>
Cc: Wendt, Shawn <WendtS@wsdot.wa.gov>
Subject: RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Hi John,

We do not have this wall programmed for replacement. We are in discussion with our HQ to see potential future replacement but we would not expect to see funding anytime soon.

Thanks,

John Chi, PE
WSDOT Project Engineer
(206) 440-4612

From: John Featherstone [mailto:jfeatherstone@shorelinewa.gov]
Sent: Tuesday, May 30, 2017 11:50 AM
To: Wendt, Shawn <WendtS@wsdot.wa.gov>
Cc: Chi, John <ChiJ@wsdot.wa.gov>
Subject: RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Hi Shawn,

I hope you're doing well. I was hoping to pick up a thread from this previous coordination to pursue a little further, as it has recently become more relevant with the City of Shoreline looking to wrap up pre-design with a recommended concept and implementation plan for the 25th Ave NE Flood Reduction project. I know you may have to forward this request, but since you were the best point of contact for me to date I figured it would make sense to start with you.

So, going back to November, one of WSDOT's structural reviewers, Richard Zeldenrust, responding to the City's question #4 related to requested protection for the remaining compromised gabion retaining wall south of NE 195th St and parallel to SR-104, wrote the following (excerpted):

Total wall replacement could solve both problems. Perhaps a cantilevered sheet pile wall or cantilevered soldier pile wall could be installed immediately behind the existing gabion wall, containing the existing fill and allowing the gabion wall to be removed from the front side (stream side). A new wall, extended deeply enough, would alleviate any scour concerns, would allow removal of the failing gabion baskets, and would provide additional space for routing of the stream.

The City of Shoreline understands (as noted in WSDOT's response to question #3) that there are currently no WSDOT plans to repair or replace this wall, although it has been acknowledged that the existing wall is in poor condition, with existing gabion baskets beginning to fail due to corrosion and rock spilling out of the baskets and into the creek. At the City we would like to know if WSDOT would be willing to consider allowing the City of Shoreline and/or City of Lake Forest Park to lead efforts to repair this wall, as part of the scope of improvements related to the 25th Ave NE Flood Reduction Project, under the condition that WSDOT provide all necessary funding for the portion of work related to the wall repair. If this arrangement is possible, how would it be pursued?

Let me know if you have any questions.

Thanks,

John Featherstone, P.E.
Surface Water Engineer
City of Shoreline
Desk: 206 801 2478
Cell: 206 681 6443

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- City of Shoreline Public Works Mission

From: John Featherstone
Sent: Thursday, November 17, 2016 11:19 AM
To: 'Wendt, Shawn'
Cc: Chi, John
Subject: RE: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

Hi Shawn,

Thanks, this looks like a good first response. I have forwarded to the City's 25th Ave NE project consultant and will let you know if we have any follow-up questions.

Thanks again,

John Featherstone, P.E.
Surface Water Engineer
City of Shoreline
Desk: 206 801 2478
Cell: 206 681 6443

"Working together, protecting our resources, making a difference"
- City of Shoreline Public Works Mission

From: Wendt, Shawn [mailto:WendtS@wsdot.wa.gov]
Sent: Thursday, November 17, 2016 10:02 AM
To: John Featherstone
Cc: Chi, John
Subject: Shoreline 25th Ave NE Flood Reduction Project - WSDOT coordination memo

John,

I have solicited responses from various support groups to answer your questions within the memo. In regards to question #3; There are no long term Plans at this point to repair or replace the existing remaining gabion rock wall. Our Maintenance will most likely monitor this wall in the interim.

I hope this answers the questions in the memo. Let me know if need any additional information.

Thanks,

Shawn Neil Wendt, P.E.
Transportation Engineer 3 – Design Team Leader
Schedule: M-TH 8:00 AM- 5:30 PM
Alt Friday 8:00 AM - 4:30 PM
Office Phone: (206) 440-4614
WSDOT, NW Region
wendts@wsdot.wa.gov

Appendix L
Preliminary Alternative Evaluation

City of Shoreline
25th Avenue NE Flood Reduction Project
Subject: Preliminary Alternative Options Matrix
Date: 06-01-2016

identifies a wide range of potential options in four broad categories; conveyance options for 25th Avenue NE, conveyance options for NE 195th Street, storage options (to either mitigation for the lost of storage or to provide sufficient storage so as to reduce flooding),

		Upper 25th Avenue NE (Between Bruggers Bog Park and NE 195th Place) Note: Upper 25th Ave NE options need to be combined with a Lower 25th Ave NE option	**Initial Qualitative Assessment and Screening General Considerations**	**Flood reduction potential**	**Property acquisition or easement needed**	**Likely permitting difficulty**	**Utility Conflicts**	**Fish/ Habitat benefit**	**Street parking impact (perm)**	**Maint need/ risk**	**Cost**	**Rationale if Removed from Futher Consideration**
1		**WEST SIDE of 25th Ave NE (north of NE 195th Pl)**	**General: Avoids major utility impacts on east side, but no out-of-ROW alignment option**									
	A	*West side - Daylighted within ROW within ex shoulder Includes: 60 LF culvert across NMF driveway, 260 LF open channel, 75 LF culvert (fish passable culverts)*	*May not be enough room for stable side slopes for the daylighted creek. Might need to use walls. Not ideal for fish passage and habitat. North Maintenance Facility plan shows planned parking in the ROW on the west side.*	*HIGH*	*NO*	*MEDIUM*	*LOW*	*MEDIUM*	*MEDIUM*	*MEDIUM*	*HIGH*	
	B	*West side - Daylighted within ROW within shoulder widened by shifting roadway to the east Includes: 60 LF culvert across NMF driveway, 260 LF open channel, 75 LF culvert (fish passable culverts)*	*Likely loss of major reduction of on-street parking on both sides: west side dedicated to daylighted creek and east side park may be lost to shifted roadway. Would increase width (possibly up to 8') for the channel cross section but may not be enough to eliminate the need for a wall.*	*HIGH*	*NO*	*MEDIUM*	*LOW*	*MEDIUM*	*HIGH*	*MEDIUM*	*HIGH*	
	C	*West side - Daylighted beyond ROW (onto NMF property) Includes: 60 LF culvert across NMF driveway, 260+ LF meadnering open channel, 75 LF culvert (fish passable culverts)*	*Infeasible - All of NMF property needed for NMF facility, HOWEVER if somehow feasible: Best option to provide a natural channel cross section for the daylighted creek. Lower utility conflicts than other east side options due to alignment being outside of right-of-way. No easement or property acquisition necessary*	*HIGH*	*NO*	*LOW*	*LOW*	*HIGH*	*LOW*	*LOW*	*HIGH*	*LIKELY* Infeasible - All of NMF property is currently reserved for NMF facility; however, there is a remote chance that a radiacl overhaul in NMF plan could make some portion of the site available for daylighting
	D	*West side - Continuous box culvert below existing shoulder Includes: 60 LF culvert across NMF driveway, 260 LF culvert parallel to 25th Ave NE, 75 LF culvert (fish passable culverts)*	*WDFW discourges pipe lengths greater than 10XBankfull Width. WDFW requires that the width be increased further to accommodate geomorphological features, increasing the hydraulic radius by increasing the width by 30% over the typical fish passage width or using a bridge. This will increase the cost of this option.*	*HIGH*	*NO*	*HIGH*	*LOW*	*LOW*	*LOW*	*HIGH*	*HIGH*	
2		**EAST SIDE of 25th Ave NE (north of NE 195th Pl)**	**General: Best out-of-ROW alignment option, but major utility impacts**									
	A	*East side - Daylighted within ROW within ex shoulder Includes: 75 LF culvert across 25th Ave NE, 300 LF open channel, 50 LF culvert across NE 195th Pl (fish passable culverts)*	*May not be enough room for stable side slopes for the daylighted creek. Might need to use walls. Not ideal for fish passage and habitat. Loss of parking on east side of 25th Ave NE, mostly used by commercial truckers, some use by others. Likely major utility conflicts with water, communications, utility poles.*	*HIGH*	*NO*	*MEDIUM*	*HIGH*	*MEDIUM*	*MEDIUM*	*MEDIUM*	*HIGH*	Comment - Could make argument to not consider further because this alternative has many more utility conflicts than 1A (if don't need extra culvert)
	B	*East side - Daylighted within ROW within shoulder widened by shifting roadway alignment to west Includes: 75 LF culvert across 25th Ave NE, 300 LF open channel, 50 LF culvert across NE 195th Pl (fish passable culverts)*	*Likely loss of major reduction of on-street parking on both sides: east side dedicated to daylighted creek and west side parking may be lost to shifted roadway. Would increase width (possibly up to 8') for the channel cross section but may not be enough to eliminate the need for a wall. Likely major utility conflicts with water, communications, utility poles.*	*HIGH*	*NO*	*MEDIUM*	*HIGH*	*MEDIUM*	*HIGH*	*MEDIUM*	*HIGH*	Infeasible - this option would have major utility conflicts compared to similar west side option.
	C	*East side - Daylighted beyond ROW (onto Alderwood Annex property) Includes: 75 LF culvert across 25th Ave NE, 325 LF meadnering open channel, 50 LF culvert across NE 195th Pl (fish passable culverts)*	*Best option to provide a natural channel cross section for the daylighted creek. Lower level of utility conflicts than other east side options due to alignment being outside of right-of-way. Depends entirely upon easement or property acquisition from Shoreline School District*	*HIGH*	*YES*	*LOW*	*MEDIUM*	*HIGH*	*LOW*	*LOW*	*HIGH*	
	D	*East side - Continuous box culvert below existing shoulder Includes: 75 LF culvert across 25th Ave NE, 350 LF culvert running down east side of 25th and across NE 195th Pl*	*WDFW discourges pipe lengths greater than 10XBankfull Width. WDFW requires that the width be increased further to accommodate geomorphological features, increasing the hydraulic radius by increasing the width by 30% over the typical fish passage width or using a bridge. This will increase the cost of this option. Likely major utility conflicts.*	*HIGH*	*NO*	*HIGH*	*HIGH*	*LOW*	*LOW*	*HIGH*	*HIGH*	Infeasible - this option would have major utility conflicts compared to similar west side option.
		Lower 25th Avenue NE (Between NE 195th Place and NE 195th Street) Note: Lower 25th Ave NE options need to be combined with an Upper 25th Ave NE option	**General: All Lower 25th Ave NE options will likely require improvements to existing open channel segment crossing southwest corner of 2518 NE 195th St**									**Rationale if Removed from Futher Consideration**
3		**WEST SIDE of 25th Ave NE (south of NE 195th Pl)**	**General: Avoids major utility and parking impacts on east side, no daylight option**									
	A	*West side - Daylighted within ROW Includes: 200 LF open channel, 60 LF culvert crossing 25th Ave NE to existing open channel*	*Conflicts with existing sidewalk, roadway, and large apartment building located close to ROW boundary*	*HIGH*	*NO*	*MEDIUM*	*LOW*	*MEDIUM*	*LOW*	*MEDIUM*	*HIGH*	Infeasible - this option would require permanent removal of existing sidewalk
	B	*West side - Daylighted beyond ROW*	*Conflict with large apartment building located close to ROW bounadry*	*HIGH*	*YES*	*LOW*	*LOW*	*HIGH*	*LOW*	*LOW*	*HIGH*	Infeasible - this option would require purchase and removal of large apartment building
	C	*West side - Continuous box culvert Includes: 200 LF culvert parallel to 25th Ave NE, 60 LF culvert crossing 25th Ave NE to existing open channel*	*Work would requirement removal and replacement of newer sidewalk and excavation work close to foundation of newer large apartment building at 19500. WDFW discourges pipe lengths greater than 10XBankfull Width. WDFW requires that the width be increased further to accommodate geomorphological features, increasing the hydraulic radius by increasing the width by 30% over the typical fish passage width or using a bridge. This will increase the cost of this option.*	*HIGH*	*NO*	*HIGH*	*LOW*	*LOW*	*LOW*	*HIGH*	*HIGH*	
4		**EAST SIDE of 25th Ave NE (south of NE 195th Pl)**	**General: Follows most closely existing stream conveyance alignment**									
	A	*East side - Daylighted within ROW Includes: 115 LF open channel parallel to 25th Ave NE, 60 LF culvert crossing driveway for 2518 complex*	*May not be enough room for stable side slopes for the daylighted creek. Might need to use walls. Not ideal for fish passage and habitat. Total loss of parking on east side of 25th Ave NE, currently used by residents. Likely major utility conflicts with water, communications, utility poles.*	*HIGH*	*NO*	*MEDIUM*	*HIGH*	*MEDIUM*	*HIGH*	*MEDIUM*	*HIGH*	

	B	*East side - Daylighted beyond ROW Includes: 115+ LF open channel meandering parallel to 25th Ave NE, 60 LF culvert crossing 2518 complex driveway or parking*	*Best option to provide a natural channel cross section for the daylighted creek; could also provide floodplain storage potential due to need to acquire whole parcel. Lower level of utility conflicts than other east side options due to alignment being outside of right-of-way. Depends entirely upon property acquisition of 2500 NE 195th Pl fourplex (>$700k cost)*	*HIGH*	*YES*	*LOW*	*MEDIUM*	*HIGH*	*LOW*	*LOW*	*HIGH*	Infeasible - this option would require purchase and removal of fourplex building
	C	*East side - Continuous box culvert Includes: 175 LF culvert parallel to 25th Ave NE, below parking area and crossing driveway for 2518 complex*	*WDFW discourges pipe lengths greater than 10XBankfull Width. WDFW requires that the width be increased further to accommodate geomorphological features, increasing the hydraulic radius by increasing the width by 30% over the typical fish passage width or using a bridge. This will increase the cost of this option.Likely major utility conflicts with water, communications, utility poles.*	*HIGH*	*NO*	*HIGH*	*HIGH*	*LOW*	*LOW*	*HIGH*	*HIGH*	
		25th Avenue NE - full length options (Between Brugger's Bog Park and NE 195th Street) All 25th Ave NE Full Length options would be done in lieu of any of the Upper and Lower 25th Ave NE options	**General:**									**Rationale if Removed from Futher Consideration**
5		Install high-flow bypass (likely along west side of 25th Ave NE to minimize utility impacts); existing system to remain	WDFW requires a fish screen for highflow bypass. Fish screens can be prohibitively expensive. Fish screens require fine mesh to exclude fish which results in a very large structure. It would be difficult to fit a large fish screen into a site. Fish screens can get clogged with debris easilty and become a maintenance issue or render the highflow bypass blocked during big events. Could use a self-cleaning screen like used in irrigation. Need to consult with WDFW to determine if the fish screen requirement might be waved if above OHW, or waived if significant off-site habitat mitigation is provided. Even it approved, this option may be technically challenging because the existing system is so shallow.	*HIGH*	*NO*	*HIGH*	*LOW*	*LOW*	*LOW*	*HIGH*	*MEDIUM*	Infeasible - this option would be difficult to permit. In future, when City needs to replace culvert system, fish passage likely required at that time. A large fish screen is undesirable. Also, would need to get similar buy in from agencies as 6A, so 6A would be considered better option.
6	A	Upsize existing pipes with non-fish passable pipe sizes sized only for conveyance and seek permit approvals using significant off-site habitat mitigation. This could also include other elements to increase the flooding LOP (such as Interim Solutions 2 and 5).	May not eliminate as much storage as replacing the culverts with fish-passable culverts and therefore may not need to add as much flood storage to compensate. Need to consult with WDFW to determine if this option would be permittable.	*MEDIUM*	*NO*	*HIGH*	*MEDIUM*	*LOW*	*LOW*	*MEDIUM*	*MEDIUM*	
6	B	Line existing pipes (would presumably lengthen pipe lifespan and slightly increase capacity due to increased smoothness) and seek permit approvals using significant off-site habitat mitigation. This would require other elements to increase the flooding LOP (such as Interim Solutions 2 and 5).	May not eliminate as much storage as replacing the culverts with fish-passable culverts and therefore may not need to add as much flood storage to compensate. Need to consult with WDFW to determine if this option would be permittable.	*LOW*	*NO*	*HIGH*	*LOW*	*LOW*	*LOW*	*MEDIUM*	*LOW*	This option is viable for consideration only if (1) it is allowable by permitting, and (2) implementation of other improvements would be sufficient to dramatically reduce flooding
7		Do Nothing Alternative	Flooding would continue. Flooding would include the sole access to the new City NFM, and there could be negative perception if new NMF subject to recurrent flooding. In future, whenever culvert needs to be replaced due to failing condition, the City would be presented with the same costly requirements for providing fish passage at that time. This flooding problem is considered one of the worst, if not worst, flooding problems in the City.	*LOW*	*NO*	*LOW*	*LOW*	*LOW*	*LOW*	*HIGH*	*LOW*	Option is not considered desirable because (1) eventually the City will need to consider replacing of this system and meeting costly fish passage requirementss, and (2) if this is the case, its better to proceed earlier than later to reduce flood hazards to private properties, 25th, and the NFM.

			Initial Qualitative Assessment and Screening									
		Conveyance Options NE 195th Street	**Considerations**									**Rationale if Removed from Futher**
8		Replace with fish passable culvert	Easily permittable. Good for for fish passage.	*HIGH*	*NO*	*LOW*	*HIGH*	*HIGH*	*LOW*	*LOW*	*HIGH*	
9		Buy-out flooding property	High water levels upstream of NE 195th Street impact flooding at 25th Avenue NE. This option would not eliminate the high water levels and therefore may severely limit the improvements that can be made at 25th Avenue NE. Note the assessed values of 2518 and 2500 are $2.2 million and $690,000, repsectively). Would require re-locating residents.	*LOW*	*YES*	*LOW*	*HIGH*	*LOW*	*LOW*	*LOW*	*HIGH*	Because this option would not help alleviate flooding upstream along 25th Ave NE, this option will not be further considered.
10		Line the existing culvert, potentially in combination with floodwall improvements and signficant habitat mitigation in order to obtain permits.	May not eliminate as much storage as replacing the culverts with fish-passable culverts and therefore may not need to add as much flood storage to mitigate for increased downstream flows. High water levels upstream of NE 195th Street impact flooding at 25th Avenue NE. It is not clear at this point how much flood reduction benefit this option would have on 25th Avenue NE. Existing culvert is set below the downstream grade. Cleaning out and sliplining the culvert would improve the capacity, but it is likely that it would fill up with sediment again and be a maintenance issue. Would need to consult with WDFW to determine if this is permitable.	*LOW*	*NO*	*HIGH*	*LOW*	*LOW*	*LOW*	*MEDIUM*	*LOW*	This option is viable for consideration only if (1) it is allowable by permitting, and (2) implementation of other improvements would be sufficient to dramatically reduce flooding
11		Flood proofing structures (such as raising buildings) (culvert would remain LFP's).	High water levels upstream of NE 195th Street impact flooding at 25th Avenue NE. This option would most likely prevent the flooding at 25th Avenue NE from being solved. Flooding of parking areas (including parked cars) would remain. Ultimately in future when culvert is replaced due to failure (in this case by LFP), the cost spent on flood proofing would have not been needed. Would not need a HPA	*LOW*	*YES*	*LOW*	*LOW*	*LOW*	*LOW*	*HIGH*	*MEDIUM*	Because this option would not help alleviate flooding upstream along 25th Ave NE, this option will not be further considered. Property acquisition not necessary, but would represent a significant investment of public funds on private property.
12		Add a high flow bypass (could potentially be configured above OHW?)	WDFW requires a fish screen for highflow bypass. Fish screens can be prohibitively expensive and large with fine mesh. Typically hard to fit a large fish screen into a site. Tend to get clogged with debris and become a maintenance issue or render the highflow bypass blocked during big events. Need to consult with WDFW to determine if the fish screen requirement might be waved if above OHW, or waived if signficant off-site habitat mitigation is provided	*MEDIUM*	*NO*	*HIGH*	*LOW*	*LOW*	*LOW*	*HIGH*	*MEDIUM*	
13		Do Nothing Alternative	Flooding would continue. Even with improvements to the 25th system, flooding would include the sole access to the new City NMF, and there could be negative perception if new NMF subject to recurrent flooding. In future, whenever culvert needs to be replaced due to failing condition, the City would be presented with the same costly requirements for providing fish passage at that time. This flooding problem is considered one of the worst, if not worst, flooding problems in the City.	*LOW*	*NO*	*LOW*	*LOW*	*LOW*	*LOW*	*HIGH*	*LOW*	Option is not considered desirable. see discussion under 25th Ave NE No Action Option.

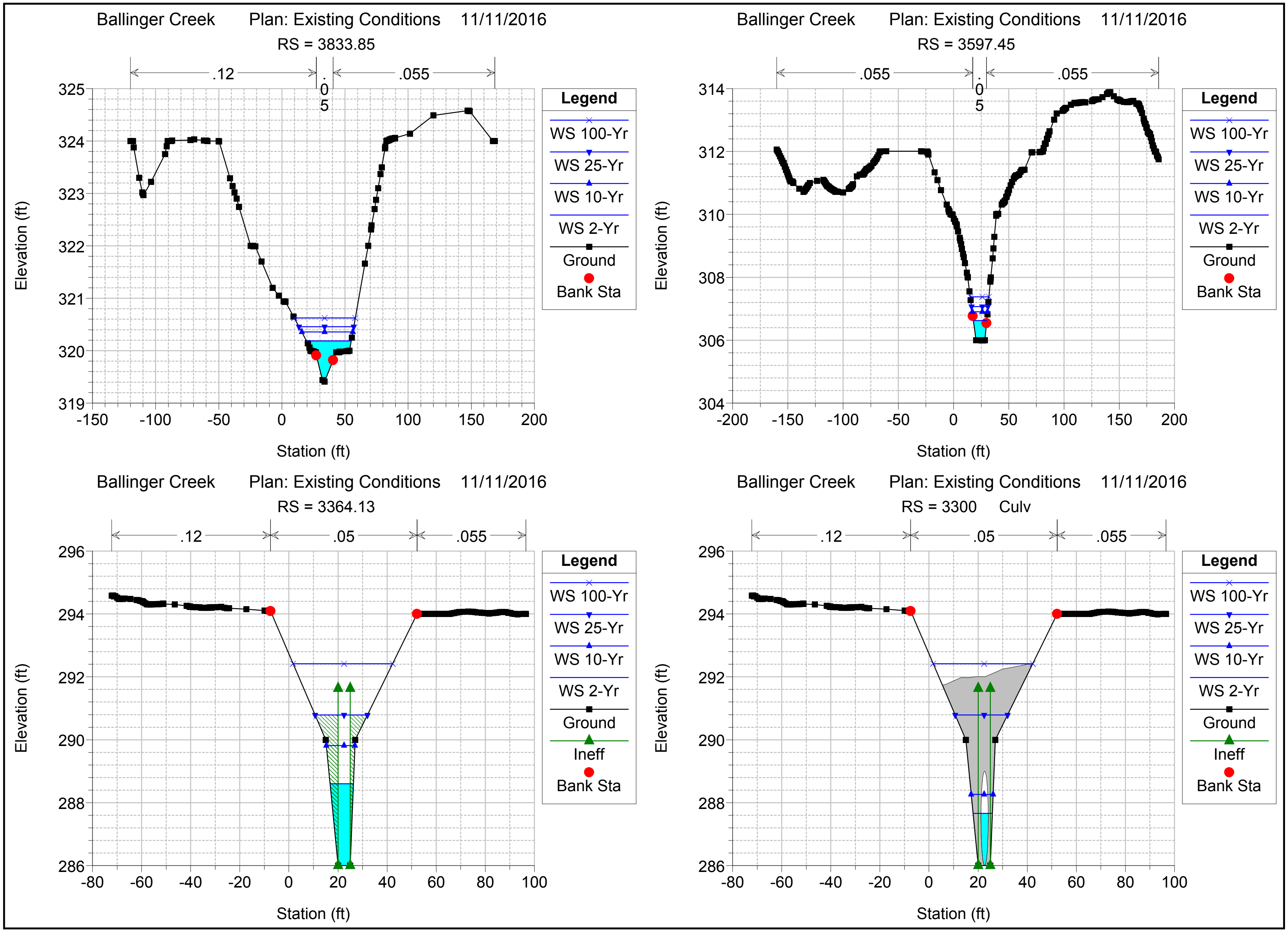
			Initial Qualitative Assessment and Screening									
		Storage Options	**Considerations**									**Rationale if Removed from Futher Consideration**
14		Brugger's Bog Southeast Floodplain Storage (using southeast portion of bog)	Site is steeply sloped. May not be enough area to fully mitigate the loss of flood storage. Would need to replace and mitigate for loss of 0.23 acre Type II wetland , although with expansion of flood storage, it may be self mitigating.	*MEDIUM*	*NO*	*MEDIUM*	*LOW*	*HIGH*	*LOW*	*LOW*	*MEDIUM*	
15		Brugger's Bog Northwest Floodplain Storage (using northwest portion of bog)	Site is steeply sloped. May not be enough area to fully mitigate the loss of flood storage. This location may be within the BPA corridor where open water is discouraged.	*MEDIUM????*	*NO*	*LOW????*	*LOW*	*MEDIUM*	*LOW*	*LOW*	*MEDIUM*	
16		Shoreline School District 412 Property	General: Option requires acquiring an easement/property.									
	A	*Floodplain storage (open natural floodplain with habitiat features/planting)*	*Baseball field adjacent to where the daylighted creek would be is less sloped than other flood storage sites.* *Requires easement/property acquisition.*	*MEDIUM*	*YES*	*LOW*	*LOW*	*HIGH*	*LOW*	*LOW*	*HIGH*	
	B	*Underground vault (allowing for above use such as playfield)*	*Expensive and less environmentally desirable than using floodplain storage.* *Allows improvements, such as recreational fields or paved parking, to be constructed above the vault.*	*MEDIUM*	*YES*	*LOW*	*LOW*	*MEDIUM???*	*LOW*	*LOW*	*HIGH*	
17		Ballinger Open Space Area	General: 2.6 acre City-owned property; no easement/acquisition required.									
	A	*Site excavation and regrading and add floodwall along NE 200th St to increase storage.*	*Site is steeply sloped. May not be enough area to fully mitigate the loss of flood storage. Adding a flood wall will help increase storage volume. South portion of site is likely wetland. An optioal configuration could be to focuse on the north portion of site.*	*MEDIUM????*	*NO*	*LOW????*	*LOW*	*MEDIUM*	*LOW*	*LOW*	*MEDIUM*	
	B	*Site excavation and regrading and raise NE 200th to increase storage*	*Site is steeply sloped. May not be enough area to fully mitigate the loss of flood storage. Raising NE 200th will help increase storage volume.*	*MEDIUM????*	*NO*	*LOW????*	*LOW*	*MEDIUM*	*LOW*	*LOW*	*MEDIUM*	
18		Half-Time III LLC property (just u/s of Ballinger Way at 2609 NE 195TH ST 98155)	May not be enough area to fully mitigated the loss of flood storage. Site may contain wetland, which may make permitting more complicated. Requires easement/property acquisition. Note this would be in Lake Forest Park.									Option is not considered viable. Based on H/H modeling, this area already provides significant storage and is subject to flooding. Also, in future when downstream culvert is replaced, likley needs to be fish passable.

		Initial Qualitative Assessment and Screening									
	Basin-wide	**Considerations**									**Rationale if Removed from Futher**
19	Apply green streets to the tributary basin	A significant portion of the basin would need to be converted to green streets to have a significant impact on the site. This could take a long time to implement. A large portion of the basin is within Mountlake Terrace. Would need to obtain an agreement with Mountlake Terrace to convert to green streets.									Likely not feasible as a primary solution because much of the basin is in Mountlake Terrace and a fairly large portion of the remaining area in Shoreline is very highly developed.
20	Retrofit tributary basin with UIC (underground injection to infiltration wells/trenches)	Need to consult with a geotech to determine if UIC is an realistic option in this basin. All infiltrated stormwater would need pre-treatment using Ecology standards. This would likely be prohibitively expense for retrofit situations.									Not considered a viable option due to unknown benefit and likely cost prohibitive pre-treatement required.
21	Upstream diversion with regional detention at Shoreline School District Property	Need further study to determine if this would provide enough relief to mitigate for the flooding. Requires easement/property acquisition.	*MEDIUM*	*YES*	*LOW*	*LOW*	*MEDIUM???*	*LOW*	*LOW*	*HIGH*	
22	Buyouts and provide storage in upper piped portion of basin (avoiding signficant permitting) (such as trailer park at NW corner of 54th Ave W and NE 205th St).	Property within Mountlake Terrace. Would require cooperation of MLT to proceed. Would require relocating residents. Not clear whether this would provide enough detention to mitigate the flooding at the project site.	*MEDIUM*	*YES*	*LOW*	*LOW*	*MEDIUM???*	*LOW*	*LOW*	*HIGH*	Not considered as further option due to uncertainty of benefits and difficulty of potential execution due to location being outside of City and County jurisdiction. Potential for coordiation with MLT on future projects.
23	Downstream culvert replacement (to avoid flood storage mitigation)	Would need to assess downstream flow impacts in Lake Forest Park. There are six culverts on Ballinger Creek and if the increase in downstream flow continues into Lyons Creek, there are an additional nine culvert crossings. Upsizing one (if the increase in flow causes flooding) has the potential to further increase downstream flows/flooding which may result in a domino effect. Also, increased downstream flows may adversely impact the stream channel. The *Lake Forest Park Flood Reduction Study* (Otak) notes reaches with stability problems on Lyon Creek downstream of the project. However, the study did not study Ballinger Creek.									Likely not feasible due to costs and likely negative impacts of inceasing downstream flows.
24	Regional detention in the northwest corner of Brugger's Bog.	A large commercial basin enters Ballinger Creek at this location (about 55 acres). This would be a good location to detain and treat flow entering the creek. Not clear if this would mitigate for the flooding at 25th Avenue NE. This location is in the BPA easement. Generally, BPA doesn't permit facilities within the easement.	*MEDIUM????*	*NO*	*LOW????*	*LOW*	*MEDIUM*	*LOW*	*LOW*	*MEDIUM*	(need to clarify difference between this alternative and Alt #15 - Floodplain storage vs. inline detention??)
25	High flow bypass for Ballinger Way storm system	This would convey a large (25%) portion of the basin impervious area to a location downstream of NE 195th Street An issue would be potential increases in downstream flows, which would likely require mitigation storage. Another consideration is that if the City has to replace the 25th system in the future due to failure, the City would still need to meet the costly fish passage. Thus, this may not be considere viable, unless WDFW/agencies agree to not requireing fish passage in future replacement.	*LOW*	*NO*	*LOW*	*MEDIUM*	*LOW*	*LOW*	*LOW*	*HIGH*	Option is not considered viable, based on liklihood of increased downstream peak flows and that fish passage conveyance will likely be required in future.
26	High flow bypass and storage at North Maintenance Facilty	The North Maintenance Facility already lacks area for its own use. No significant area remaining for flood storage in pond arrangement. However, there may potential for underground storage in vault and serving the west portion of the basin if combined with a high flow pipe system extension (e.g. from Ballinger Way just west of 22nd Ave NE an existing 24-inch pipe system could be extended to the NMF and detained in a vault in the west portion of the site prior to discharge to the existing system. In this location the vault could be deep. One additional consideration is that the storage may be able to serve as the "sites" mitigation for stormwater detention.	*MEDIUM????*	*NO*	*LOW*	*LOW*	*MEDIUM*	*LOW*	*LOW*	*HIGH*	This option is viable for consideration only if NMF design can accommodate
-											

	Interim Solutions	Initial Qualitative Assessment and Screening Considerations									Rationale if Removed from Futher
27	Clean out culvert at 195th and channel downstream	The culvert appears to be set lower than the downstream channel. Cleaning out the culvert would improve capacity, but it is likely that it would just get filled in again and continue to be a maintenance issue. Not clear if cleaning the culvert would reduce flooding sufficiently. The Basin Plan model includes a culvert that is completely open at this location and is still showing flooding.	*MEDIUM*	*NO*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	
28	Raise 25th Avenue NE	Raising 25th Avenue NE may be not a good investment if the culvert under the road needs to be replaced in the future and it is replaced with a fish passable culvert. It is likely that a fish passable culvert would lower the upstream water level such that the extra roadway elevation would not be needed to prevent flooding of the roadway.	*MEDIUM*	*NO*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	*MEDIUM*	This option is not considered beneficial if fish passage is required .
29	Construction a short wall/berm at 25th Avenue NE	This would be similar to rasing 25th Avenue but the investment would be smaller. May need to use a wall rather than a berm due to the lack of space available.	*MEDIUM*	*NO*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	
30	Construction a short berm (large speed humps) along 25th Ave NE along all driveways and adjacent to driveways in attempt to keep flood flows contained in ROW.	Potentially could increase LOP for structures. May make flood depths along 25th Ave NE slightly higher.	*MEDIUM*	*NO*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	*LOW*	

Appendix M
Hydraulic Model Output

Appendix M.1
Existing Conditions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.05
.055
Legend
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WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
325
324
323
322
321
320
319
-150
-100
-50
0
50
100
150
200
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 3597.45
.055
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
314
312
310
308
306
304
-200
-150
-100
-50
0
50
100
150
200
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 3364.13
.12
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
296
294
292
290
288
286
-80
-60
-40
-20
0
20
40
60
80
100
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 3300 Culv
.12
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
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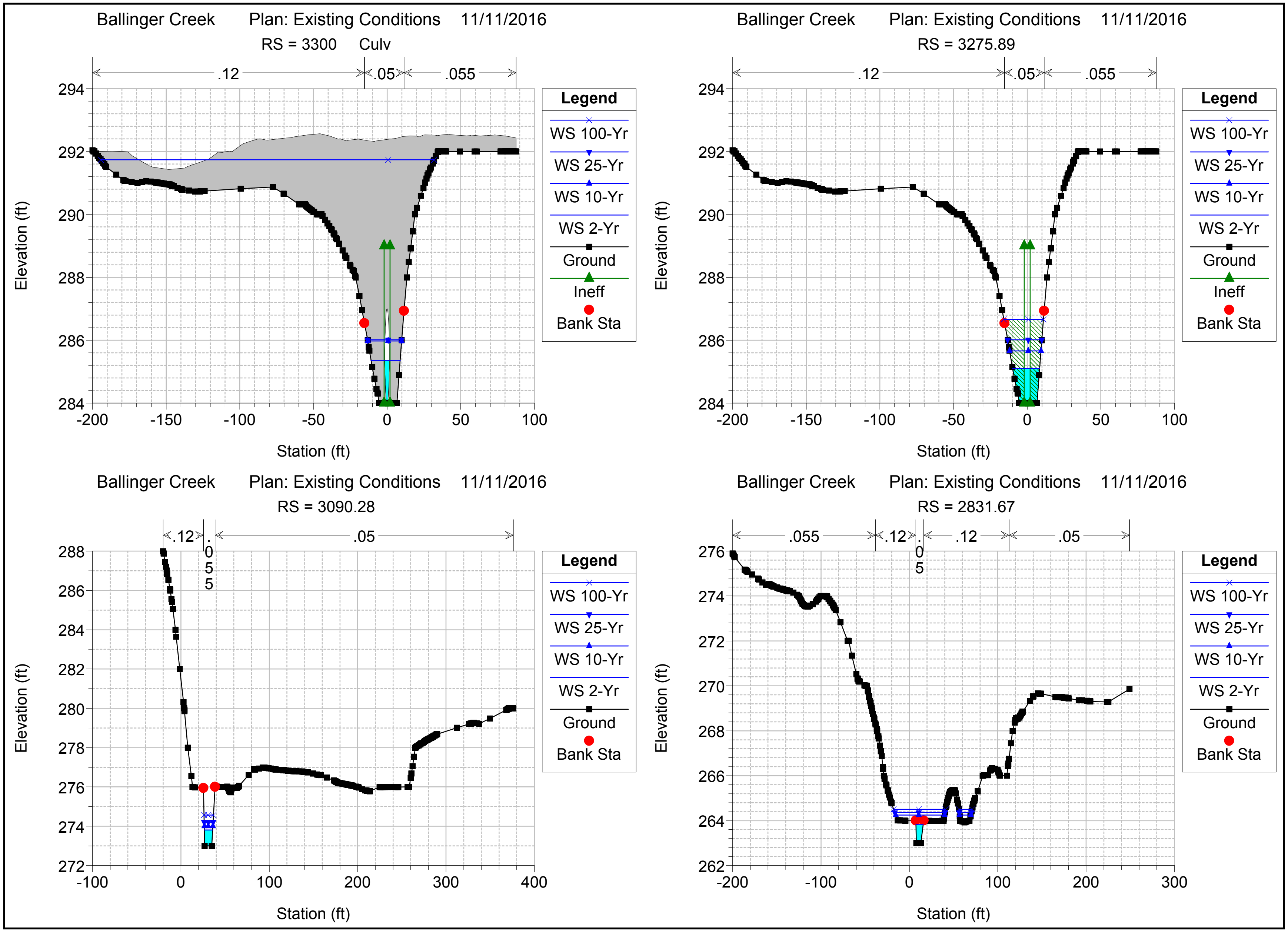
294
292
290
288
286
-80
-60
-40
-20
0
20
40
60
80
100



Ballinger Creek Plan: Existing Conditions 11/11/2016
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.12 .05 .055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
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Legend
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WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
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WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
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WS 25-Yr
WS 10-Yr
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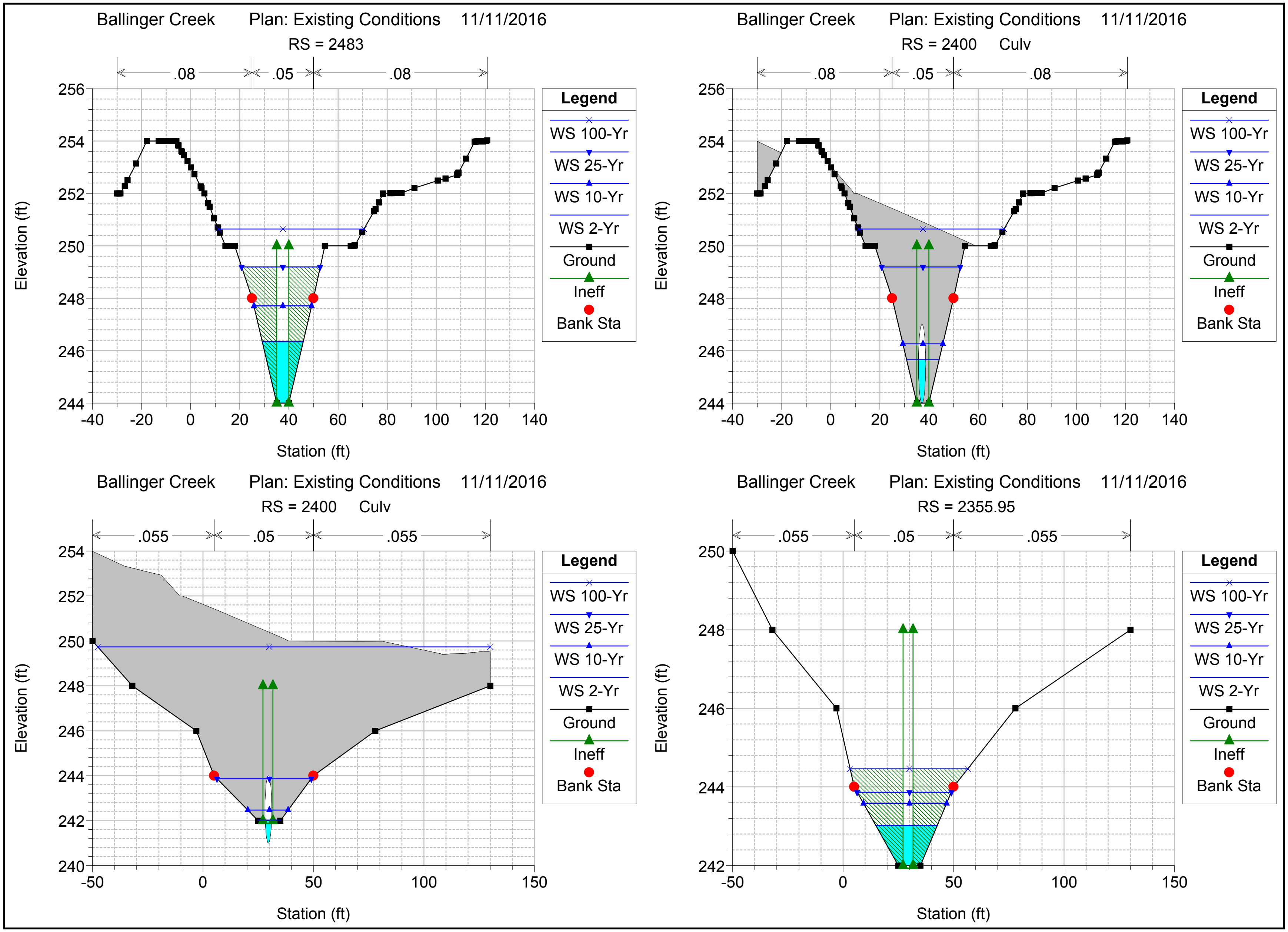
Ground
Bank Sta
Elevation (ft)
Station (ft)


Ballinger Creek
Plan: Existing Conditions
11/11/2016
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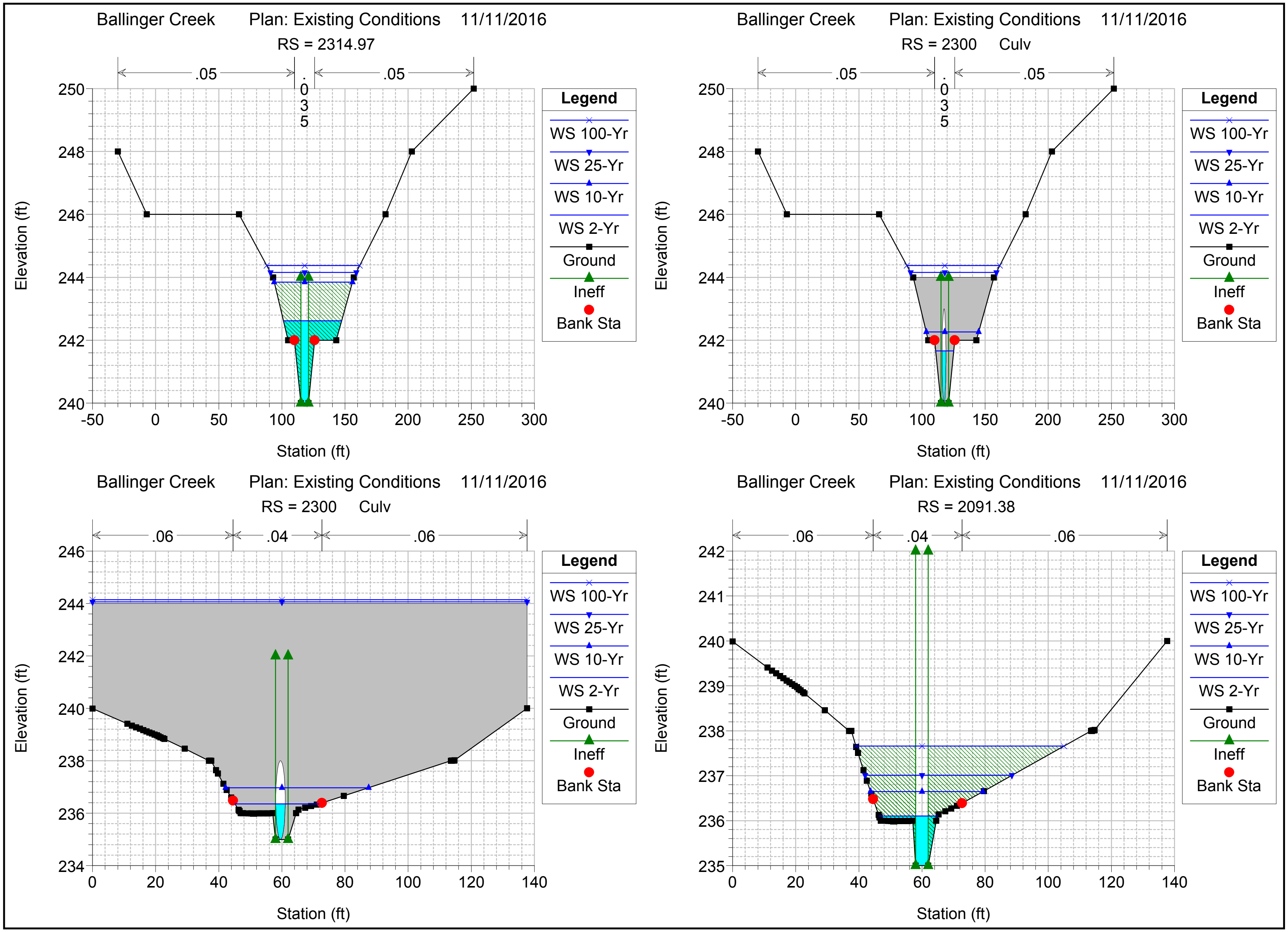
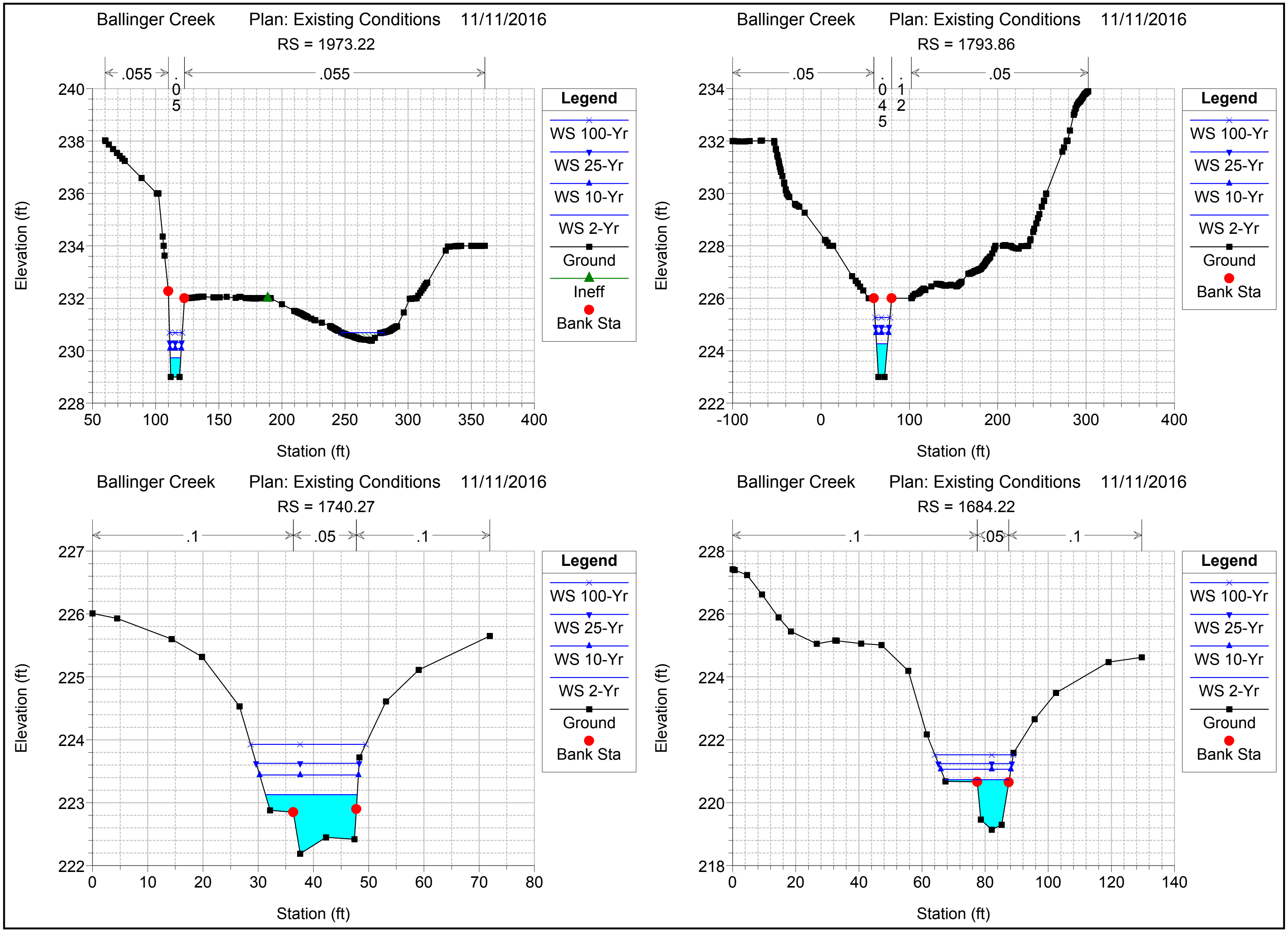
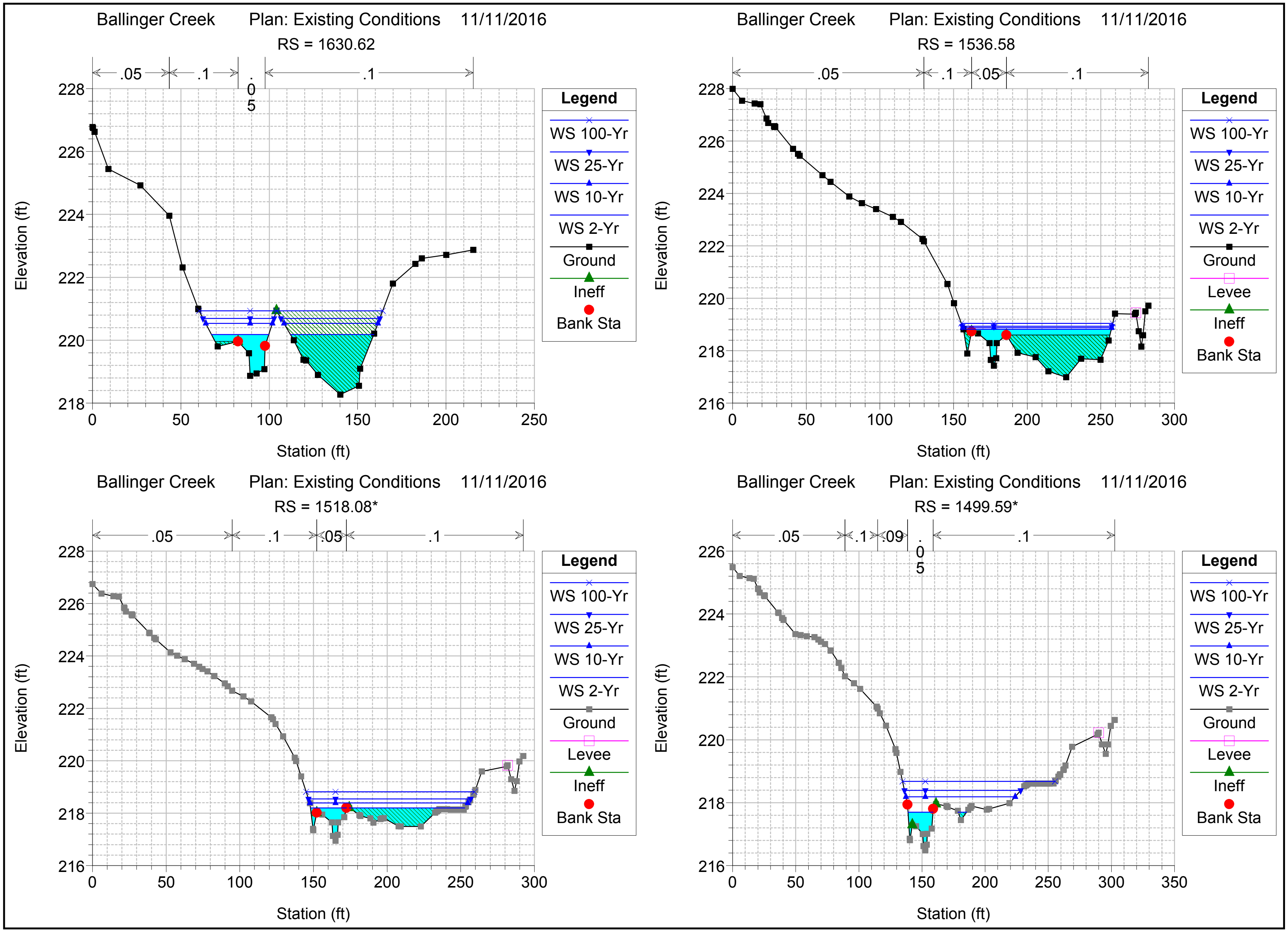
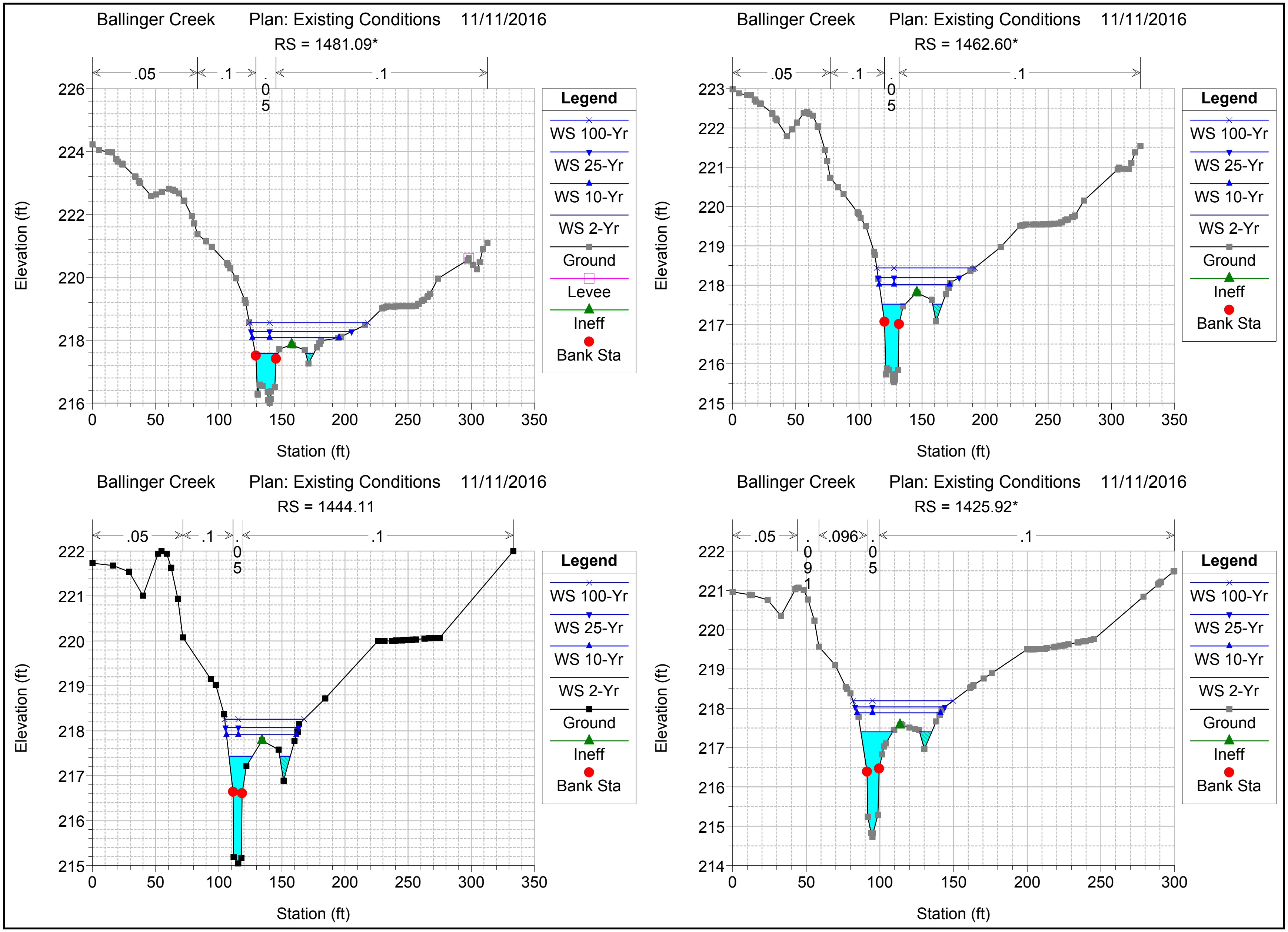
.08
.05
.08
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek
Plan: Existing Conditions
11/11/2016
RS = 2400 Culv
.08
.05
.08
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek
Plan: Existing Conditions
11/11/2016
RS = 2400 Culv
.055
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek
Plan: Existing Conditions
11/11/2016
RS = 2355.95
.055
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



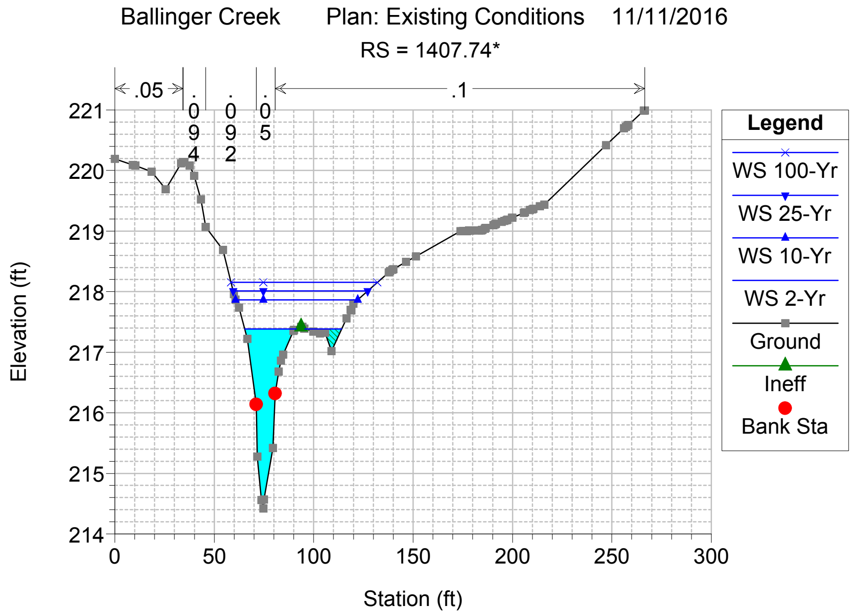
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 2314.97
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 2300 Culv
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 2300 Culv
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 2091.38
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

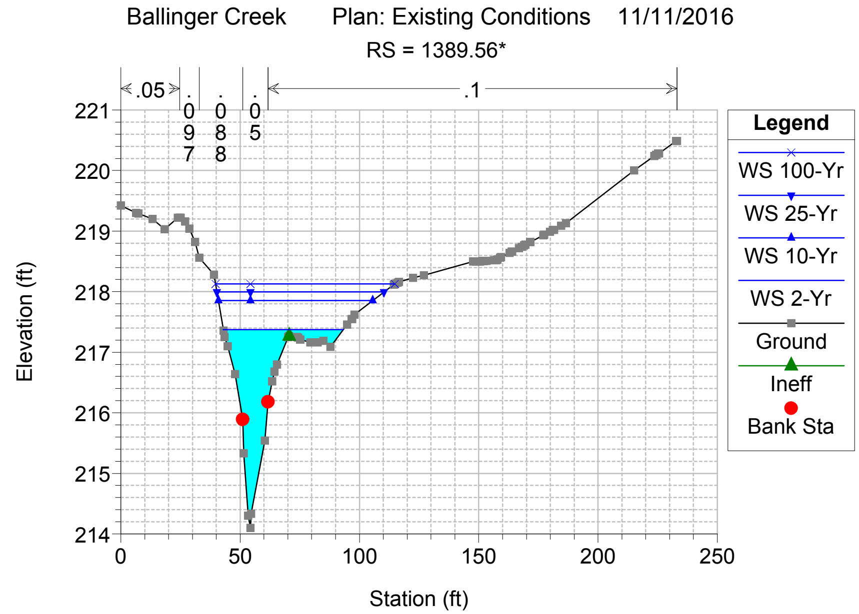

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1973.22
.055
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1793.86
.05
.045
.12
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1740.27
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1684.22
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

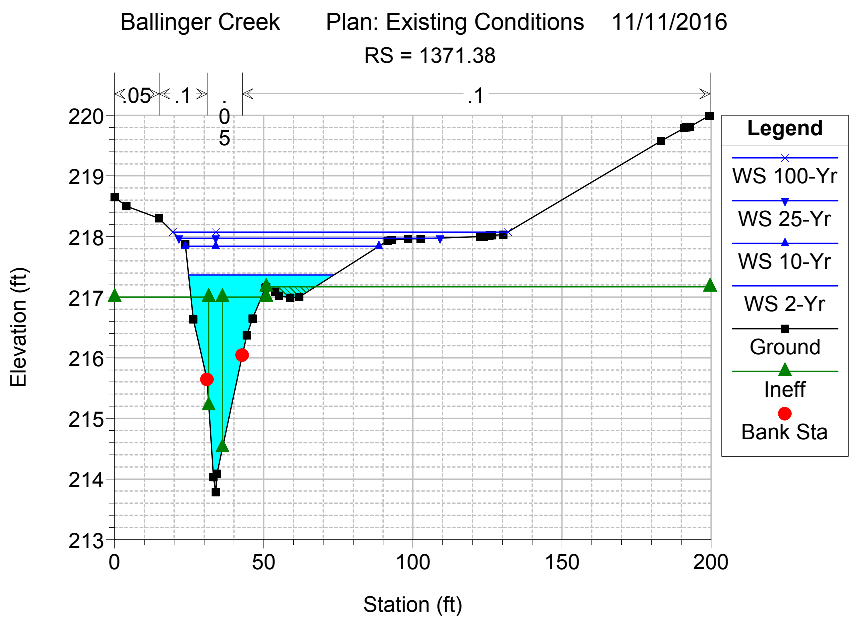

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1630.62
.05 .1 .05 .1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1536.58
.05 .1 .05 .1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1518.08*
.05 .1 .05 .1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1499.59*
.05 .1 .09 .05 .1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

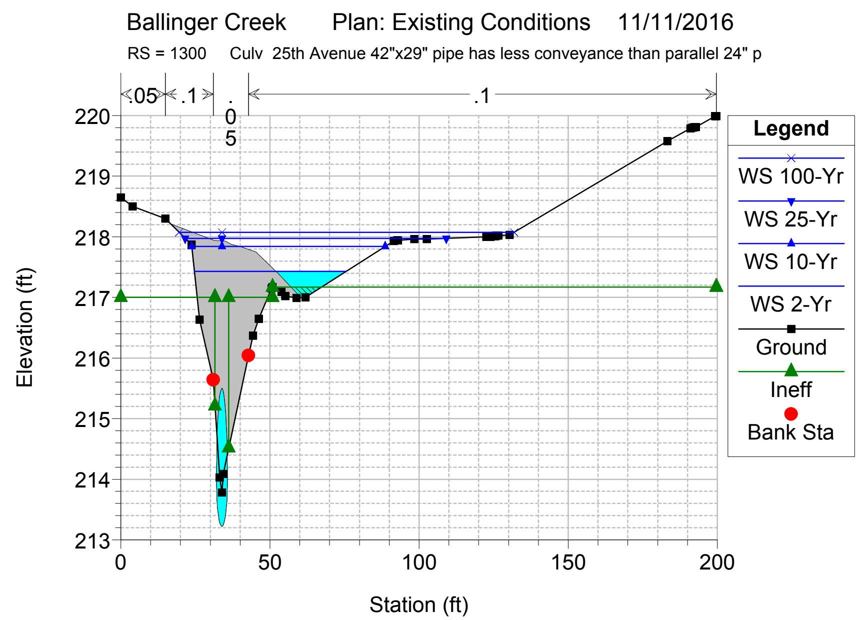


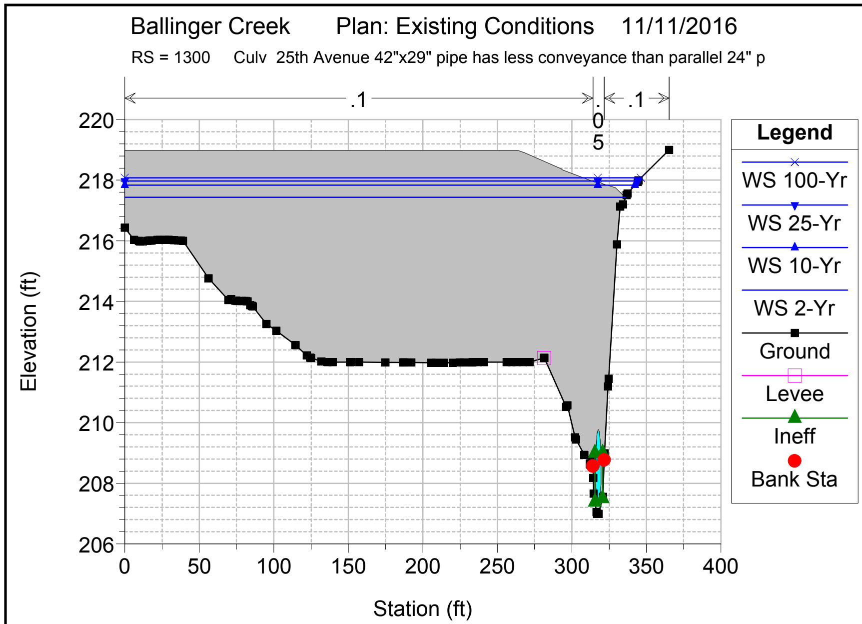
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1481.09*
.05
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1462.60*
.05
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1444.11
.05
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1425.92*
.05
.091
.096
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

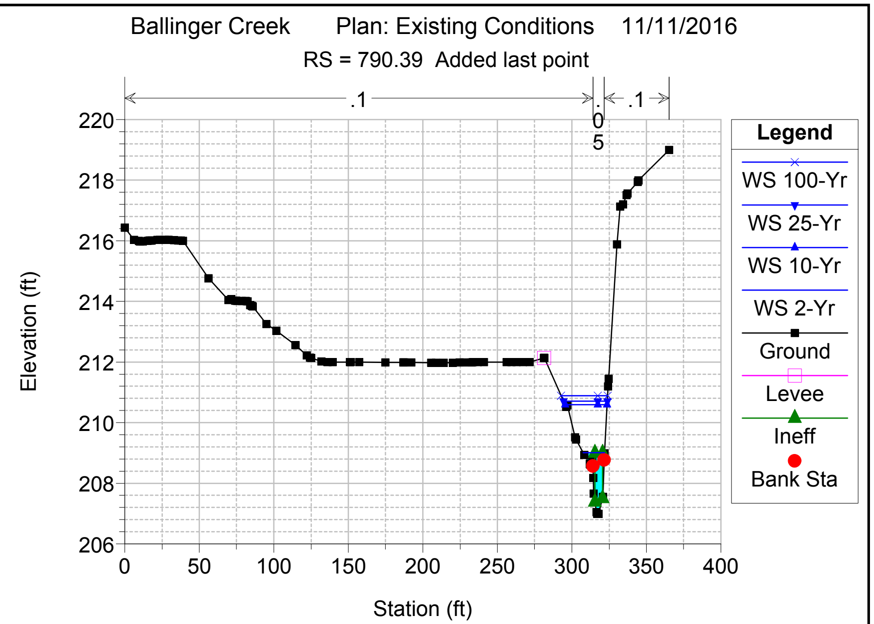

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1407.74*
.05
.094
.092
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

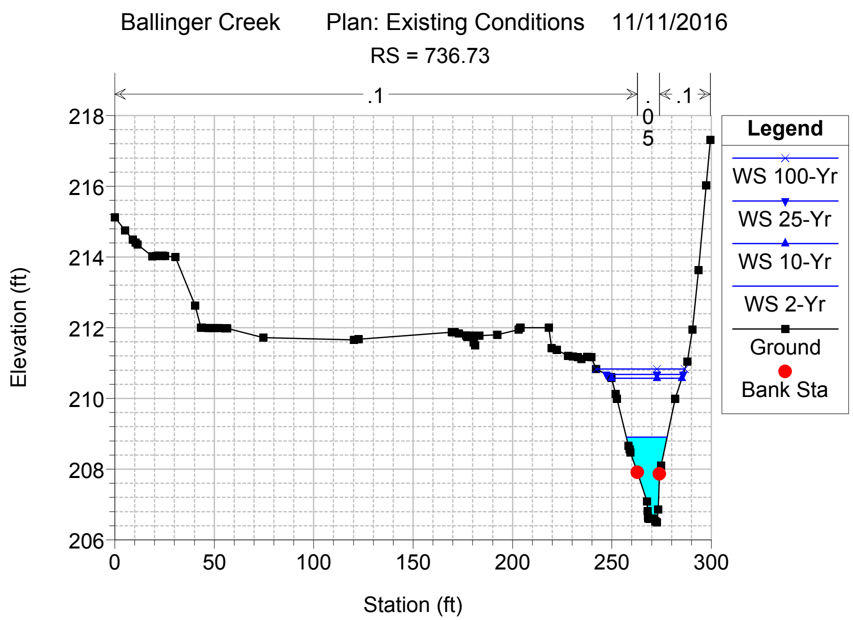

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1389.56*
.05
.097
.088
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

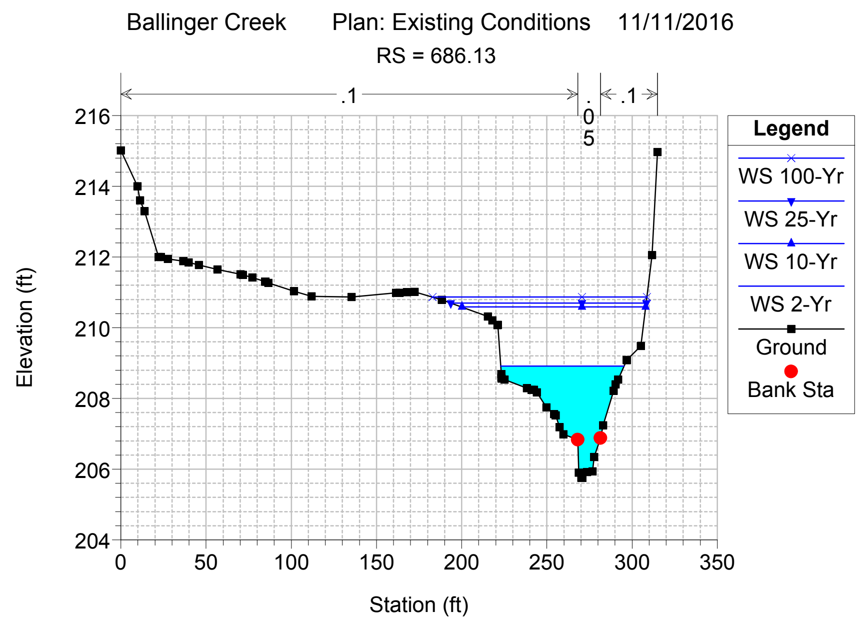

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1371.38
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

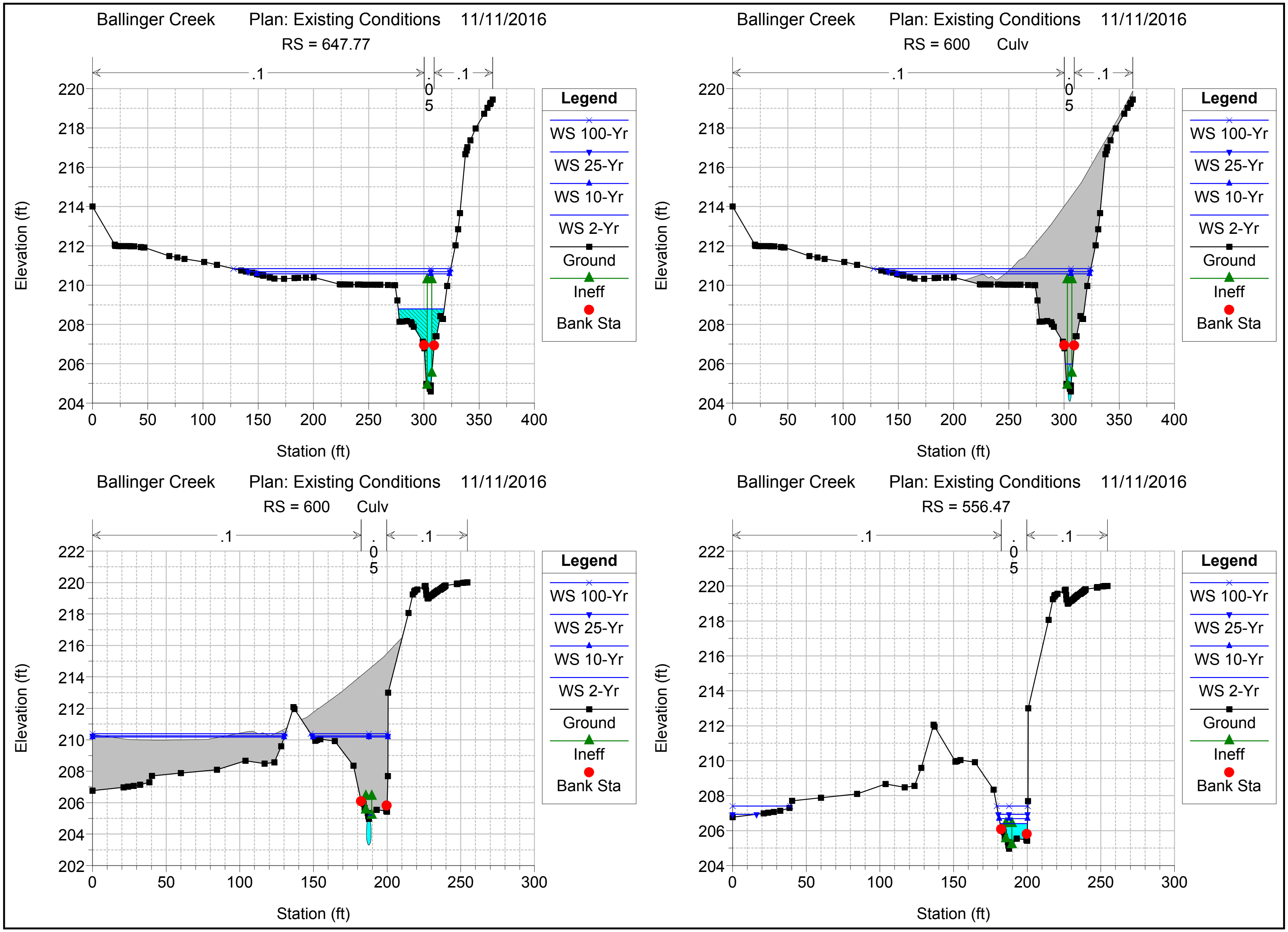

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1300 Culv 25th Avenue 42"x29" pipe has less conveyance than parallel 24" p
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

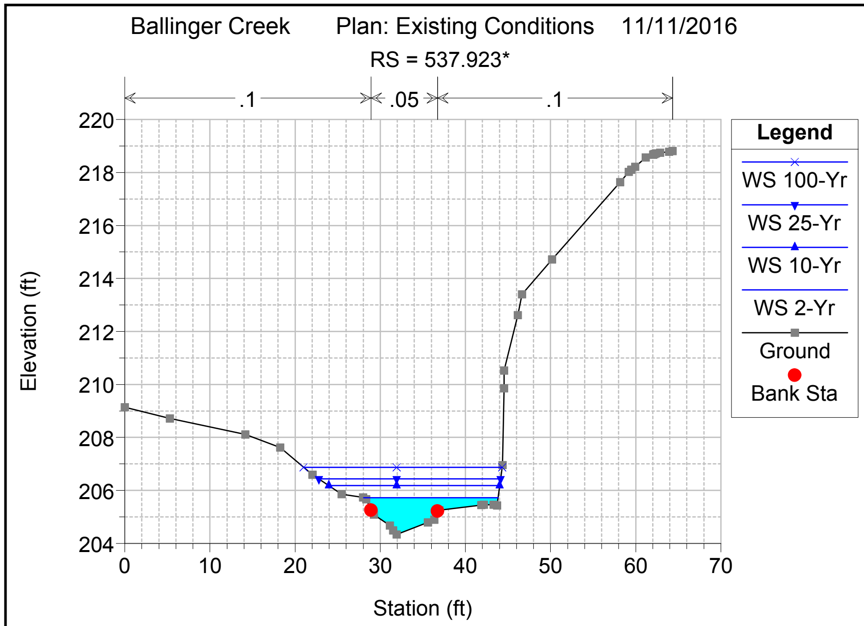

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 1300 Culv 25th Avenue 42"x29" pipe has less conveyance than parallel 24" p
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

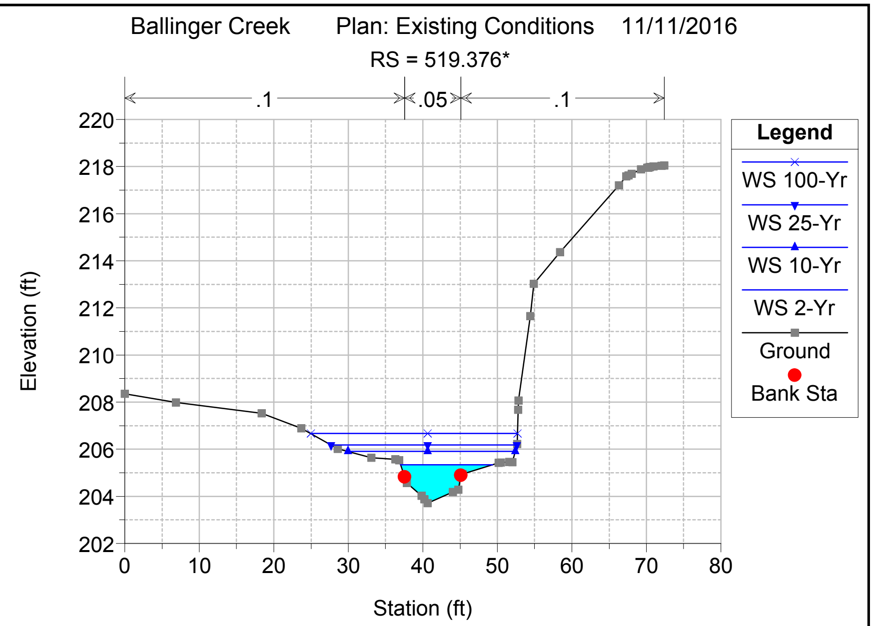

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 790.39 Added last point
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

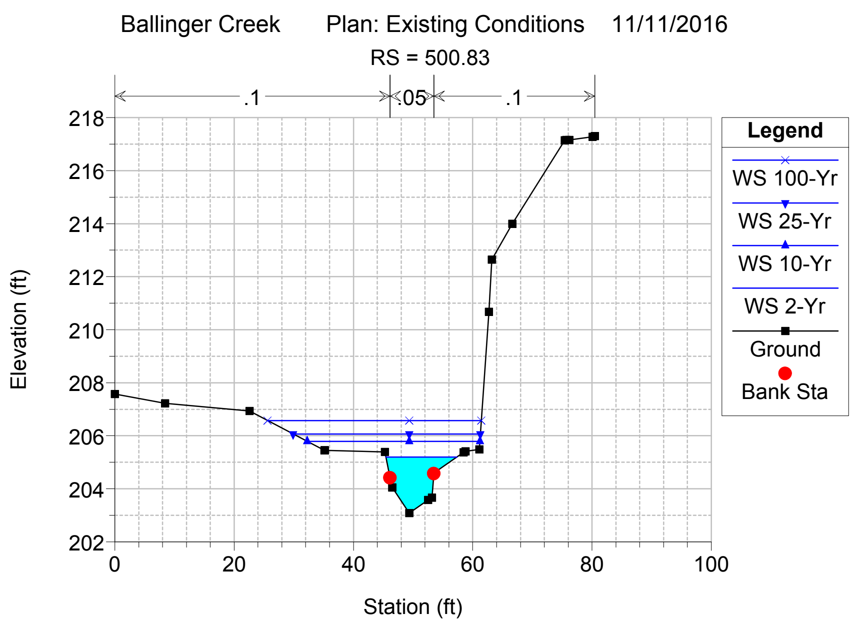

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 736.73
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

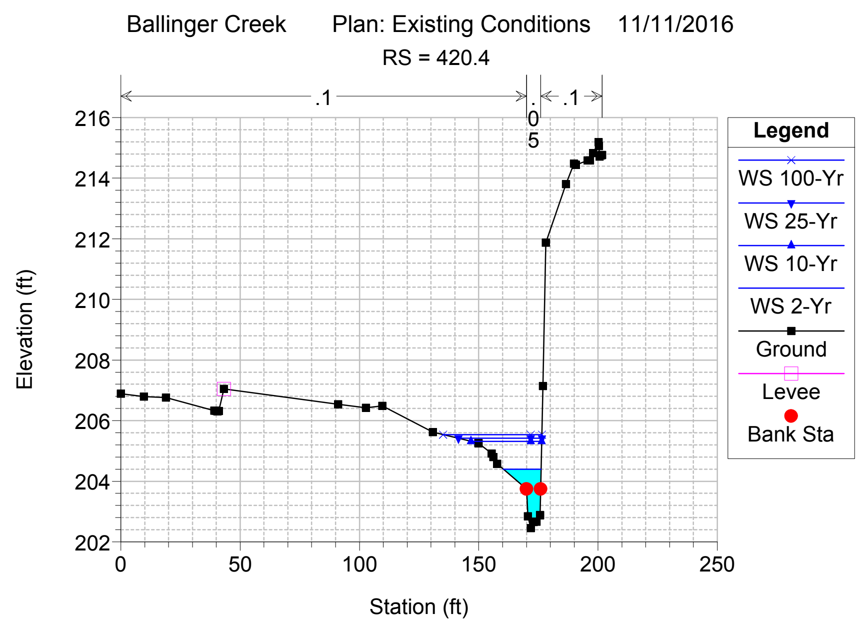

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 686.13
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

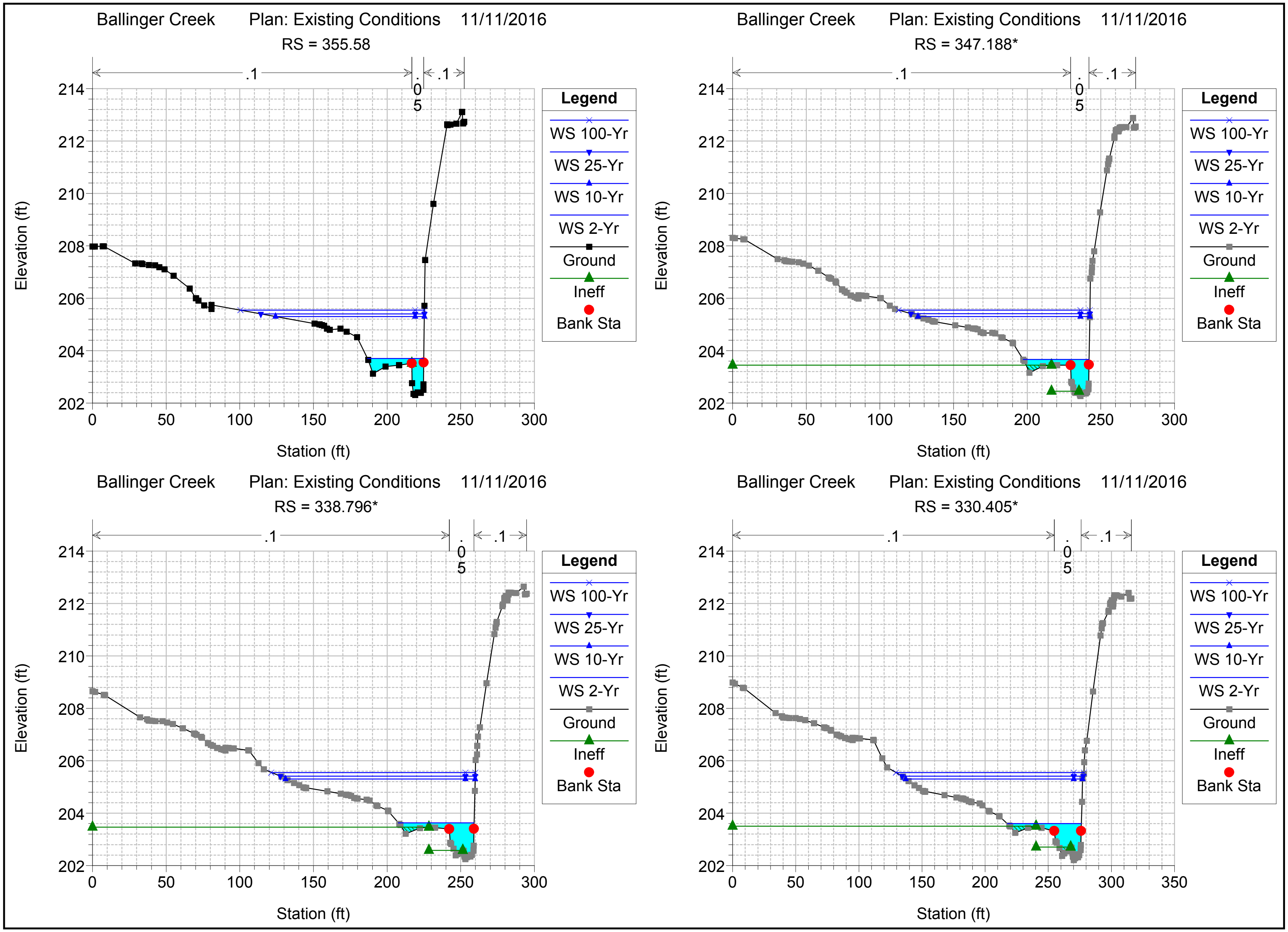

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 647.77
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 600 Culv
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 600 Culv
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 556.47


Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 537.923*
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

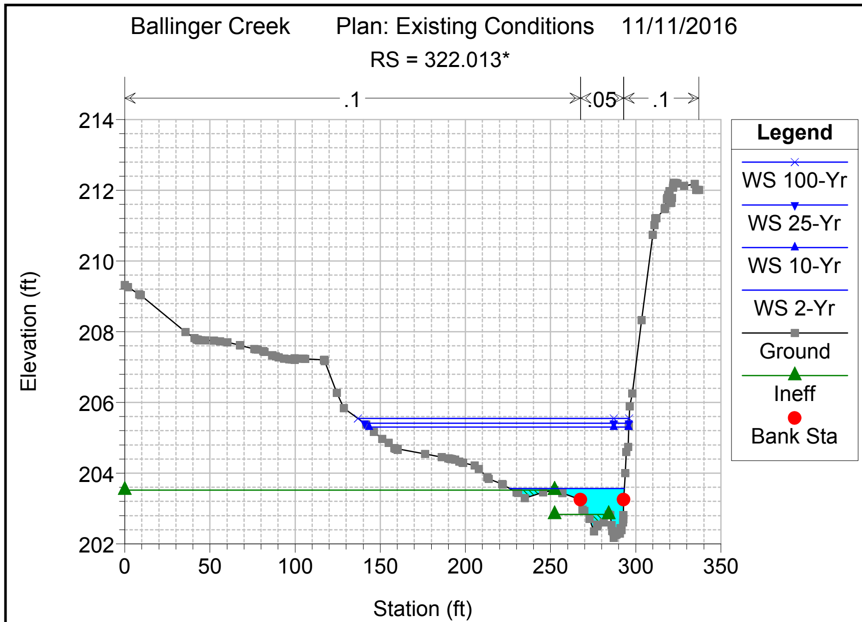

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 519.376*
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

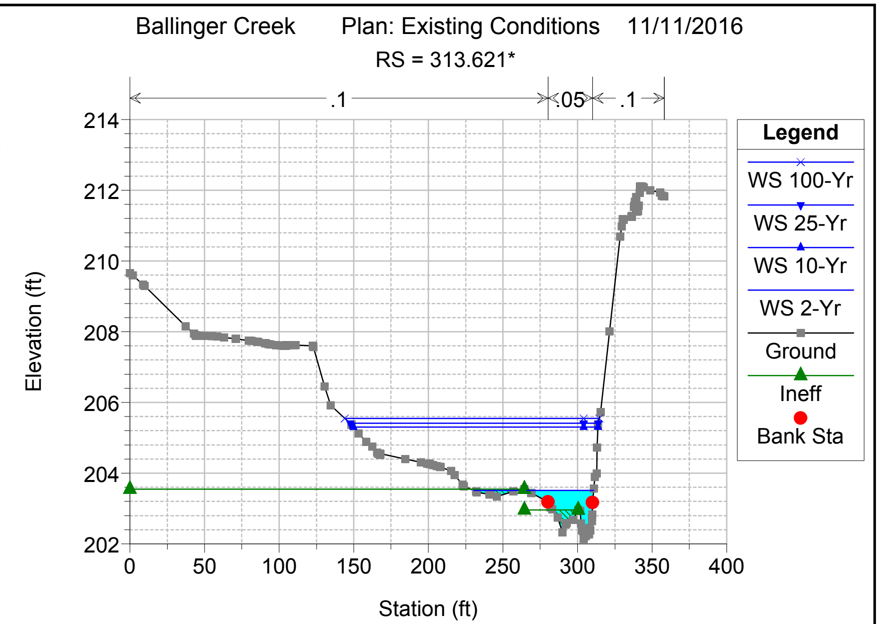

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 500.83
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

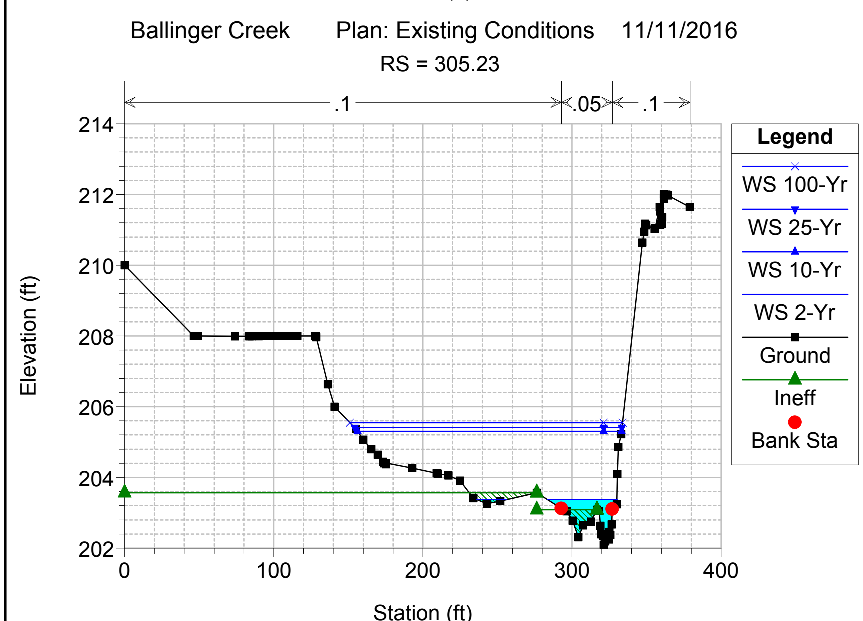

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 420.4
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta

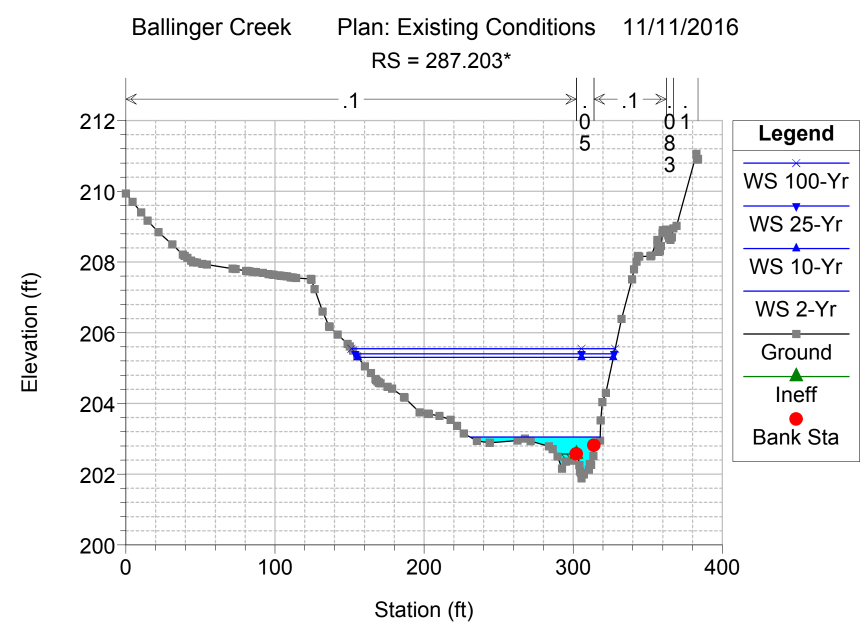


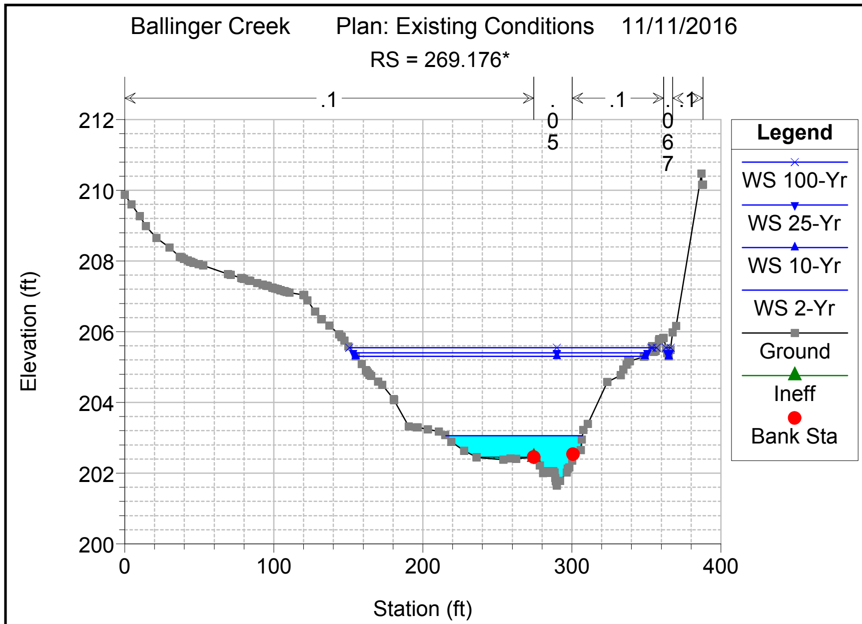
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 355.58
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 347.188*
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 338.796*
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 330.405*

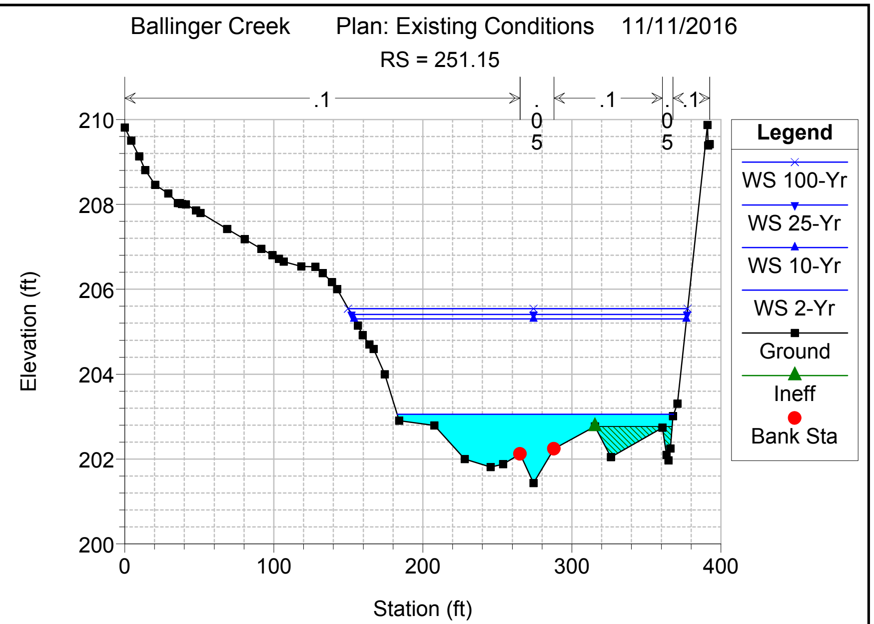

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 322.013*
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

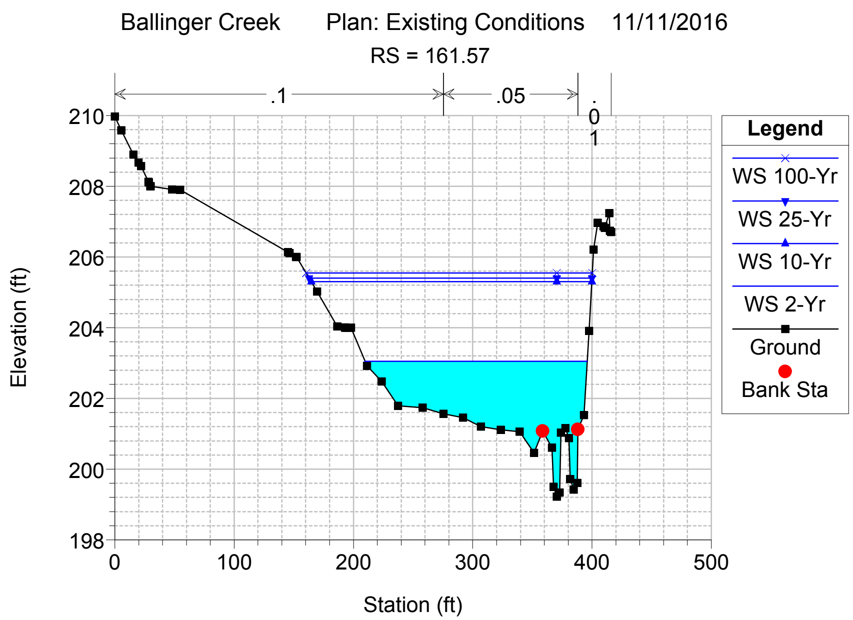

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 313.621*
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

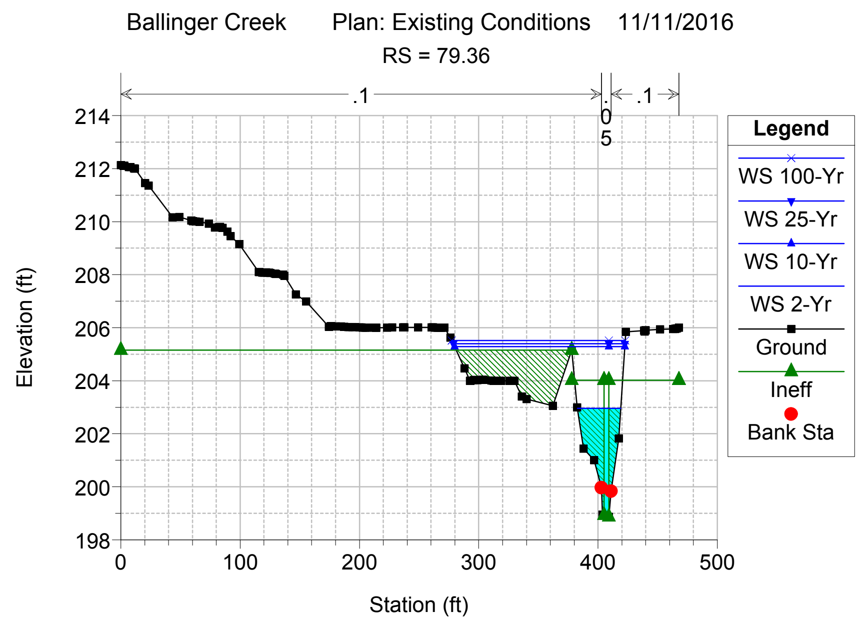

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 305.23
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

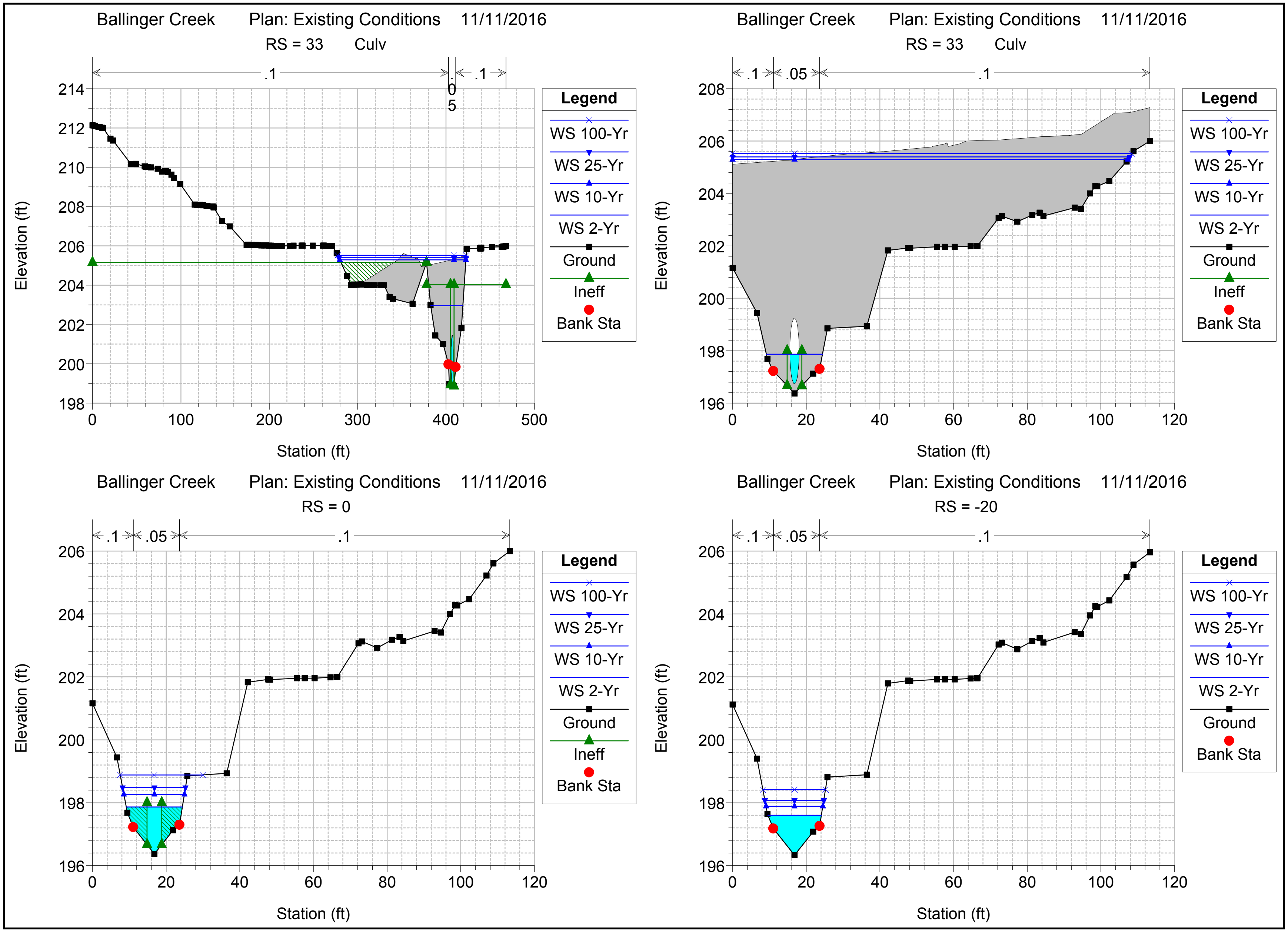

Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 287.203*
.1
.05
.1
.083
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 269.176*
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 251.15
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 161.57
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta


Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 79.36
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 33 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 33 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = 0
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Existing Conditions 11/11/2016
RS = -20
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	3833.85	2-Yr	26.33	319.41	320.19	320.12	320.30	0.019303	2.85	11.85	35.40	0.66
Ballinger Creek	3833.85	10-Yr	48.20	319.41	320.36		320.52	0.021093	3.55	18.37	40.44	0.72
Ballinger Creek	3833.85	25-Yr	64.61	319.41	320.46	320.38	320.65	0.022360	3.97	22.51	43.35	0.76
Ballinger Creek	3833.85	100-Yr	98.19	319.41	320.62	320.55	320.88	0.024322	4.66	30.11	48.24	0.82
Ballinger Creek	3597.45	2-Yr	26.33	305.99	306.63	306.63	306.90	0.046186	4.15	6.35	12.13	1.00
Ballinger Creek	3597.45	10-Yr	48.20	305.99	306.90	306.90	307.28	0.039418	4.94	9.89	13.85	0.99
Ballinger Creek	3597.45	25-Yr	64.61	305.99	307.07	307.07	307.52	0.035780	5.38	12.36	14.89	0.97
Ballinger Creek	3597.45	100-Yr	98.19	305.99	307.38	307.38	307.93	0.031360	6.06	17.17	16.83	0.95
Ballinger Creek	3364.13	2-Yr	26.33	286.00	288.60	286.95	288.66	0.001300	2.03	13.00	9.55	0.22
Ballinger Creek	3364.13	10-Yr	48.20	286.00	289.82	287.43	289.92	0.001210	2.53	19.09	11.68	0.23
Ballinger Creek	3364.13	25-Yr	64.61	286.00	290.79	287.73	290.90	0.001020	2.70	23.96	21.33	0.22
Ballinger Creek	3364.13	100-Yr	98.19	286.00	292.41	288.29	292.43	0.000409	1.01	97.38	40.49	0.11
Ballinger Creek	3300		Culvert									
Ballinger Creek	3275.89	2-Yr	26.33	284.00	285.10	285.10	285.66	0.035695	6.00	4.39	18.36	1.01
Ballinger Creek	3275.89	10-Yr	48.20	284.00	285.66	285.66	286.49	0.030800	7.31	6.60	21.30	1.00
Ballinger Creek	3275.89	25-Yr	64.61	284.00	286.01	286.01	287.02	0.028923	8.06	8.02	23.17	1.00
Ballinger Creek	3275.89	100-Yr	98.19	284.00	286.66	286.66	288.00	0.026287	9.26	10.60	26.90	1.00
Ballinger Creek	3090.28	2-Yr	26.33	273.00	273.80		274.02	0.031928	3.76	7.00	9.39	0.77
Ballinger Creek	3090.28	10-Yr	48.20	273.00	274.00	274.00	274.46	0.052246	5.45	8.85	9.73	1.01
Ballinger Creek	3090.28	25-Yr	64.61	273.00	274.21	274.21	274.75	0.050184	5.93	10.90	10.08	1.00
Ballinger Creek	3090.28	100-Yr	98.19	273.00	274.57	274.57	275.26	0.047959	6.68	14.69	10.71	1.01
Ballinger Creek	2831.67	2-Yr	26.33	263.00	263.84	263.84	264.18	0.045929	4.69	5.62	8.34	1.01
Ballinger Creek	2831.67	10-Yr	48.20	263.00	264.25	264.25	264.46	0.020802	4.15	23.55	67.81	0.72
Ballinger Creek	2831.67	25-Yr	64.61	263.00	264.37	264.37	264.59	0.020655	4.45	31.74	70.46	0.73
Ballinger Creek	2831.67	100-Yr	98.19	263.00	264.51	264.51	264.80	0.025665	5.36	41.91	73.69	0.83
Ballinger Creek	2483	2-Yr	26.33	244.00	246.34	244.95	246.42	0.001837	2.25	11.72	16.72	0.26
Ballinger Creek	2483	10-Yr	48.20	244.00	247.71	245.43	247.81	0.001333	2.60	18.54	23.54	0.24
Ballinger Creek	2483	25-Yr	64.61	244.00	249.20	245.73	249.29	0.000777	2.49	25.99	31.97	0.19
Ballinger Creek	2483	100-Yr	98.19	244.00	250.64	246.29	250.65	0.000078	0.74	157.42	59.27	0.06
Ballinger Creek	2400		Culvert									

HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	2355.95	2-Yr	26.33	242.00	243.02	243.02	243.54	0.036663	5.76	4.57	27.84	1.01
Ballinger Creek	2355.95	10-Yr	48.20	242.00	243.58	243.53	244.30	0.028577	6.81	7.07	37.64	0.96
Ballinger Creek	2355.95	25-Yr	64.61	242.00	243.86	243.86	244.79	0.029532	7.74	8.35	42.62	1.00
Ballinger Creek	2355.95	100-Yr	98.19	242.00	244.46	244.46	245.69	0.026927	8.90	11.04	53.35	1.00
Ballinger Creek	2314.97	2-Yr	26.33	240.00	242.62	240.84	242.66	0.000431	1.67	15.72	46.06	0.18
Ballinger Creek	2314.97	10-Yr	48.20	240.00	243.85	241.26	243.92	0.000400	2.09	23.10	62.05	0.19
Ballinger Creek	2314.97	25-Yr	64.61	240.00	244.15	241.53	244.16	0.000059	0.73	134.10	67.98	0.07
Ballinger Creek	2314.97	100-Yr	98.19	240.00	244.37	242.03	244.38	0.000106	1.02	149.60	73.67	0.09
Ballinger Creek	2300		Culvert									
Ballinger Creek	2091.38	2-Yr	26.33	235.00	236.11	236.11	236.66	0.022466	5.95	4.42	18.67	1.00
Ballinger Creek	2091.38	10-Yr	48.20	235.00	236.65	236.65	237.48	0.019903	7.31	6.59	35.64	1.00
Ballinger Creek	2091.38	25-Yr	64.61	235.00	237.01	237.01	238.01	0.018449	8.04	8.04	46.52	1.00
Ballinger Creek	2091.38	100-Yr	98.19	235.00	237.66	237.66	238.98	0.016751	9.23	10.64	65.87	1.00
Ballinger Creek	1973.22	2-Yr	26.33	229.00	229.73	229.73	230.07	0.047142	4.70	5.61	8.35	1.01
Ballinger Creek	1973.22	10-Yr	48.20	229.00	230.08	230.08	230.56	0.042907	5.58	8.63	8.99	1.00
Ballinger Creek	1973.22	25-Yr	64.61	229.00	230.30	230.30	230.87	0.040888	6.04	10.70	9.40	1.00
Ballinger Creek	1973.22	100-Yr	98.19	229.00	230.69	230.69	231.41	0.039167	6.78	14.47	42.53	1.00
Ballinger Creek	1793.86	2-Yr	39.36	223.00	224.26		224.42	0.010301	3.21	12.24	12.45	0.57
Ballinger Creek	1793.86	10-Yr	71.45	223.00	224.68		224.93	0.011725	4.01	17.83	14.27	0.63
Ballinger Creek	1793.86	25-Yr	93.25	223.00	224.90		225.21	0.012335	4.40	21.19	15.25	0.66
Ballinger Creek	1793.86	100-Yr	134.32	223.00	225.27		225.65	0.013023	4.97	27.05	16.83	0.69
Ballinger Creek	1740.27	2-Yr	39.36	222.19	223.13	223.13	223.45	0.038340	4.59	9.52	16.64	0.95
Ballinger Creek	1740.27	10-Yr	71.45	222.19	223.44	223.44	223.90	0.035471	5.60	14.91	17.90	0.97
Ballinger Creek	1740.27	25-Yr	93.25	222.19	223.63	223.63	224.16	0.033814	6.10	18.27	18.65	0.97
Ballinger Creek	1740.27	100-Yr	134.32	222.19	223.93	223.93	224.59	0.031855	6.86	24.22	20.85	0.98
Ballinger Creek	1684.22	2-Yr	39.36	219.14	220.73		220.89	0.010102	3.22	12.82	20.37	0.51
Ballinger Creek	1684.22	10-Yr	71.45	219.14	221.07		221.35	0.013474	4.37	19.90	22.25	0.62
Ballinger Creek	1684.22	25-Yr	93.25	219.14	221.25		221.60	0.014961	4.95	24.00	23.26	0.66
Ballinger Creek	1684.22	100-Yr	134.32	219.14	221.52	221.32	222.00	0.017239	5.87	30.71	24.84	0.73
Ballinger Creek	1630.62	2-Yr	39.36	218.87	220.18		220.29	0.011635	2.82	16.69	79.44	0.53
Ballinger Creek	1630.62	10-Yr	71.45	218.87	220.53		220.68	0.010170	3.32	29.11	90.84	0.53

HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	1630.62	25-Yr	93.25	218.87	220.69	220.36	220.87	0.010649	3.69	35.41	96.03	0.55
Ballinger Creek	1630.62	100-Yr	134.32	218.87	220.93	220.59	221.17	0.011828	4.32	45.42	103.69	0.60
Ballinger Creek	1536.58	2-Yr	39.36	217.43	218.81	218.76	218.89	0.019320	2.49	26.85	100.41	0.63
Ballinger Creek	1536.58	10-Yr	71.45	217.43	218.88	218.88	219.03	0.037080	3.74	32.97	101.06	0.90
Ballinger Creek	1536.58	25-Yr	93.25	217.43	218.93	218.93	219.12	0.040460	4.18	38.77	101.68	0.95
Ballinger Creek	1536.58	100-Yr	134.32	217.43	219.04	219.04	219.26	0.041689	4.72	49.55	102.82	0.99
Ballinger Creek	1518.08*	2-Yr	39.36	216.95	218.20	218.15	218.38	0.037237	3.56	12.14	102.56	0.89
Ballinger Creek	1518.08*	10-Yr	71.45	216.95	218.38	218.21	218.42	0.008321	2.08	61.29	107.21	0.44
Ballinger Creek	1518.08*	25-Yr	93.25	216.95	218.55	218.21	218.58	0.006503	2.11	78.72	110.01	0.40
Ballinger Creek	1518.08*	100-Yr	134.32	216.95	218.82	218.25	218.85	0.004850	2.20	109.31	114.32	0.37
Ballinger Creek	1499.59*	2-Yr	39.36	216.48	217.70	217.56	217.85	0.022000	3.16	12.46	26.53	0.70
Ballinger Creek	1499.59*	10-Yr	71.45	216.48	218.19	217.82	218.27	0.007113	2.59	44.67	86.61	0.44
Ballinger Creek	1499.59*	25-Yr	93.25	216.48	218.39	218.05	218.47	0.005487	2.55	62.94	92.11	0.39
Ballinger Creek	1499.59*	100-Yr	134.32	216.48	218.67	218.20	218.76	0.005039	2.79	91.65	120.74	0.39
Ballinger Creek	1481.09*	2-Yr	39.36	216.00	217.58	217.02	217.65	0.005374	2.23	17.75	24.12	0.37
Ballinger Creek	1481.09*	10-Yr	71.45	216.00	218.08	217.32	218.17	0.004214	2.54	40.86	68.60	0.35
Ballinger Creek	1481.09*	25-Yr	93.25	216.00	218.27	217.49	218.37	0.004231	2.75	55.36	79.64	0.36
Ballinger Creek	1481.09*	100-Yr	134.32	216.00	218.56	217.81	218.67	0.004333	3.06	80.02	93.57	0.37
Ballinger Creek	1462.60*	2-Yr	39.36	215.53	217.52	216.53	217.58	0.002789	2.04	20.48	25.84	0.28
Ballinger Creek	1462.60*	10-Yr	71.45	215.53	218.02	216.90	218.10	0.002977	2.51	44.20	55.83	0.30
Ballinger Creek	1462.60*	25-Yr	93.25	215.53	218.19	217.12	218.30	0.003512	2.87	54.68	64.10	0.33
Ballinger Creek	1462.60*	100-Yr	134.32	215.53	218.44	217.49	218.58	0.004498	3.47	71.93	77.46	0.38
Ballinger Creek	1444.11	2-Yr	39.36	215.05	217.43	216.20	217.52	0.003287	2.44	19.18	26.96	0.29
Ballinger Creek	1444.11	10-Yr	71.45	215.05	217.92	216.71	218.04	0.004011	3.07	41.89	55.42	0.33
Ballinger Creek	1444.11	25-Yr	93.25	215.05	218.07	217.04	218.22	0.004830	3.50	50.96	57.90	0.37
Ballinger Creek	1444.11	100-Yr	134.32	215.05	218.26	217.68	218.47	0.006958	4.38	61.99	63.09	0.44
Ballinger Creek	1425.92*	2-Yr	39.36	214.73	217.40	215.99	217.46	0.001891	2.00	24.04	29.98	0.23
Ballinger Creek	1425.92*	10-Yr	71.45	214.73	217.88	216.46	217.97	0.002434	2.58	48.94	56.62	0.27
Ballinger Creek	1425.92*	25-Yr	93.25	214.73	218.03	216.75	218.15	0.003114	3.02	57.72	60.94	0.31
Ballinger Creek	1425.92*	100-Yr	134.32	214.73	218.19	217.26	218.37	0.004874	3.92	67.88	67.91	0.39
Ballinger Creek	1407.74*	2-Yr	39.36	214.42	217.39	215.82	217.43	0.001194	1.68	29.42	44.50	0.19

HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	1407.74*	10-Yr	71.45	214.42	217.86	216.26	217.93	0.001587	2.19	57.50	61.43	0.23
Ballinger Creek	1407.74*	25-Yr	93.25	214.42	218.01	216.52	218.09	0.002089	2.60	66.85	67.53	0.27
Ballinger Creek	1407.74*	100-Yr	134.32	214.42	218.15	216.95	218.29	0.003377	3.42	76.96	73.54	0.34
Ballinger Creek	1389.56*	2-Yr	39.36	214.10	217.38	215.67	217.40	0.000778	1.41	39.82	50.32	0.16
Ballinger Creek	1389.56*	10-Yr	71.45	214.10	217.85	216.10	217.90	0.001076	1.87	66.87	64.70	0.19
Ballinger Creek	1389.56*	25-Yr	93.25	214.10	217.99	216.33	218.05	0.001442	2.23	76.38	69.96	0.23
Ballinger Creek	1389.56*	100-Yr	134.32	214.10	218.13	216.72	218.23	0.002405	2.97	85.99	75.05	0.29
Ballinger Creek	1371.38	2-Yr	40.96	213.78	217.37	215.66	217.39	0.000619	1.28	44.56	48.74	0.14
Ballinger Creek	1371.38	10-Yr	71.92	213.78	217.84	216.27	217.88	0.000858	1.70	71.51	64.92	0.17
Ballinger Creek	1371.38	25-Yr	94.46	213.78	217.97	216.66	218.03	0.001275	2.13	80.77	87.52	0.21
Ballinger Creek	1371.38	100-Yr	139.46	213.78	218.07	217.00	218.19	0.002430	3.01	91.31	112.26	0.30
Ballinger Creek	1300		Culvert									
Ballinger Creek	790.39	2-Yr	40.96	206.99	209.01	208.44	209.18	0.008298	3.32	13.68	14.39	0.46
Ballinger Creek	790.39	10-Yr	71.92	206.99	210.59	209.00	210.66	0.001640	2.34	48.01	28.22	0.23
Ballinger Creek	790.39	25-Yr	94.46	206.99	210.71	209.19	210.82	0.002427	2.91	51.45	29.43	0.28
Ballinger Creek	790.39	100-Yr	139.46	206.99	210.89	209.69	211.08	0.004238	3.99	56.88	31.25	0.38
Ballinger Creek	736.73	2-Yr	40.96	206.50	208.90		208.95	0.001945	1.88	25.56	20.53	0.24
Ballinger Creek	736.73	10-Yr	71.92	206.50	210.57		210.60	0.000521	1.50	71.67	35.40	0.14
Ballinger Creek	736.73	25-Yr	94.46	206.50	210.68		210.73	0.000812	1.91	75.62	38.64	0.18
Ballinger Creek	736.73	100-Yr	139.46	206.50	210.83		210.92	0.001544	2.70	81.78	44.60	0.24
Ballinger Creek	686.13	2-Yr	40.96	205.76	208.91		208.92	0.000183	0.77	97.36	72.30	0.08
Ballinger Creek	686.13	10-Yr	71.92	205.76	210.58		210.59	0.000068	0.64	239.39	107.74	0.05
Ballinger Creek	686.13	25-Yr	94.46	205.76	210.70		210.70	0.000107	0.82	252.13	114.63	0.07
Ballinger Creek	686.13	100-Yr	139.46	205.76	210.86		210.88	0.000202	1.16	272.05	125.76	0.09
Ballinger Creek	647.77	2-Yr	40.96	204.59	208.79	206.36	208.89	0.001425	2.58	15.86	41.46	0.23
Ballinger Creek	647.77	10-Yr	71.92	204.59	210.57	207.03	210.58	0.000163	1.00	186.46	174.54	0.08
Ballinger Creek	647.77	25-Yr	94.46	204.59	210.68	207.45	210.70	0.000238	1.23	206.05	182.83	0.09
Ballinger Creek	647.77	100-Yr	139.46	204.59	210.84	208.21	210.86	0.000413	1.65	235.72	196.64	0.13
Ballinger Creek	600		Culvert									
Ballinger Creek	556.47	2-Yr	40.96	204.97	206.40	206.40	206.50	0.008382	2.54	16.36	18.51	0.47

HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	556.47	10-Yr	71.92	204.97	206.69	206.40	206.86	0.010407	3.39	21.77	19.24	0.54
Ballinger Creek	556.47	25-Yr	94.46	204.97	206.93	206.45	207.14	0.009577	3.68	27.84	36.04	0.54
Ballinger Creek	556.47	100-Yr	139.46	204.97	207.41	206.74	207.61	0.006725	3.74	52.98	60.21	0.47
Ballinger Creek	537.923*	2-Yr	40.96	204.34	205.73	205.69	206.06	0.027025	4.80	10.52	15.76	0.84
Ballinger Creek	537.923*	10-Yr	71.92	204.34	206.18		206.55	0.019821	5.27	18.97	20.05	0.77
Ballinger Creek	537.923*	25-Yr	94.46	204.34	206.43		206.84	0.018441	5.64	24.18	21.35	0.76
Ballinger Creek	537.923*	100-Yr	139.46	204.34	206.87		207.34	0.016553	6.23	34.04	23.33	0.75
Ballinger Creek	519.376*	2-Yr	40.96	203.71	205.34		205.63	0.018371	4.36	10.25	12.34	0.70
Ballinger Creek	519.376*	10-Yr	71.92	203.71	205.91		206.23	0.013233	4.78	20.29	22.45	0.63
Ballinger Creek	519.376*	25-Yr	94.46	203.71	206.18		206.53	0.012631	5.13	26.81	24.93	0.63
Ballinger Creek	519.376*	100-Yr	139.46	203.71	206.67		207.05	0.011216	5.57	39.64	27.75	0.62
Ballinger Creek	500.83	2-Yr	40.96	203.08	205.20		205.36	0.007259	3.28	13.68	11.89	0.45
Ballinger Creek	500.83	10-Yr	71.92	203.08	205.79		206.00	0.006829	3.89	26.51	28.93	0.46
Ballinger Creek	500.83	25-Yr	94.46	203.08	206.07		206.30	0.006955	4.24	34.88	31.37	0.47
Ballinger Creek	500.83	100-Yr	139.46	203.08	206.57		206.83	0.006539	4.64	51.89	35.83	0.47
Ballinger Creek	420.4	2-Yr	40.96	202.45	204.40	203.92	204.63	0.011597	3.94	13.06	15.85	0.54
Ballinger Creek	420.4	10-Yr	71.92	202.45	205.32	204.52	205.49	0.005693	3.70	32.57	29.70	0.41
Ballinger Creek	420.4	25-Yr	94.46	202.45	205.42	204.81	205.68	0.008513	4.64	35.78	34.99	0.50
Ballinger Creek	420.4	100-Yr	139.46	202.45	205.54	205.21	206.03	0.015337	6.42	40.42	41.45	0.68
Ballinger Creek	355.58	2-Yr	40.96	202.31	203.70	203.37	203.85	0.011688	3.34	19.62	38.27	0.52
Ballinger Creek	355.58	10-Yr	71.92	202.31	205.30	203.81	205.32	0.000899	1.60	107.31	100.97	0.17
Ballinger Creek	355.58	25-Yr	94.46	202.31	205.41	203.95	205.44	0.001295	1.96	118.34	111.12	0.20
Ballinger Creek	355.58	100-Yr	139.46	202.31	205.55	204.18	205.60	0.002194	2.64	135.10	124.96	0.26
Ballinger Creek	347.188*	2-Yr	40.96	202.27	203.66		203.76	0.006936	2.61	21.21	44.61	0.42
Ballinger Creek	347.188*	10-Yr	71.92	202.27	205.30		205.32	0.000463	1.20	132.62	116.63	0.13
Ballinger Creek	347.188*	25-Yr	94.46	202.27	205.41		205.43	0.000655	1.47	145.09	121.43	0.15
Ballinger Creek	347.188*	100-Yr	139.46	202.27	205.55		205.58	0.001112	1.97	163.01	129.95	0.20
Ballinger Creek	338.796*	2-Yr	40.96	202.24	203.63		203.70	0.005039	2.15	24.11	51.41	0.36
Ballinger Creek	338.796*	10-Yr	71.92	202.24	205.30		205.31	0.000277	0.94	160.48	128.72	0.10
Ballinger Creek	338.796*	25-Yr	94.46	202.24	205.41		205.42	0.000395	1.15	174.16	132.35	0.12
Ballinger Creek	338.796*	100-Yr	139.46	202.24	205.55		205.57	0.000675	1.55	193.51	138.48	0.16

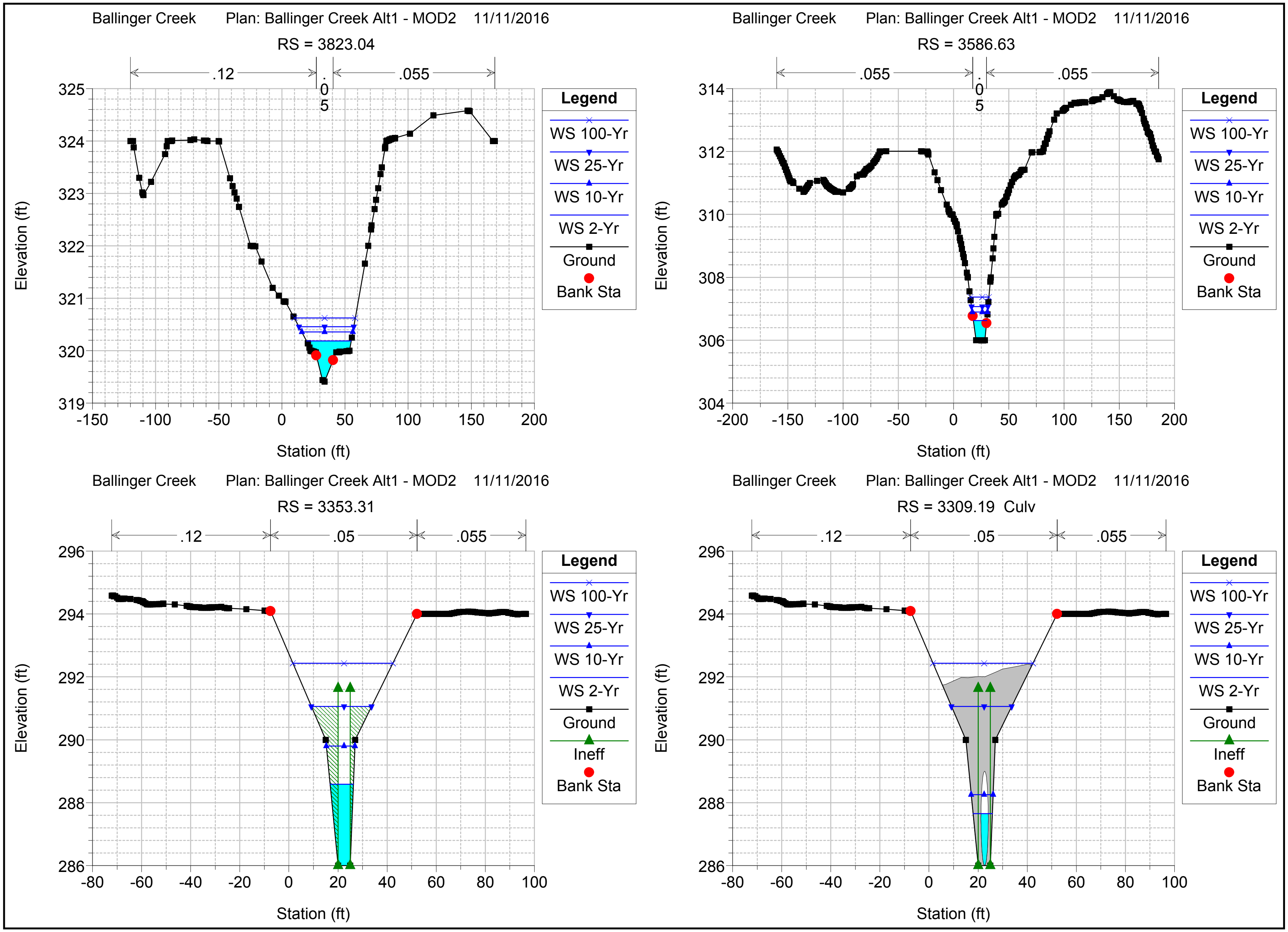
HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	330.405*	2-Yr	40.96	202.21	203.60		203.66	0.004613	1.93	25.49	58.56	0.35
Ballinger Creek	330.405*	10-Yr	71.92	202.21	205.30		205.31	0.000187	0.77	188.56	140.11	0.08
Ballinger Creek	330.405*	25-Yr	94.46	202.21	205.41		205.42	0.000268	0.94	203.44	143.46	0.10
Ballinger Creek	330.405*	100-Yr	139.46	202.21	205.55		205.57	0.000460	1.27	224.37	148.99	0.13
Ballinger Creek	322.013*	2-Yr	40.96	202.17	203.56		203.61	0.005018	1.86	25.44	67.19	0.35
Ballinger Creek	322.013*	10-Yr	71.92	202.17	205.30		205.31	0.000135	0.64	218.21	152.41	0.07
Ballinger Creek	322.013*	25-Yr	94.46	202.17	205.41		205.41	0.000194	0.79	234.32	155.04	0.08
Ballinger Creek	322.013*	100-Yr	139.46	202.17	205.55		205.56	0.000335	1.07	256.80	159.28	0.11
Ballinger Creek	313.621*	2-Yr	40.96	202.14	203.51		203.57	0.006892	1.92	23.28	74.44	0.40
Ballinger Creek	313.621*	10-Yr	71.92	202.14	205.30		205.31	0.000105	0.55	246.99	163.95	0.06
Ballinger Creek	313.621*	25-Yr	94.46	202.14	205.41		205.41	0.000150	0.68	264.29	166.25	0.07
Ballinger Creek	313.621*	100-Yr	139.46	202.14	205.55		205.56	0.000260	0.93	288.34	170.56	0.10
Ballinger Creek	305.23	2-Yr	40.96	202.10	203.37	203.27	203.47	0.020449	2.52	17.65	66.80	0.65
Ballinger Creek	305.23	10-Yr	71.92	202.10	205.30		205.31	0.000085	0.49	274.92	176.84	0.06
Ballinger Creek	305.23	25-Yr	94.46	202.10	205.41		205.41	0.000122	0.60	293.55	179.16	0.07
Ballinger Creek	305.23	100-Yr	139.46	202.10	205.55		205.56	0.000212	0.82	319.35	182.80	0.09
Ballinger Creek	287.203*	2-Yr	40.96	201.88	203.05	202.93	203.16	0.014133	3.12	25.66	87.34	0.60
Ballinger Creek	287.203*	10-Yr	71.92	201.88	205.30		205.30	0.000069	0.52	324.77	171.23	0.05
Ballinger Creek	287.203*	25-Yr	94.46	201.88	205.41		205.41	0.000102	0.64	342.76	173.58	0.06
Ballinger Creek	287.203*	100-Yr	139.46	201.88	205.55		205.55	0.000183	0.89	367.56	176.73	0.09
Ballinger Creek	269.176*	2-Yr	40.96	201.65	203.06		203.07	0.001449	1.09	59.66	91.66	0.19
Ballinger Creek	269.176*	10-Yr	71.92	201.65	205.30		205.30	0.000035	0.37	381.33	194.00	0.04
Ballinger Creek	269.176*	25-Yr	94.46	201.65	205.41		205.41	0.000053	0.47	401.79	199.38	0.05
Ballinger Creek	269.176*	100-Yr	139.46	201.65	205.55		205.55	0.000097	0.65	430.53	208.54	0.06
Ballinger Creek	251.15	2-Yr	40.96	201.43	203.05		203.06	0.000448	0.73	118.26	185.46	0.11
Ballinger Creek	251.15	10-Yr	71.92	201.43	205.30		205.30	0.000014	0.25	574.50	223.11	0.02
Ballinger Creek	251.15	25-Yr	94.46	201.43	205.41		205.41	0.000021	0.32	597.82	225.12	0.03
Ballinger Creek	251.15	100-Yr	139.46	201.43	205.55		205.55	0.000039	0.45	629.76	227.84	0.04
Ballinger Creek	161.57	2-Yr	40.96	199.22	203.05		203.05	0.000008	0.15	318.27	186.43	0.02
Ballinger Creek	161.57	10-Yr	71.92	199.22	205.30		205.30	0.000002	0.11	791.09	235.21	0.01
Ballinger Creek	161.57	25-Yr	94.46	199.22	205.41		205.41	0.000003	0.14	815.62	237.22	0.01
Ballinger Creek	161.57	100-Yr	139.46	199.22	205.55		205.55	0.000005	0.19	849.11	239.93	0.01

HEC-RAS Plan: Existing River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	79.36	2-Yr	35.42	198.87	202.95	200.25	203.03	0.000841	2.19	16.17	36.36	0.19
Ballinger Creek	79.36	10-Yr	59.42	198.87	205.29	200.80	205.30	0.000070	0.79	189.11	142.77	0.06
Ballinger Creek	79.36	25-Yr	77.88	198.87	205.39	201.18	205.40	0.000107	0.99	203.40	143.93	0.07
Ballinger Creek	79.36	100-Yr	116.81	198.87	205.52	201.89	205.54	0.000206	1.39	222.12	145.43	0.10
Ballinger Creek	33		Culvert									
Ballinger Creek	0	2-Yr	35.42	196.37	197.86	197.86	198.54	0.033790	6.61	5.36	15.25	1.00
Ballinger Creek	0	10-Yr	59.42	196.37	198.26	198.00	198.42	0.007324	3.21	20.19	16.44	0.47
Ballinger Creek	0	25-Yr	77.88	196.37	198.48	198.00	198.68	0.007650	3.61	23.92	17.10	0.49
Ballinger Creek	0	100-Yr	116.81	196.37	198.88	198.21	199.16	0.008270	4.33	31.01	22.40	0.53
Ballinger Creek	-20	2-Yr	35.42	196.33	197.60	197.41	197.79	0.018220	3.46	10.55	14.52	0.68
Ballinger Creek	-20	10-Yr	59.42	196.33	197.89	197.68	198.16	0.018203	4.24	14.87	15.45	0.71
Ballinger Creek	-20	25-Yr	77.88	196.33	198.08	197.85	198.41	0.018204	4.71	17.82	16.01	0.73
Ballinger Creek	-20	100-Yr	116.81	196.33	198.42	198.17	198.87	0.018227	5.51	23.45	17.02	0.76

Appendix M.2
Alternative 1



Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3823.04
.12
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3586.63
.055
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3353.31
.12
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3309.19 Culv
.12
.05
.055
Legend
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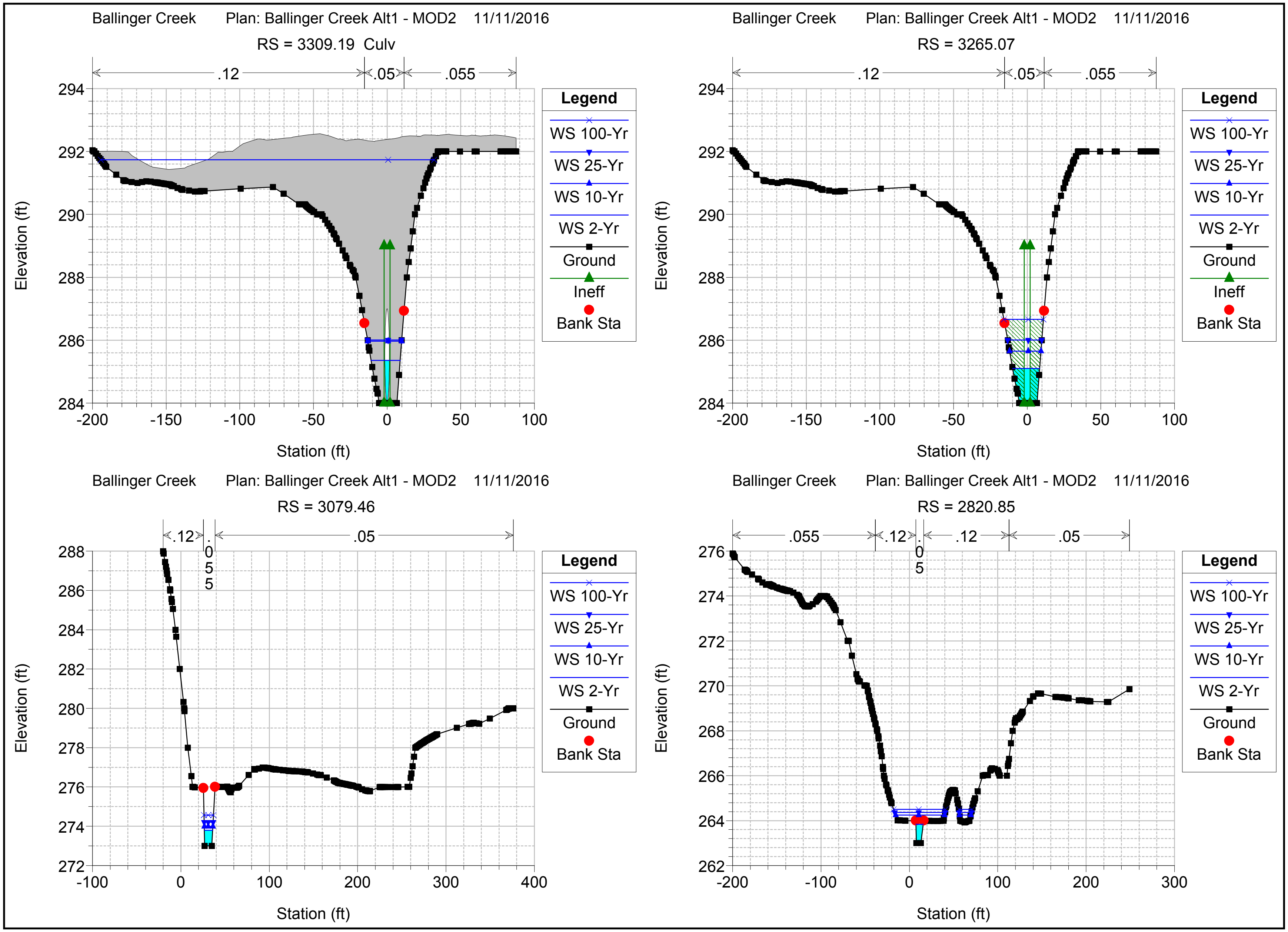
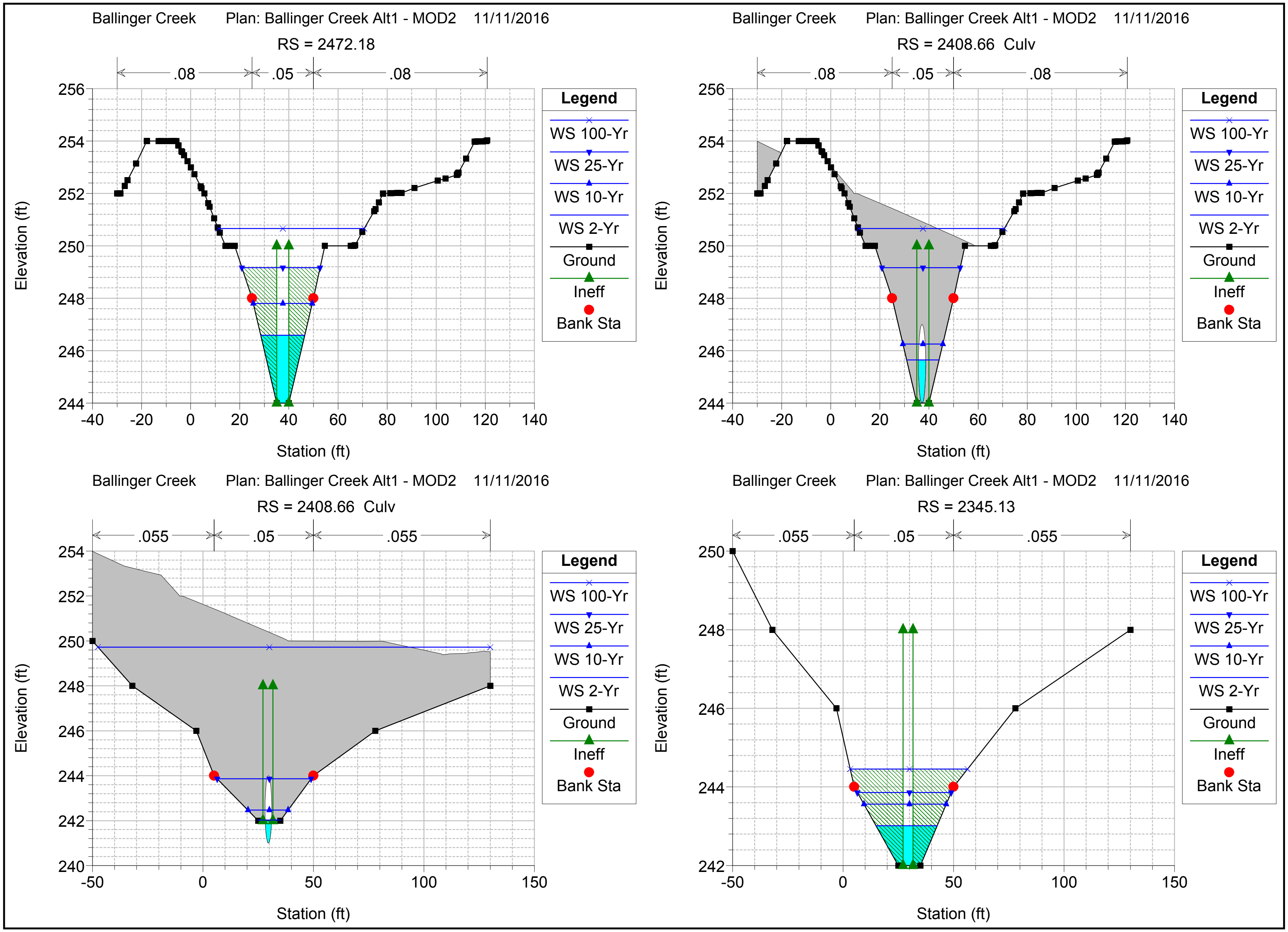
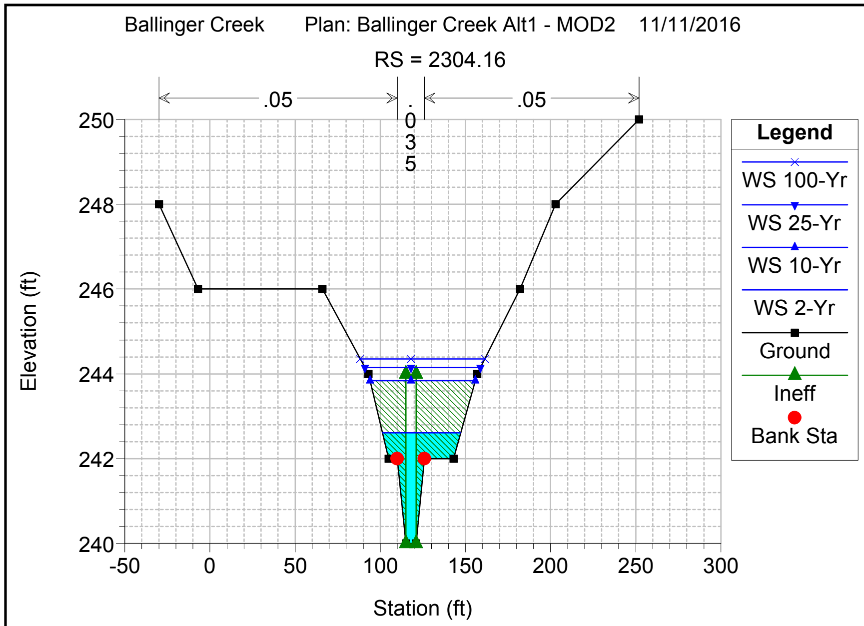
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

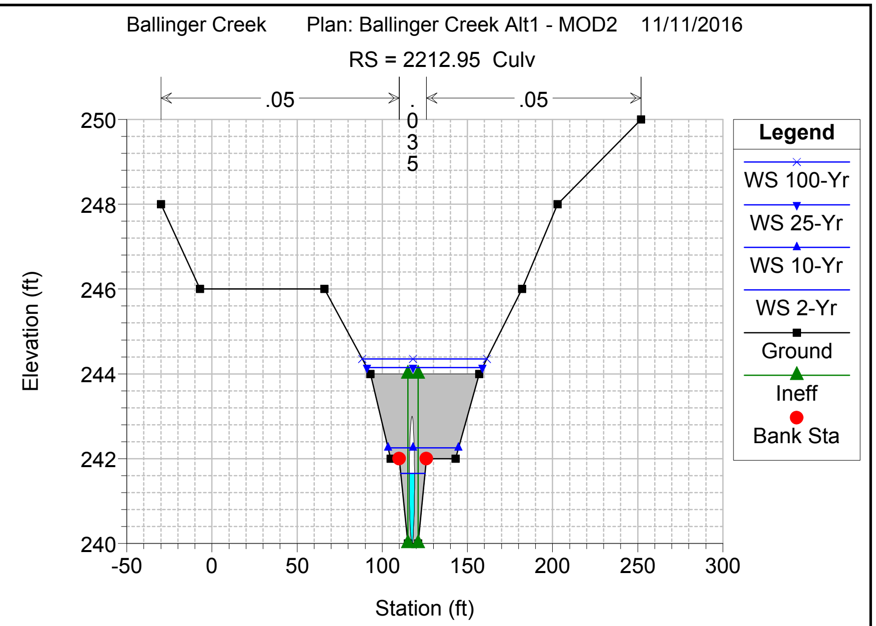


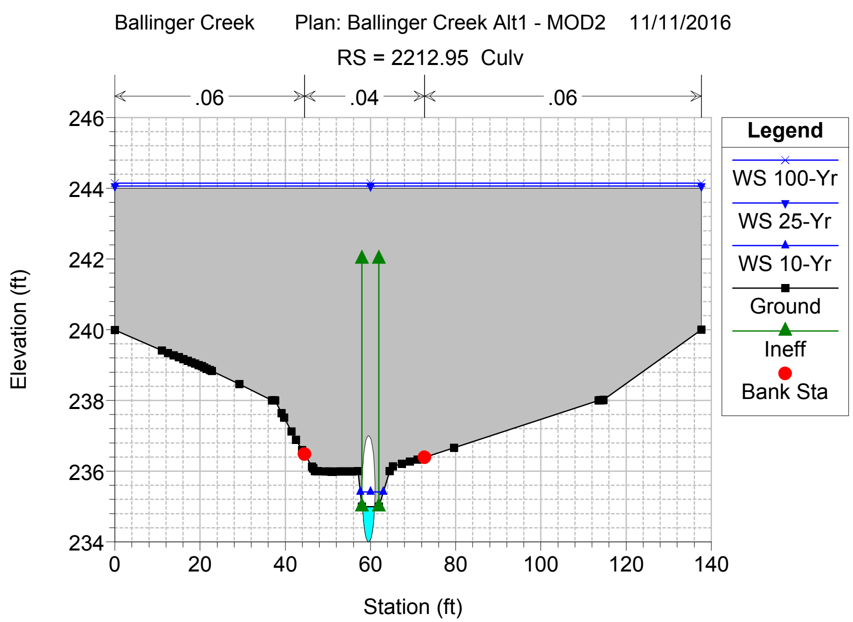
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3309.19 Culv
.12
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3265.07
.12
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 3079.46
.12
.055
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2820.85
.055
.12
.055
.12
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

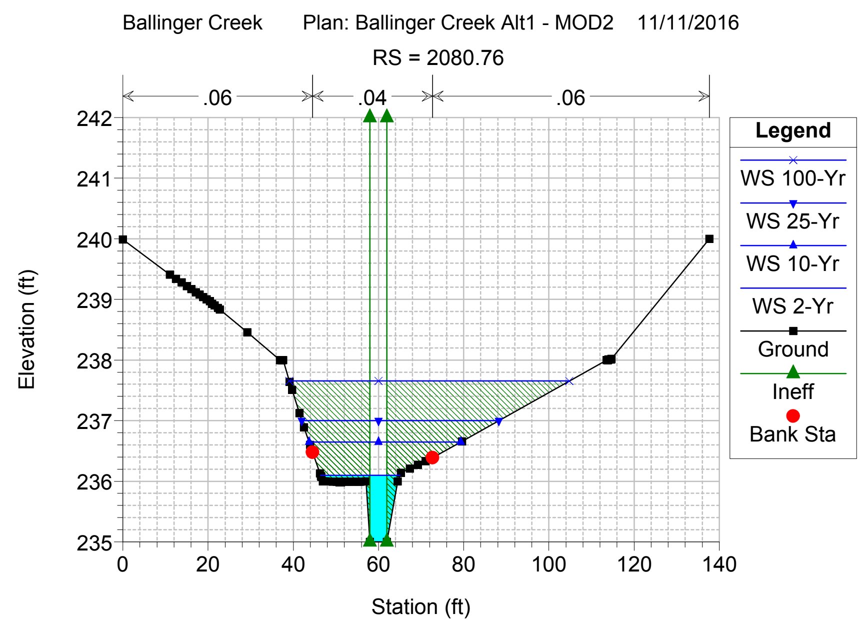


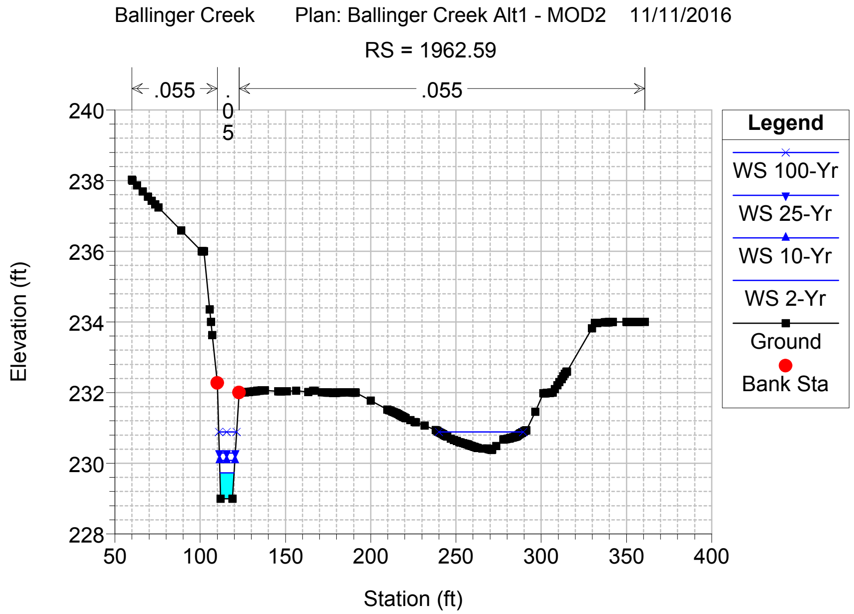
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2472.18
.08 .05 .08
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2408.66 Culv
.08 .05 .08
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2408.66 Culv
.055 .05 .055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2345.13
.055 .05 .055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

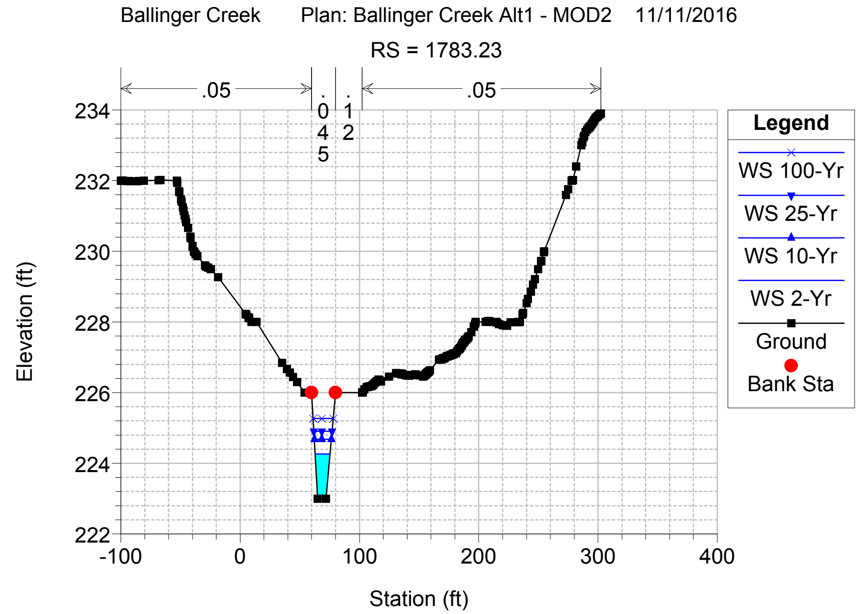

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2304.16
.05
.035
.05
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

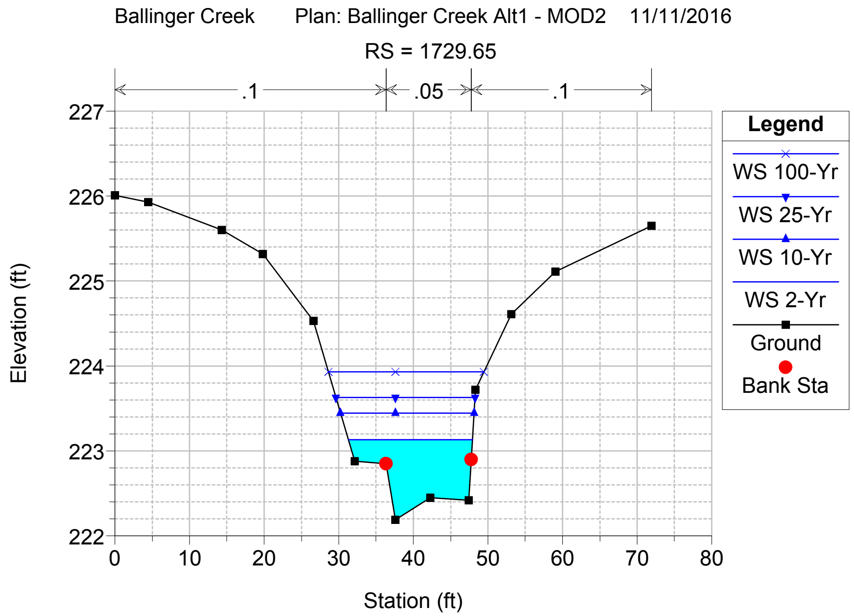

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2212.95 Culv
.05
.035
.05
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

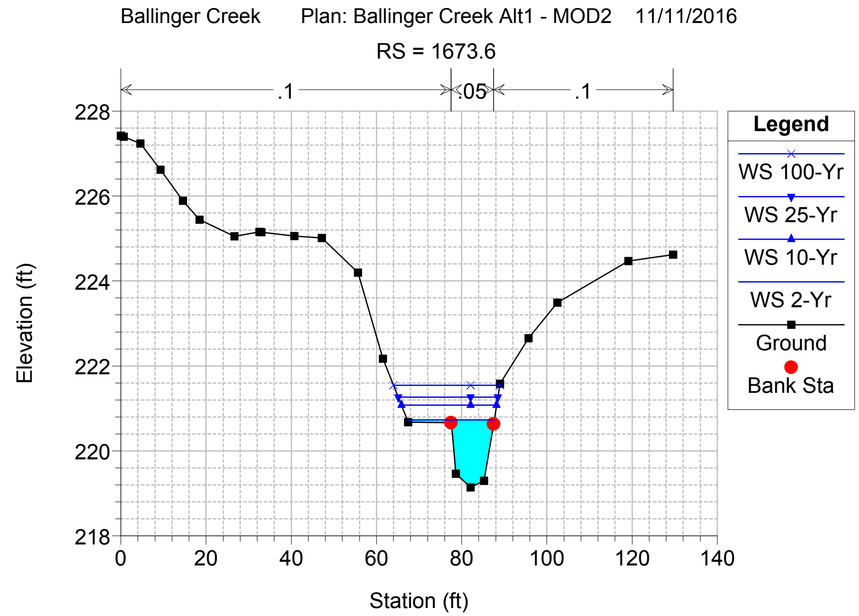

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2212.95 Culv
.06
.04
.06
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

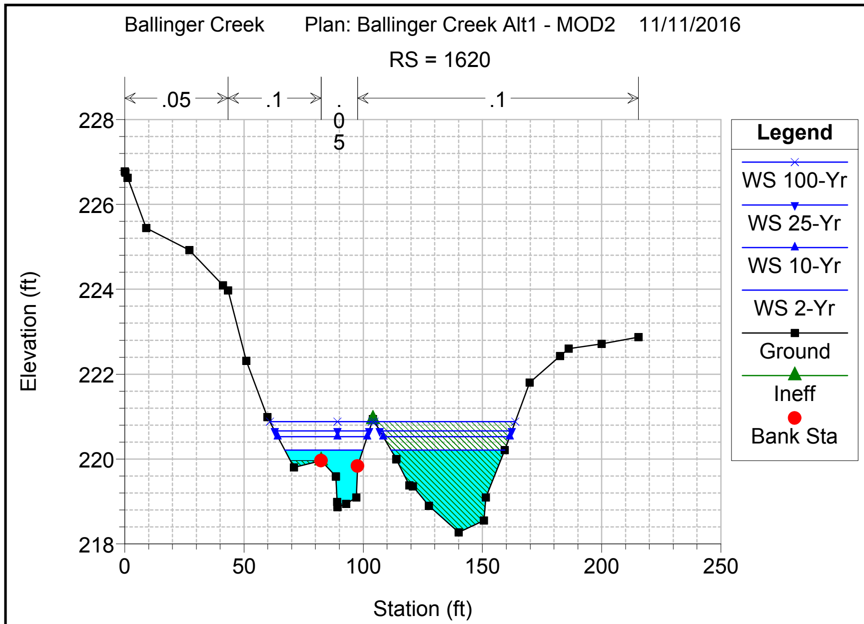

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 2080.76
.06
.04
.06
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

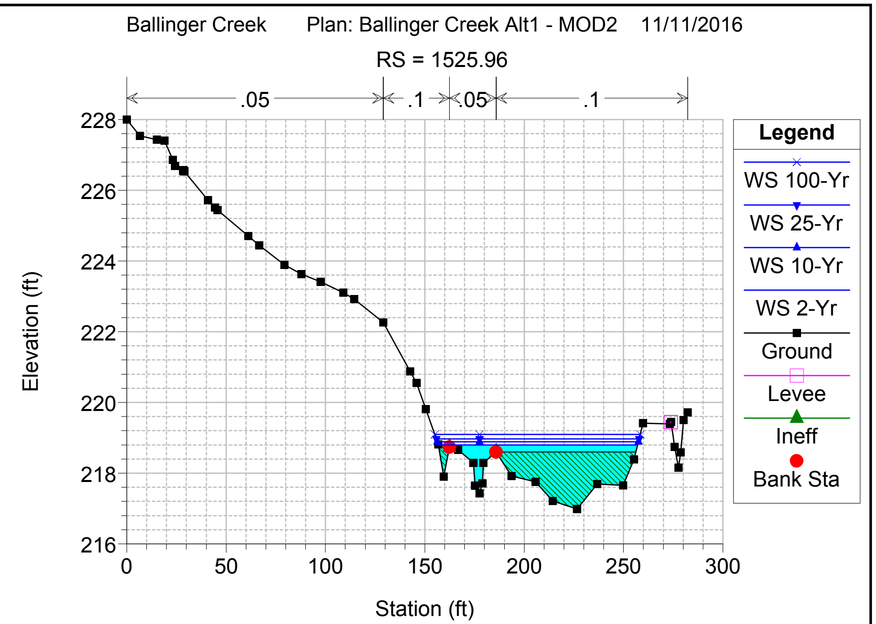

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1962.59
.055
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

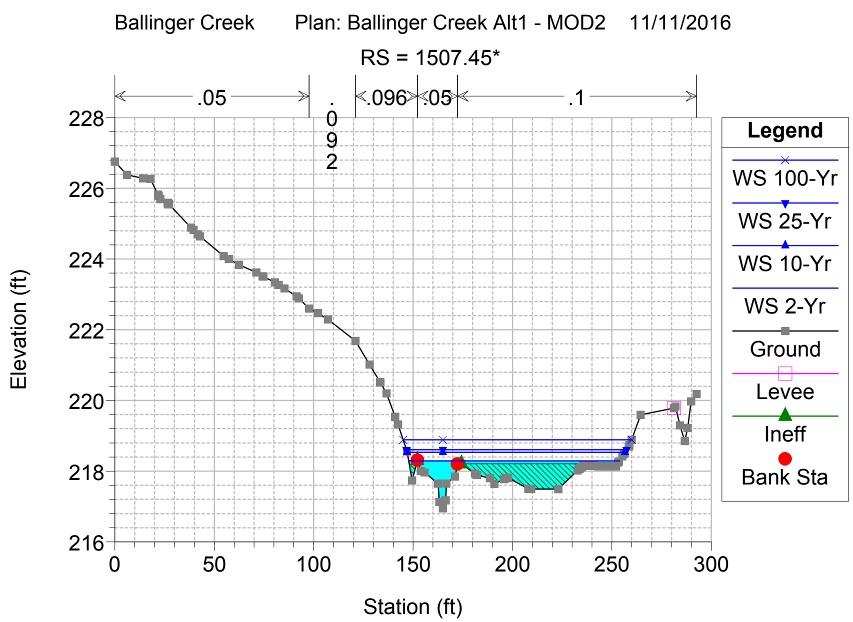

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1783.23
.05
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

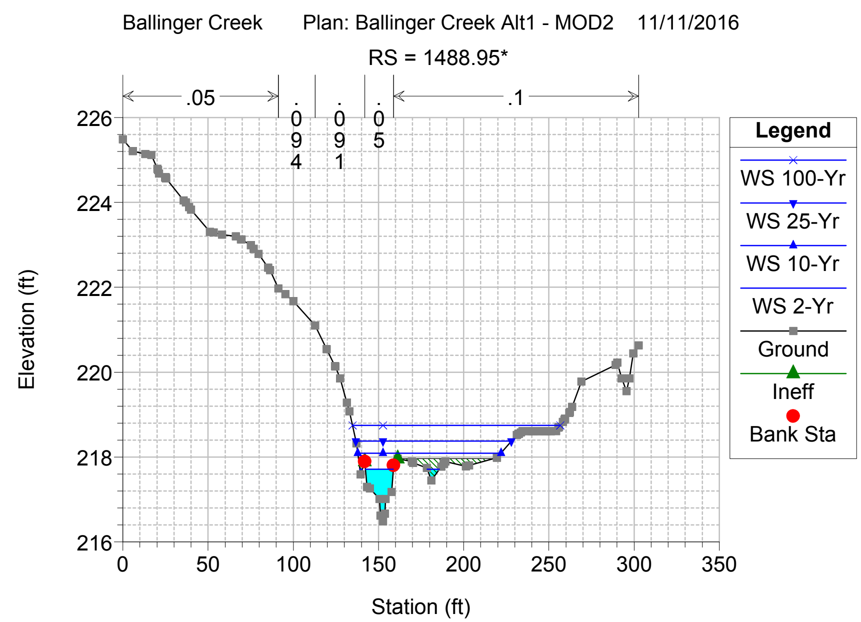

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1729.65
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

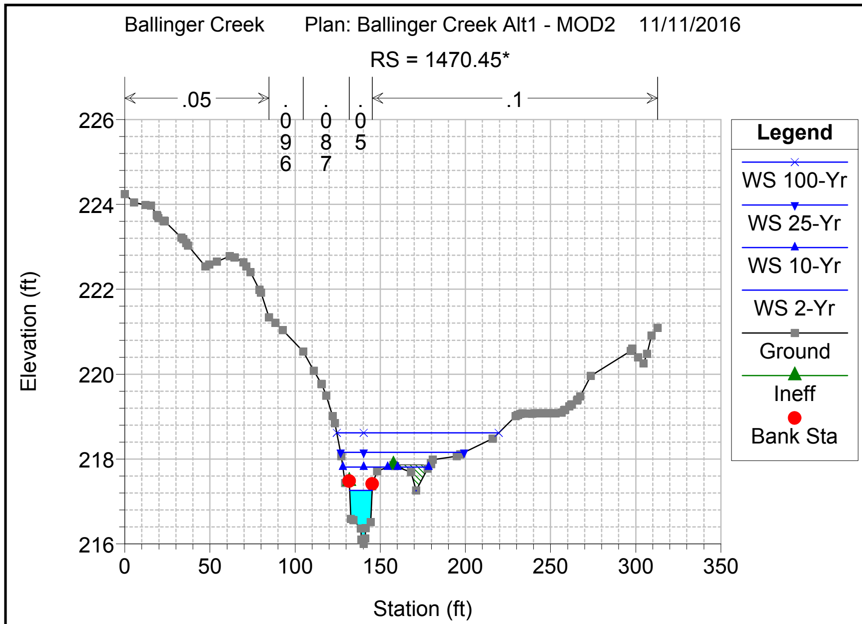

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1673.6
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta

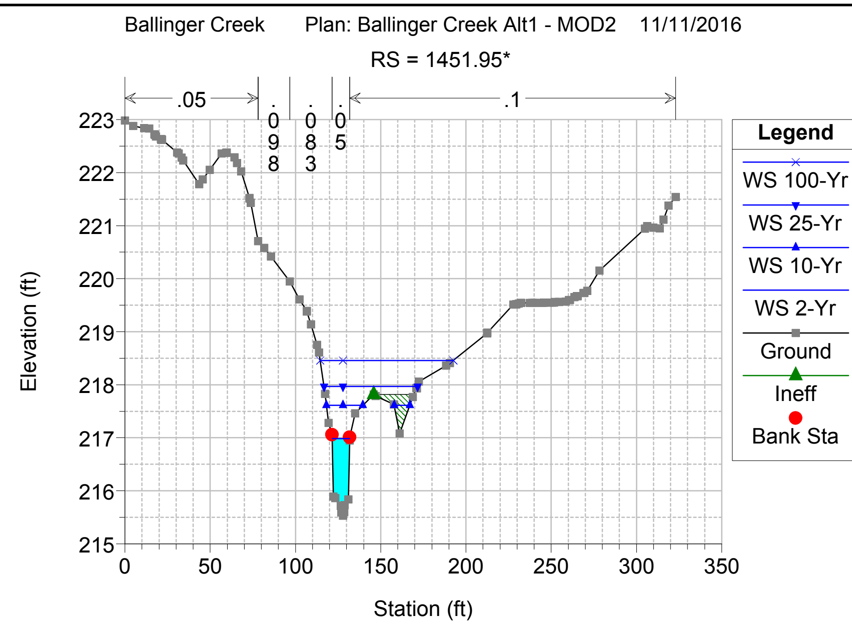

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1620
.05
.1
.
0
5
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

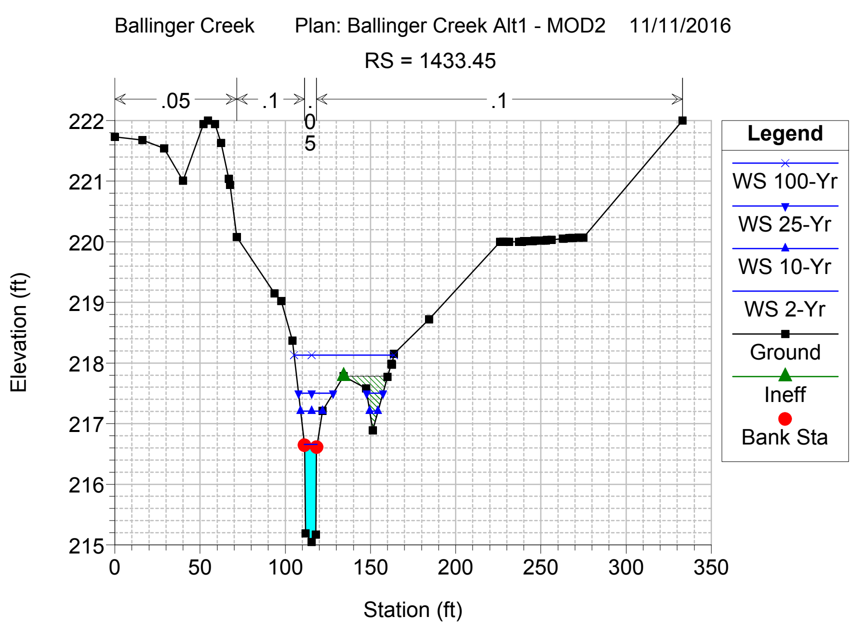

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1525.96
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

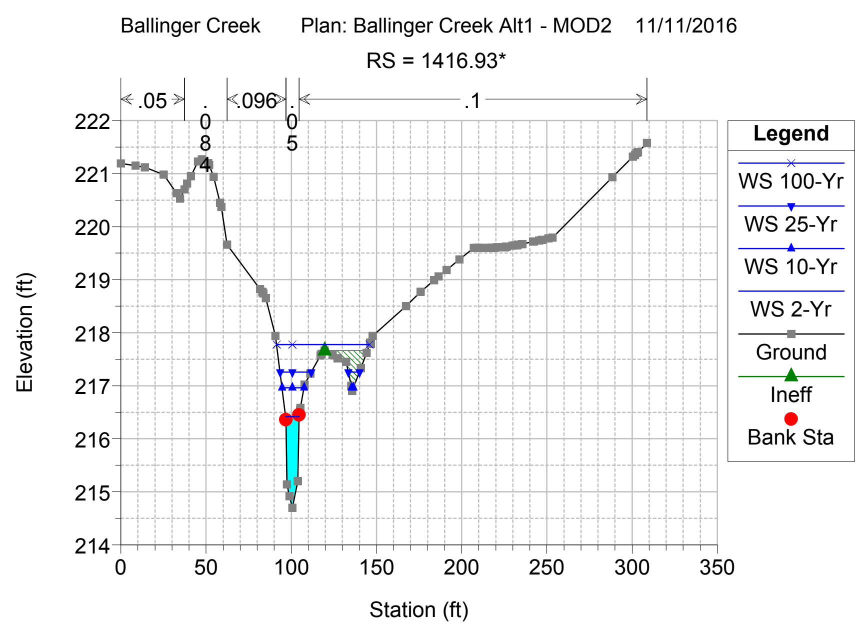

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1507.45*
.05
.
0
9
2
.096
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

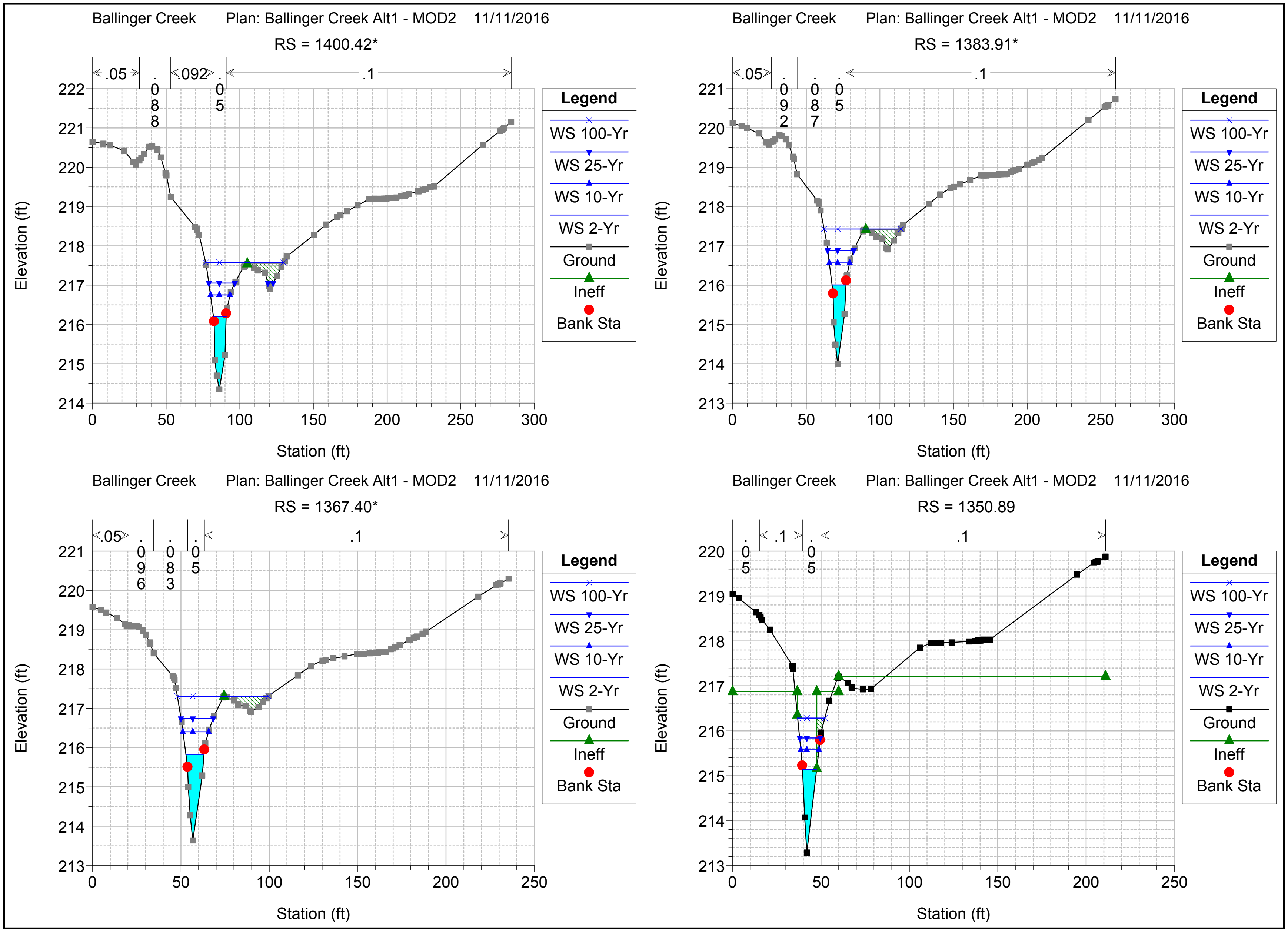

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1488.95*
.05
.
0
9
4
.
0
9
1
.
0
5
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1470.45*
.05
.096
.087
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

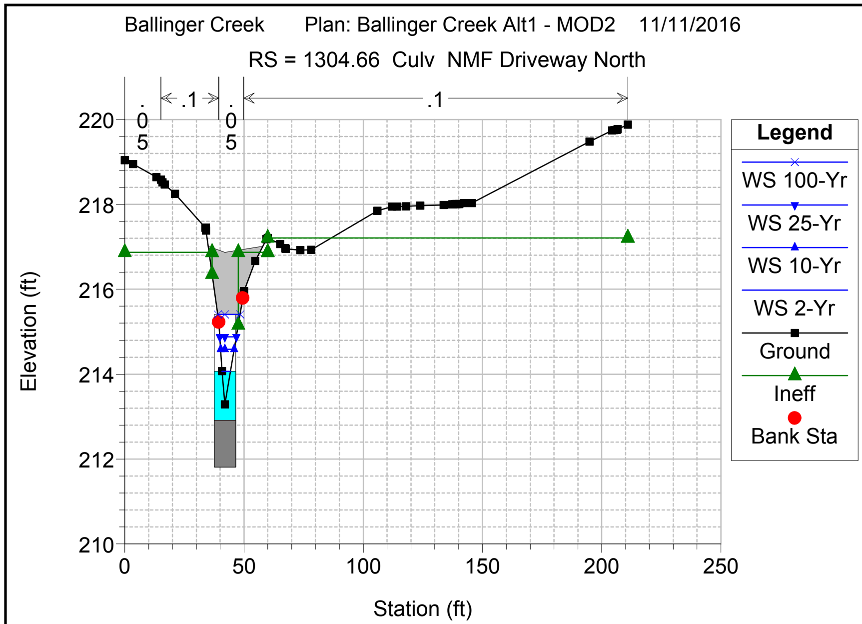

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1451.95*
.05
.098
.083
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

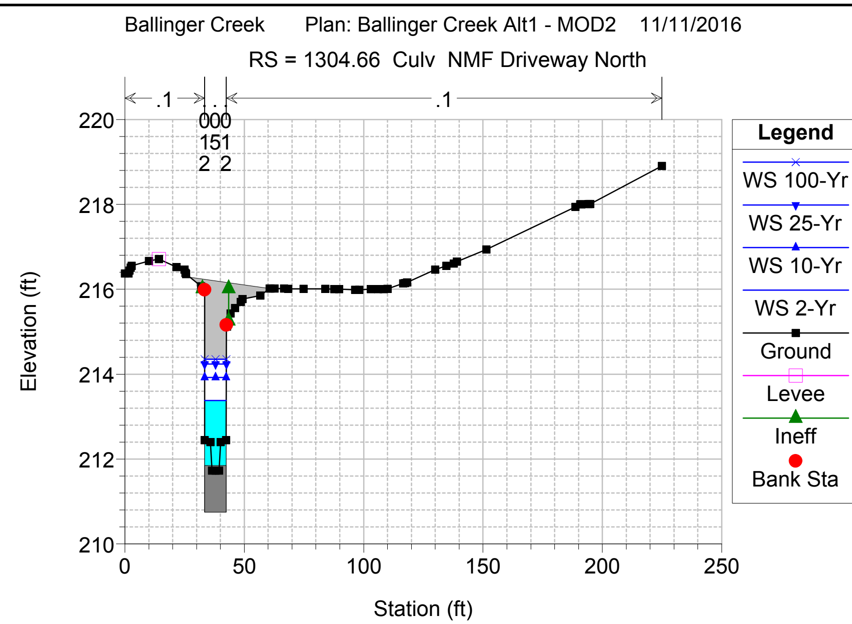

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1433.45
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

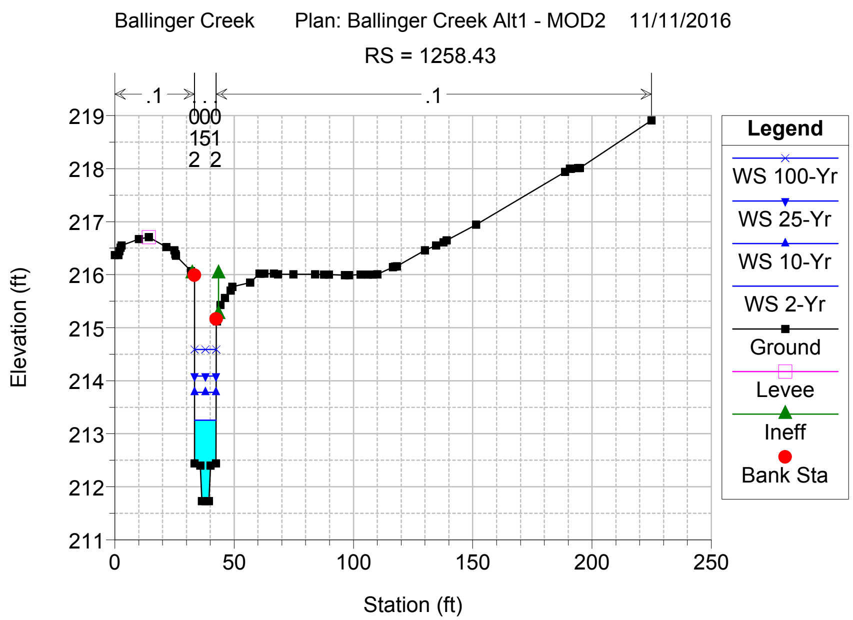

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1416.93*
.05
.084
.096
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

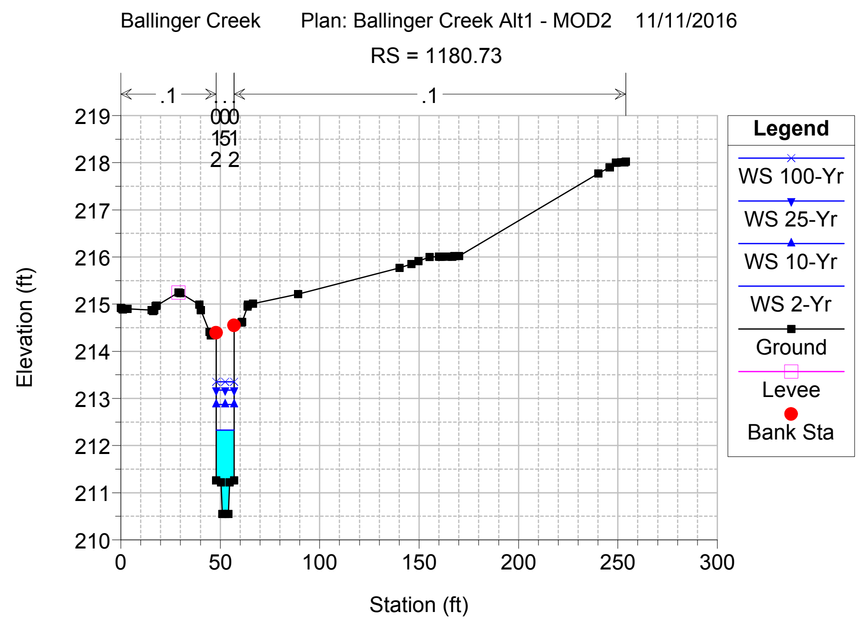


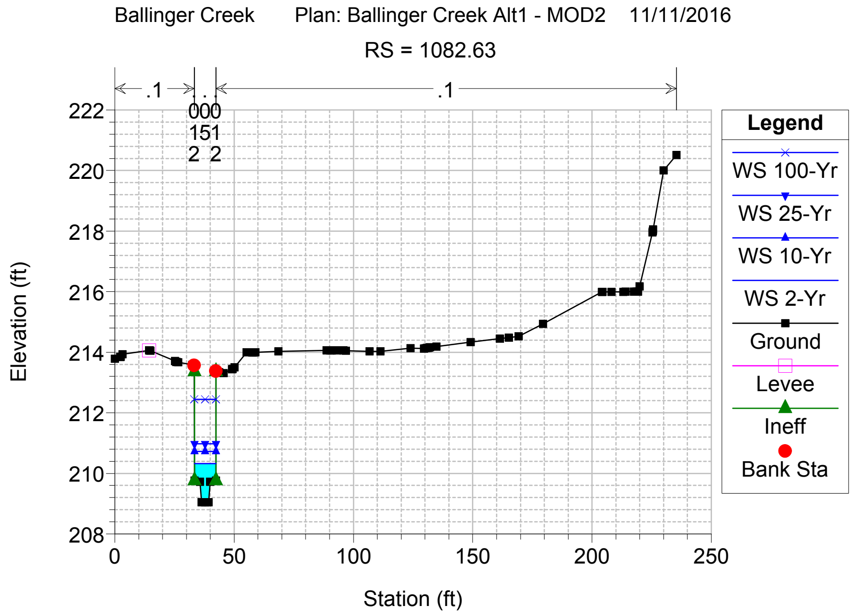
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1400.42*
.05
.088
.092
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1383.91*
.05
.092
.087
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1367.40*
.05
.096
.083
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1350.89
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

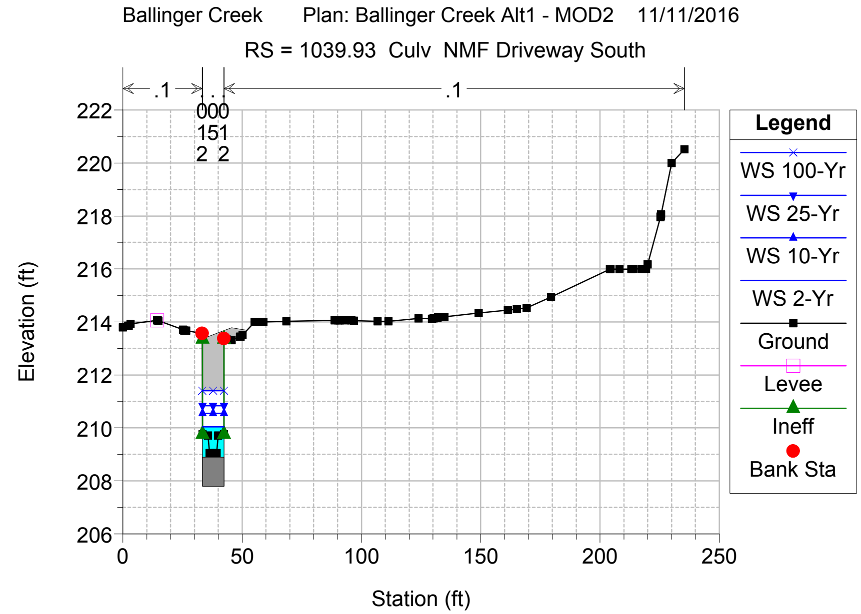

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1304.66 Culv NMF Driveway North
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

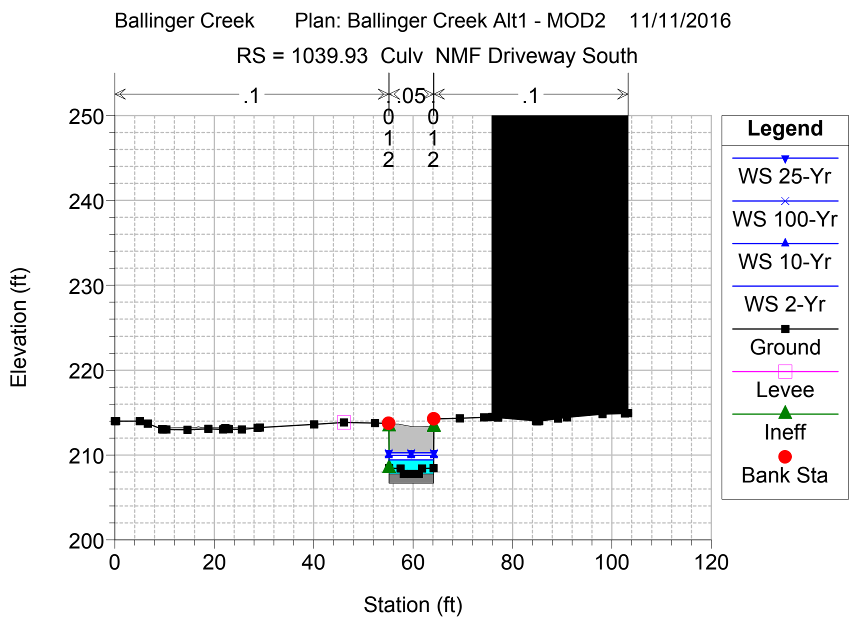

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1304.66 Culv NMF Driveway North
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

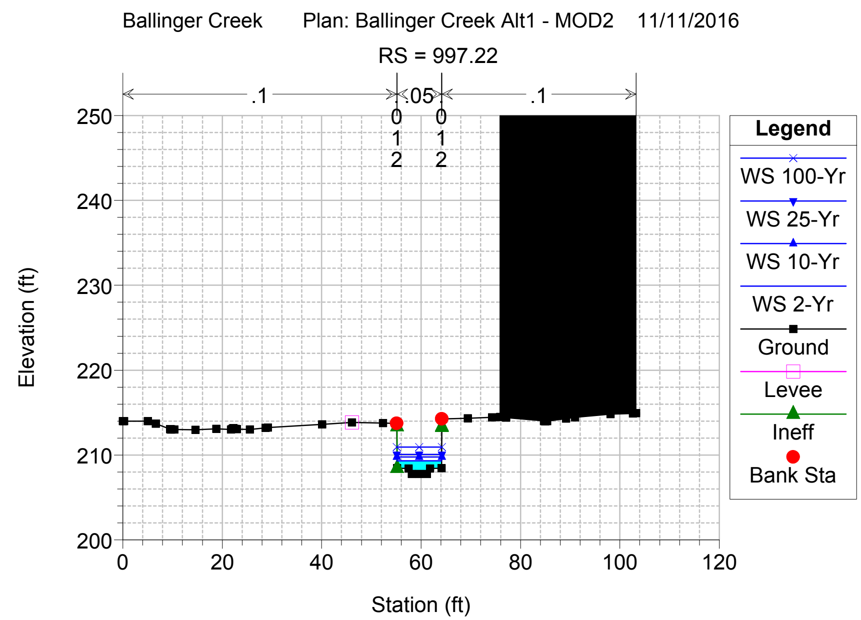

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1258.43
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

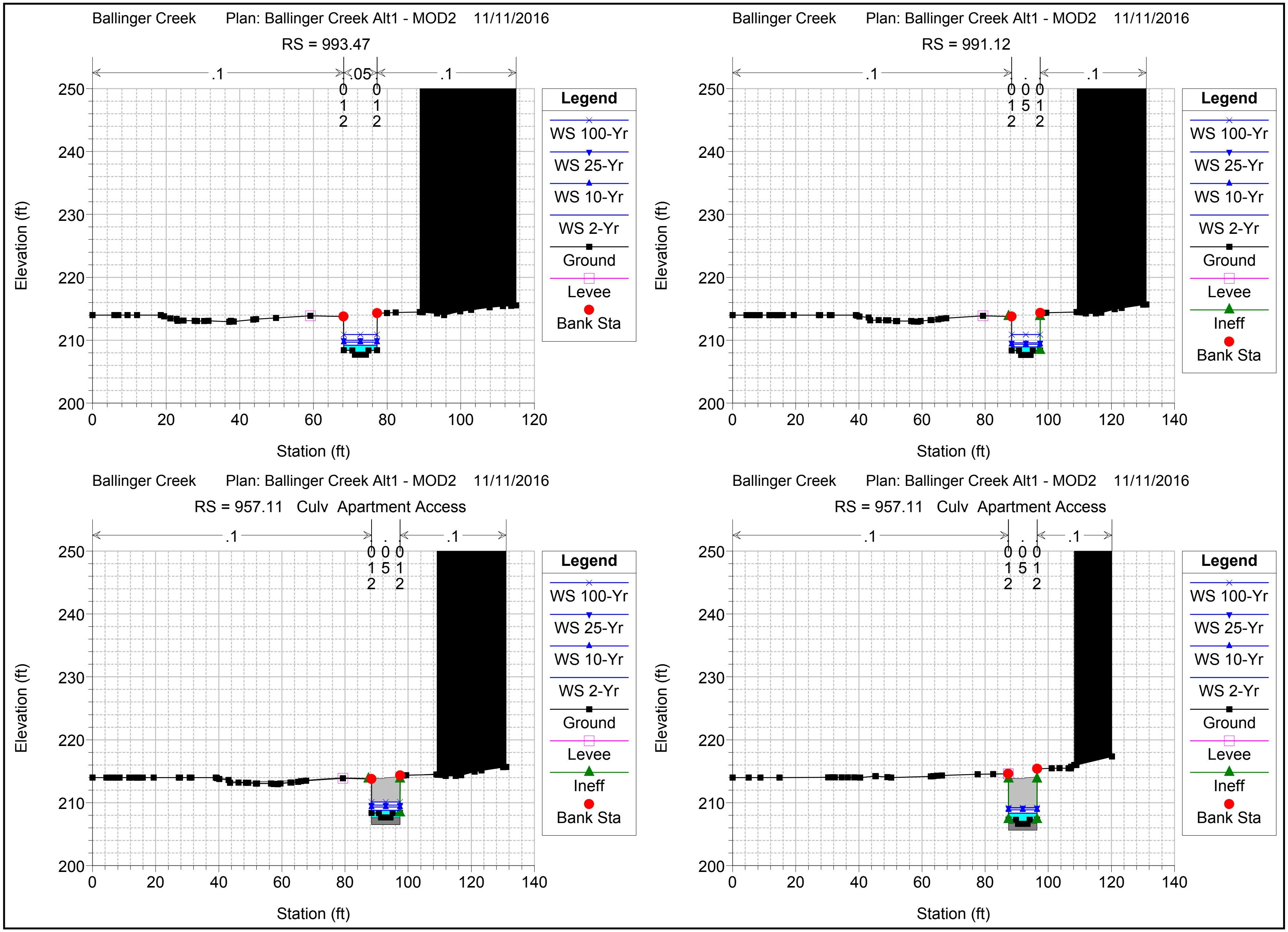

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1180.73
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta

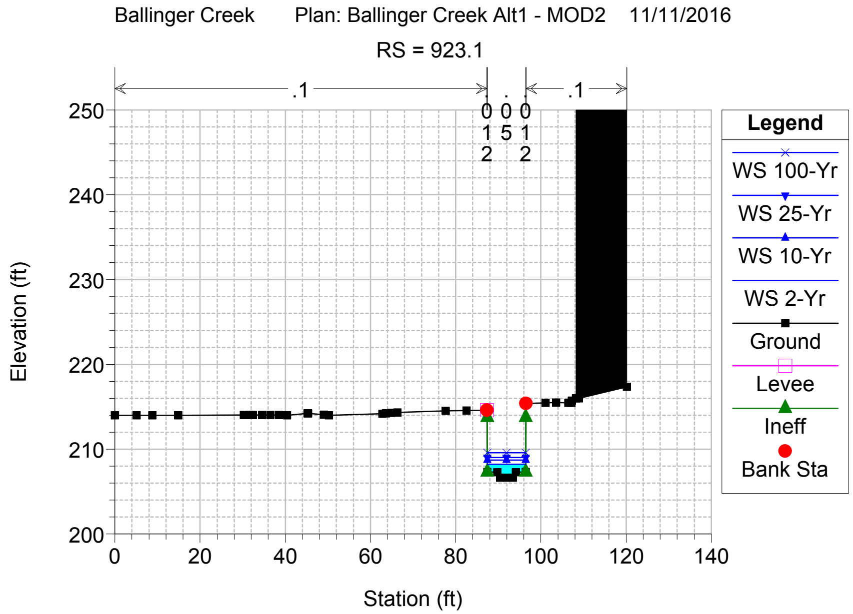

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1082.63
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

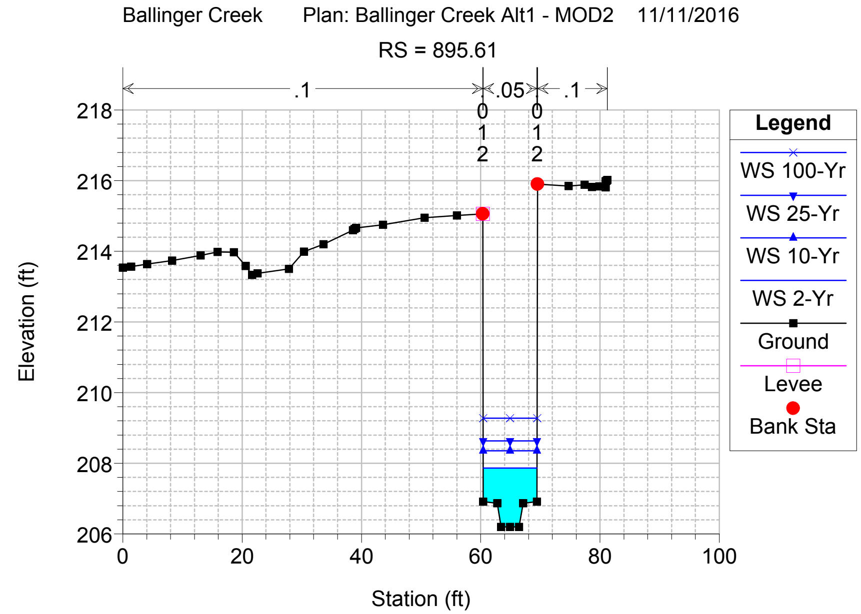

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1039.93 Culv NMF Driveway South
.1
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

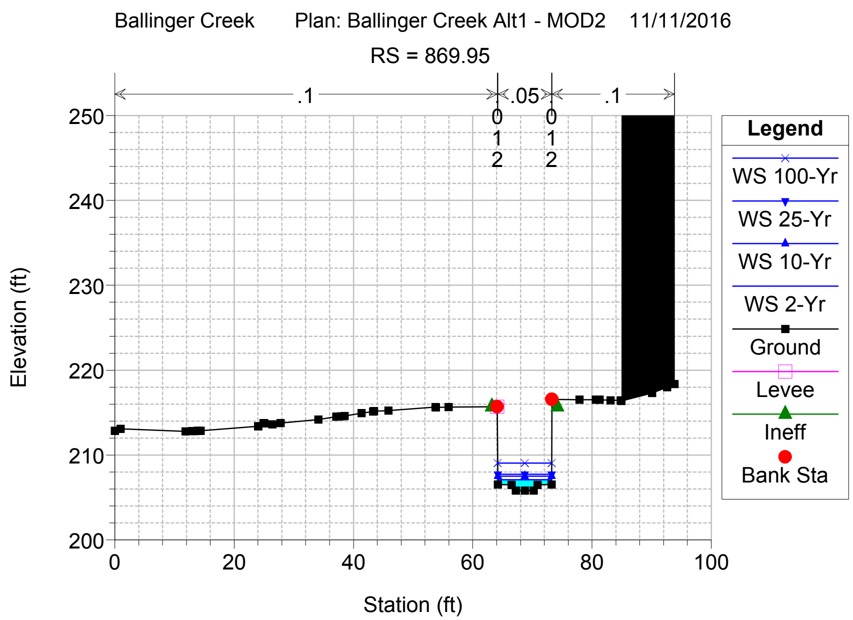

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 1039.93 Culv NMF Driveway South
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 25-Yr
WS 100-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

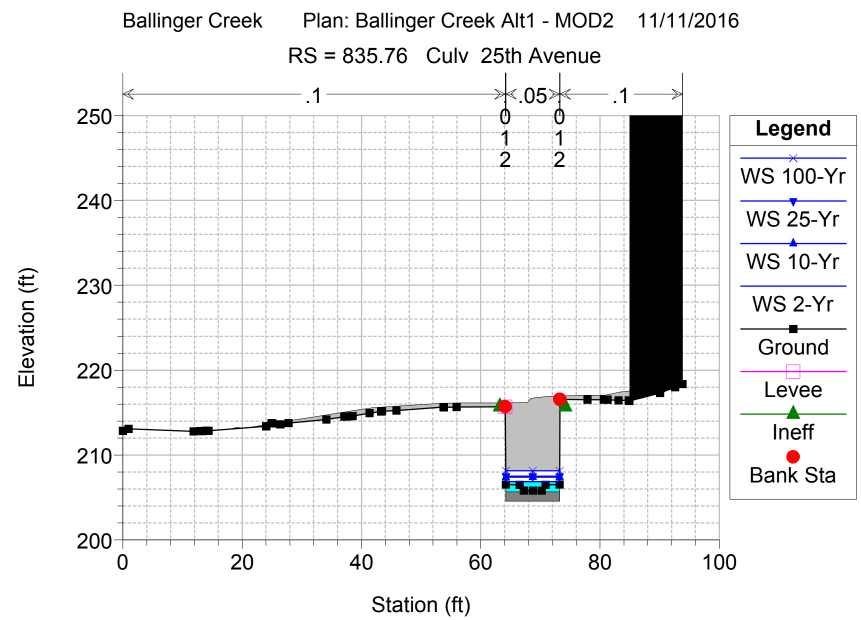

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 997.22
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

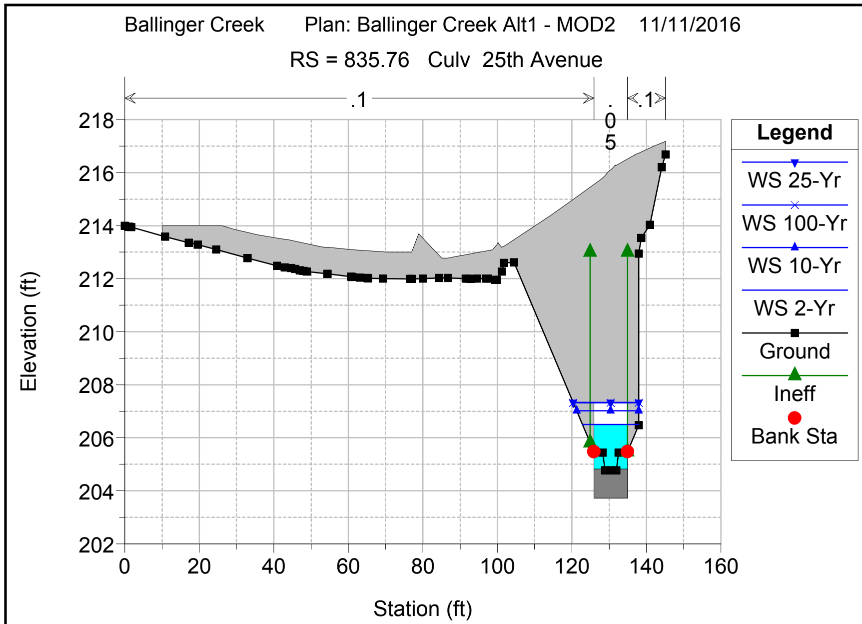

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 993.47
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 991.12
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 957.11 Culv Apartment Access
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 957.11 Culv Apartment Access
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

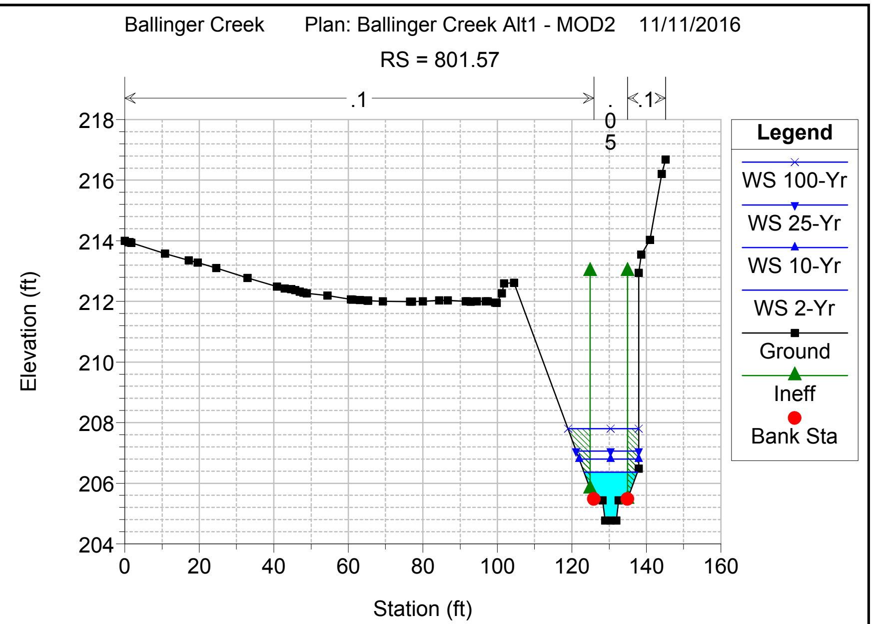

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 923.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

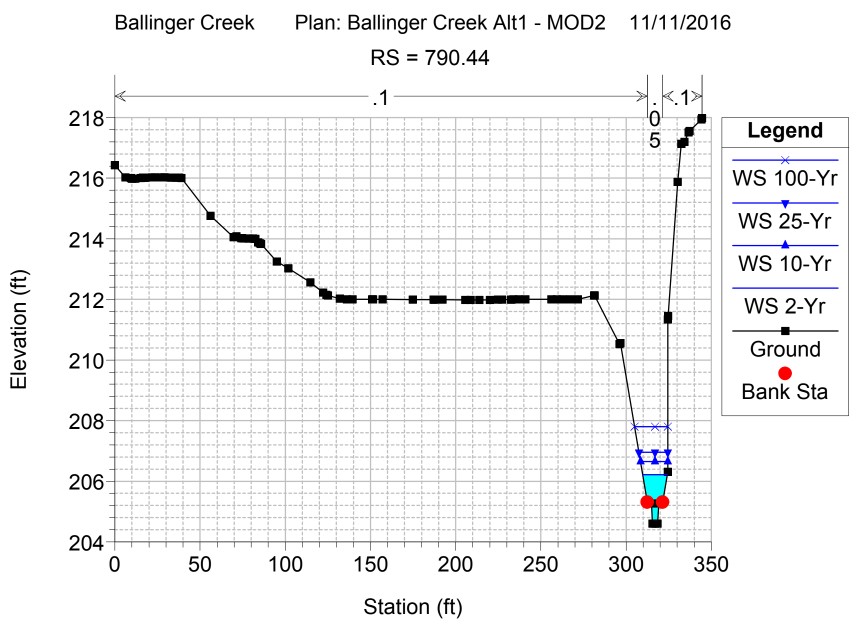

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 895.61
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta

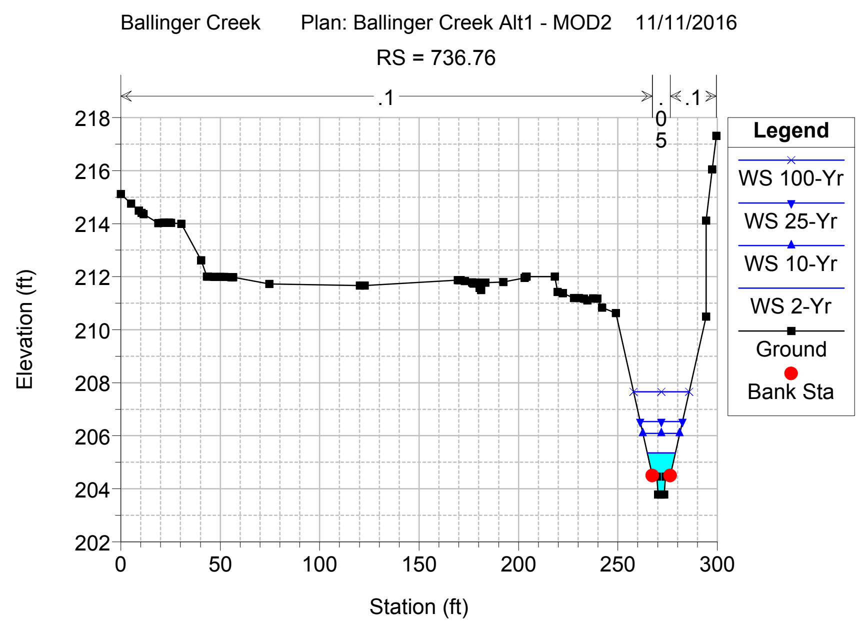

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 869.95
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

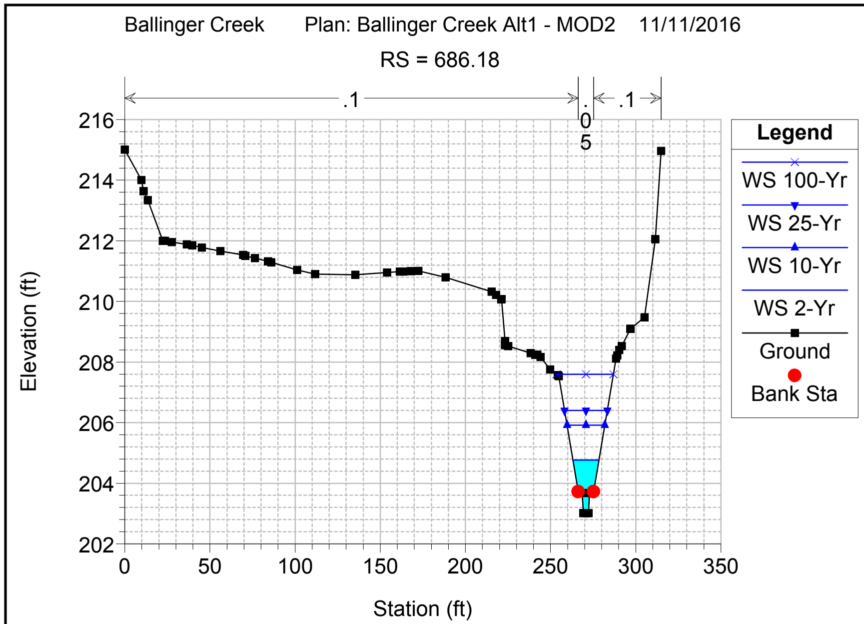

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 835.76 Culv 25th Avenue
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

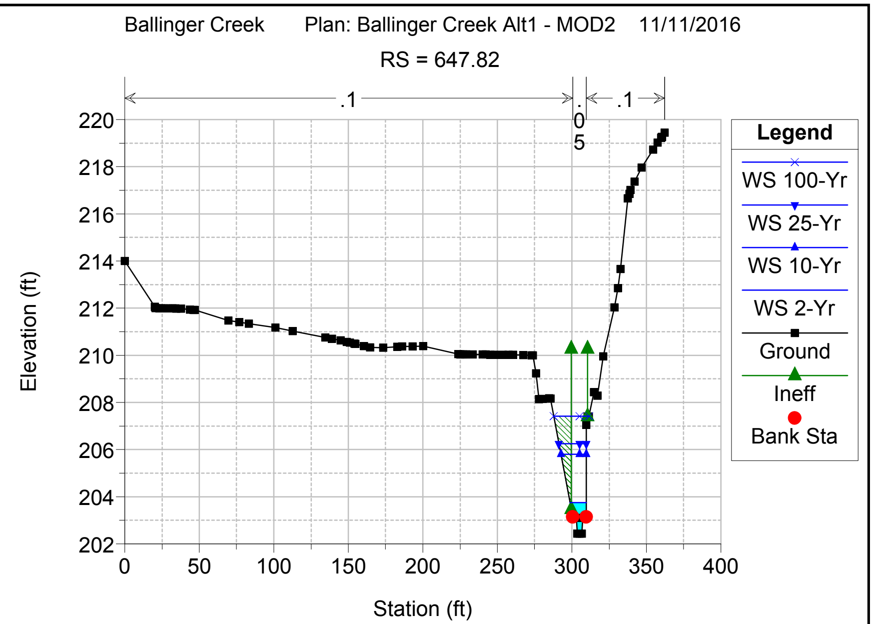

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 835.76 Culv 25th Avenue
.1
.05
.1
Legend
WS 25-Yr
WS 100-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

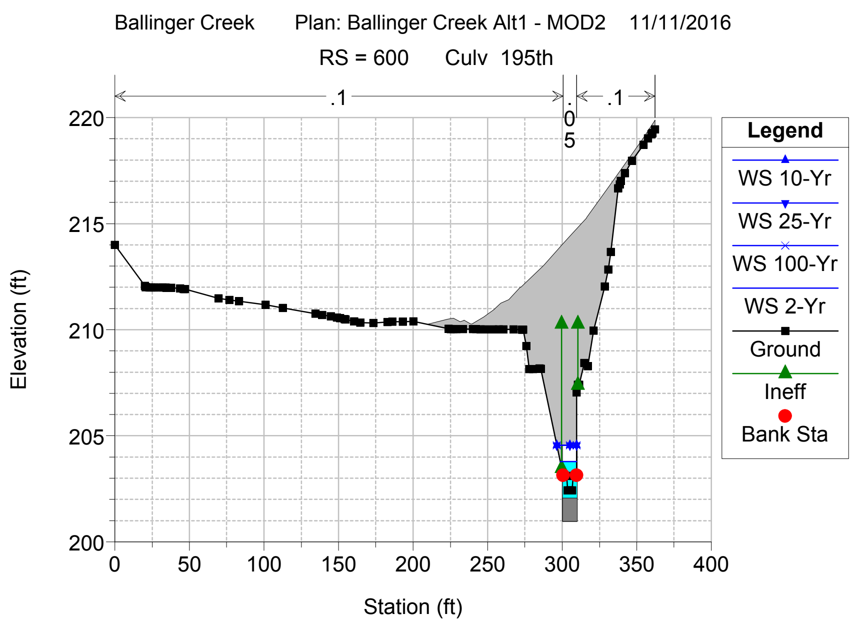

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 801.57
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

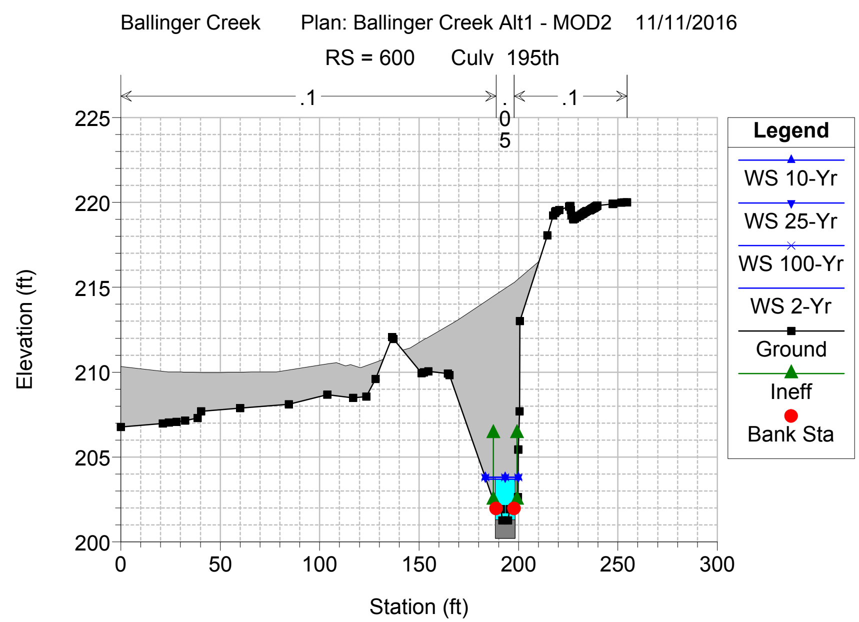

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 790.44
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

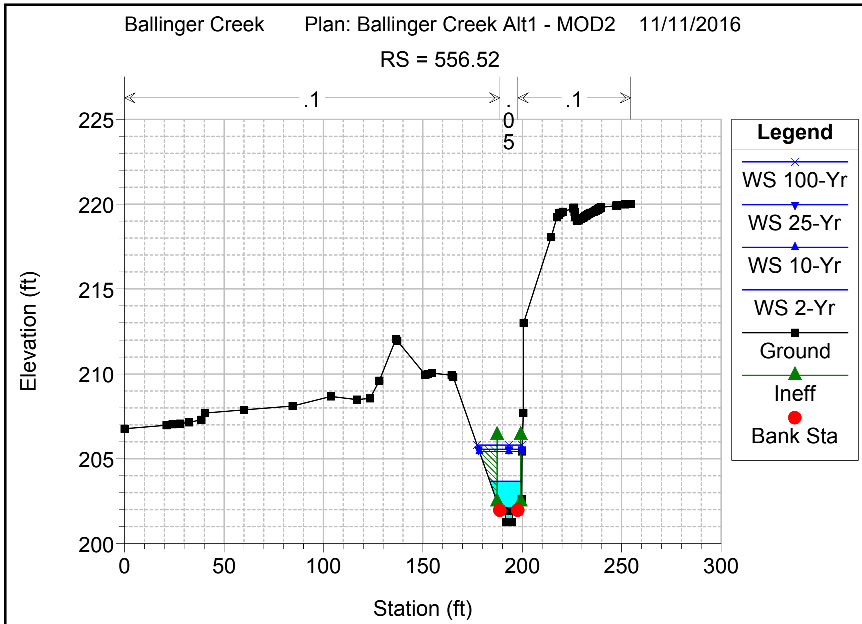

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 736.76
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

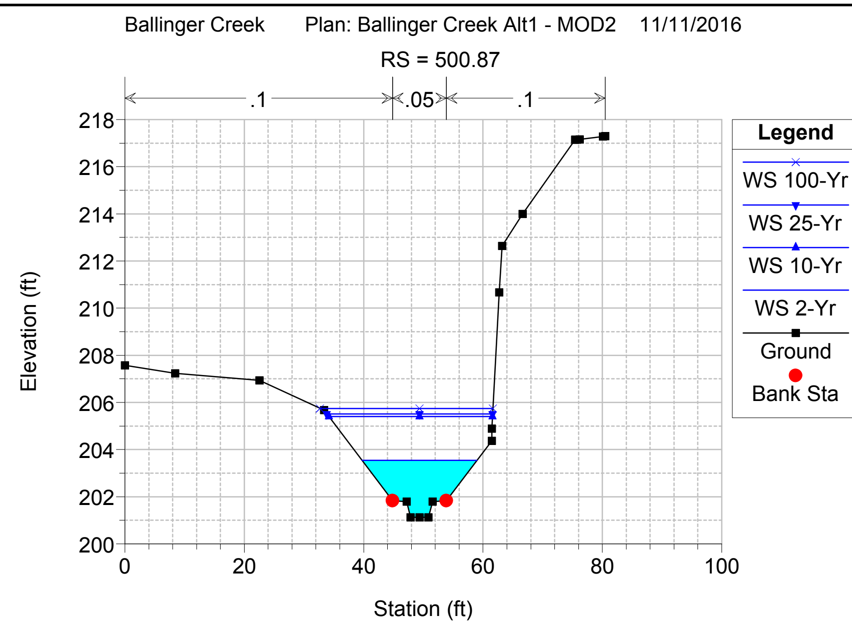

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 686.18
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

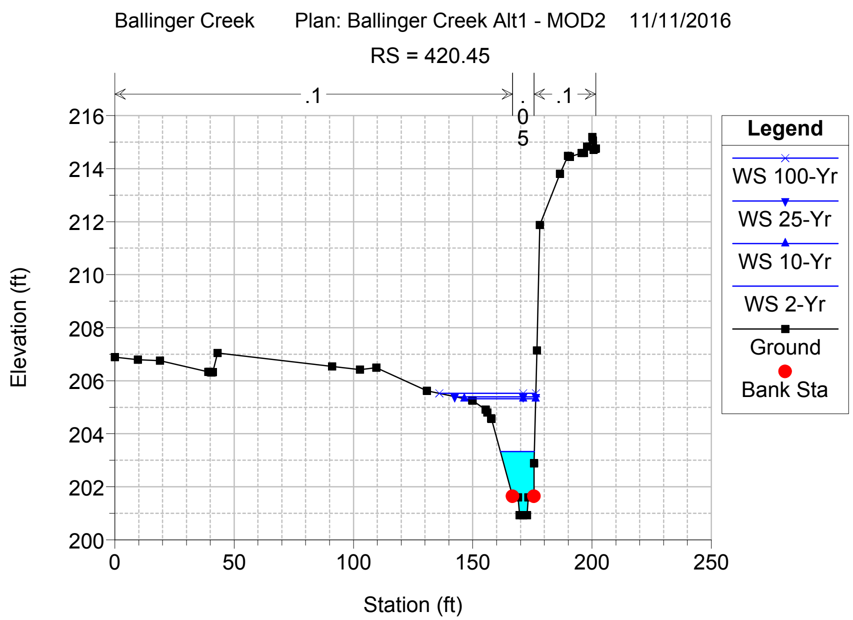

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 647.82
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

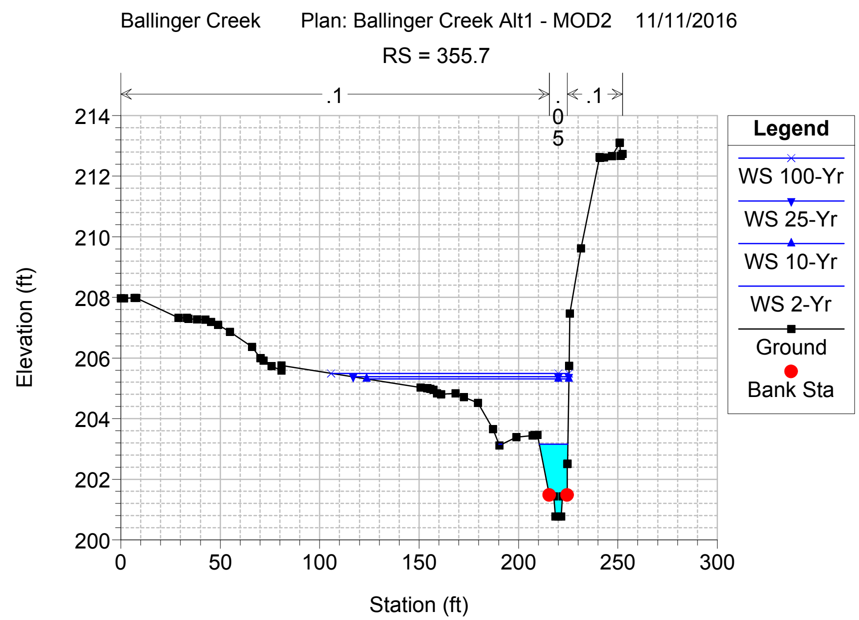

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 600 Culv 195th
.1
.05
.1
Legend
WS 10-Yr
WS 25-Yr
WS 100-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

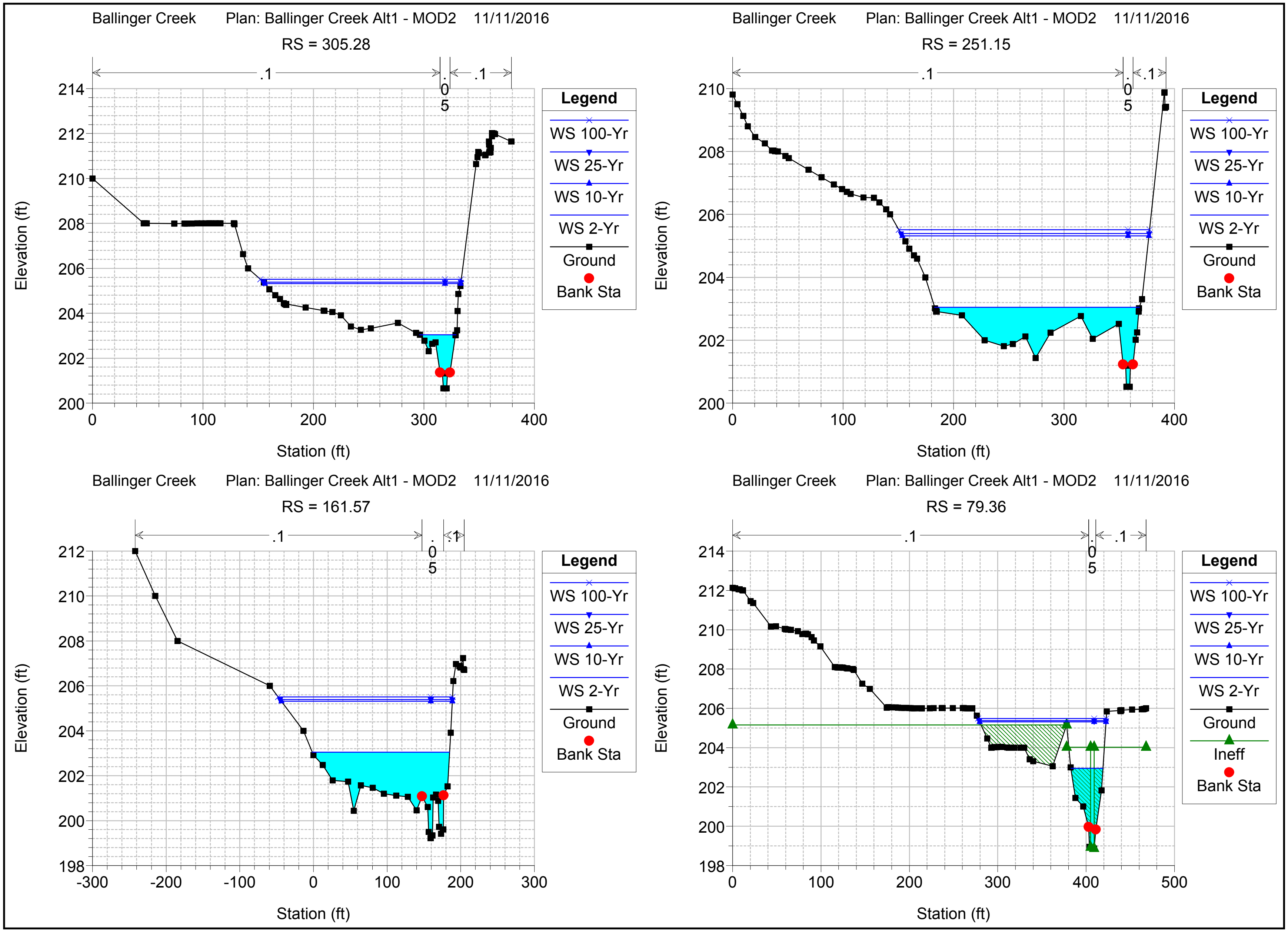

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 600 Culv 195th
.1
.05
.1
Legend
WS 10-Yr
WS 25-Yr
WS 100-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

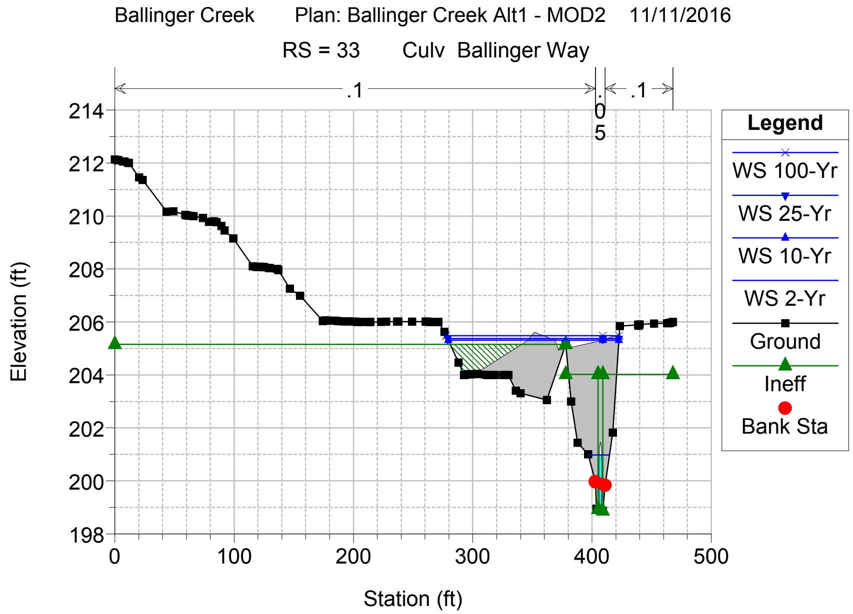

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 556.52
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
225
220
215
210
205
200
0
50
100
150
200
250
300

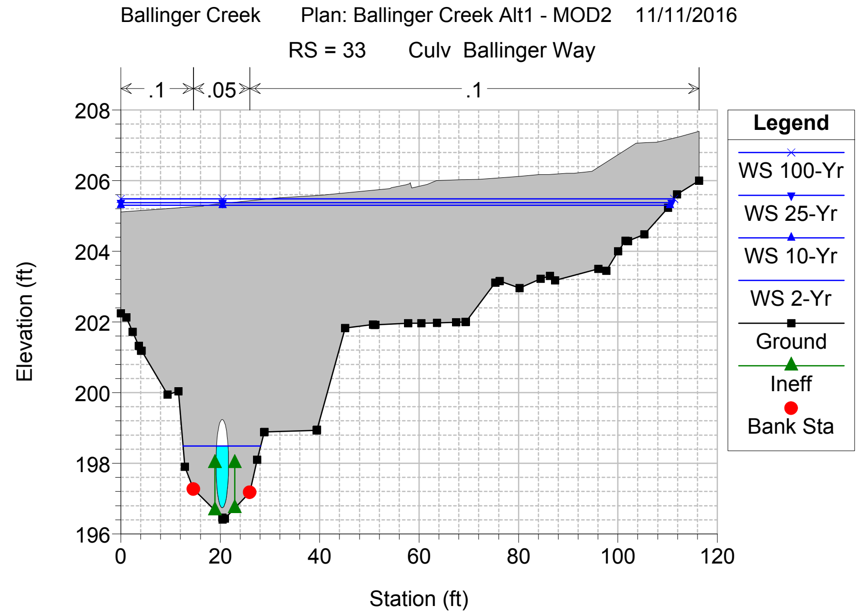

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 500.87
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
218
216
214
212
210
208
206
204
202
200
0
20
40
60
80
100

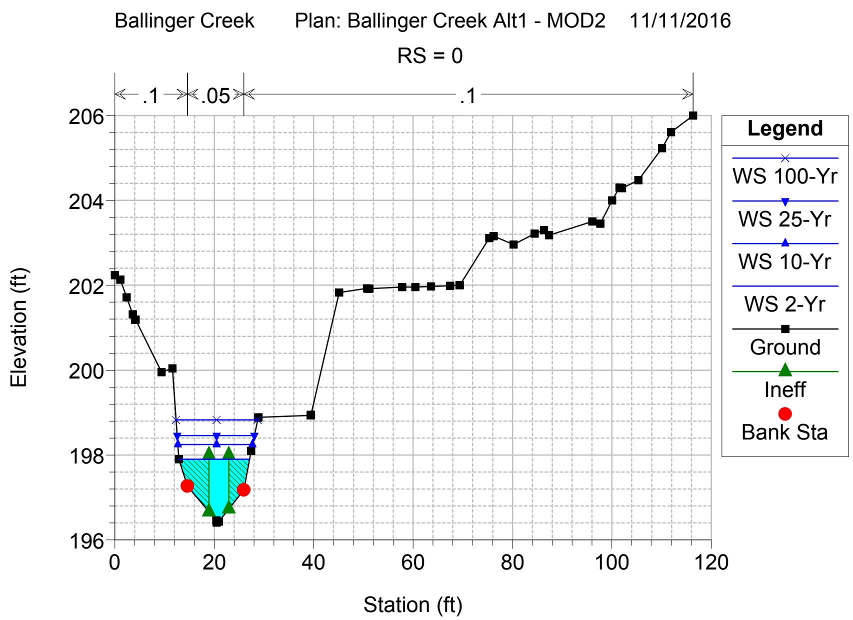

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 420.45
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
216
214
212
210
208
206
204
202
200
0
50
100
150
200
250

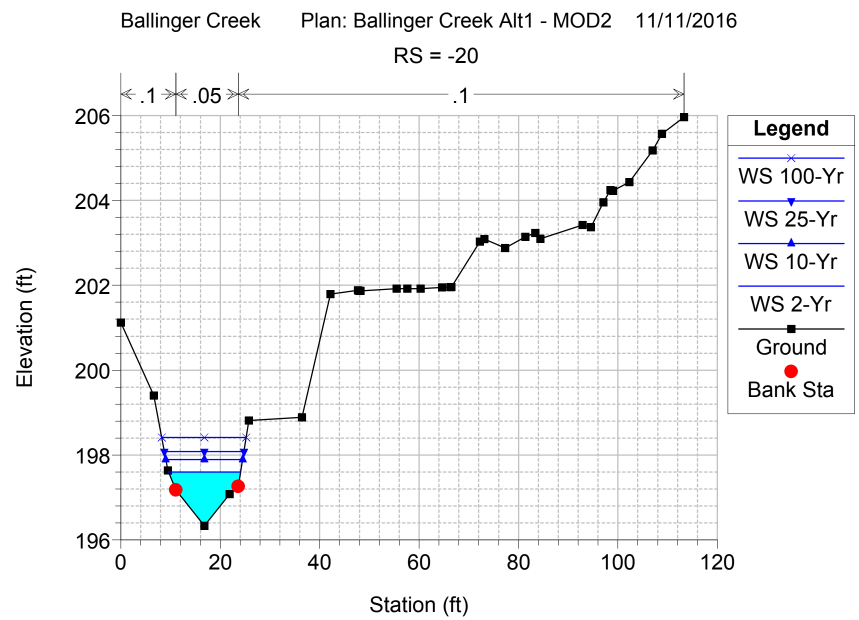

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 355.7
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
214
212
210
208
206
204
202
200
0
50
100
150
200
250
300

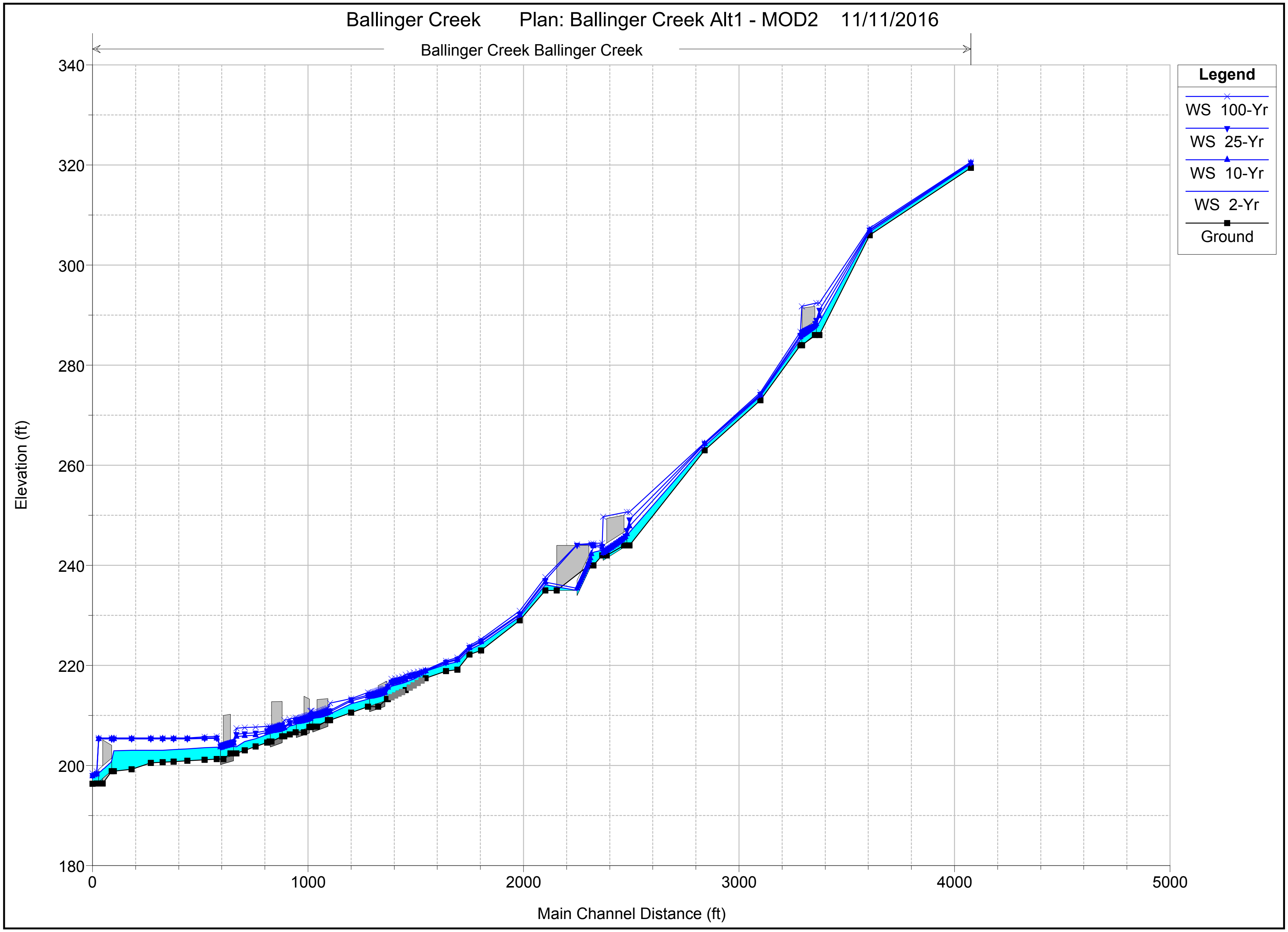

Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 305.28
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 251.15
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 161.57
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 79.36
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 33 Culv Ballinger Way
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 33 Culv Ballinger Way
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = 0
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
RS = -20
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt1 - MOD2 11/11/2016
Ballinger Creek Ballinger Creek
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Elevation (ft)
Main Channel Distance (ft)
340
320
300
280
260
240
220
200
180
0
1000
2000
3000
4000
5000

HEC-RAS Plan: Alt1-MOD2 River: Ballinger Creek Reach: Ballinger Creek

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	3823.04	2-Yr	26.10	319.41	320.18	320.12	320.29	0.019274	2.84	11.77	35.33	0.66
Ballinger Creek	3823.04	10-Yr	47.94	319.41	320.36	320.28	320.51	0.021037	3.54	18.31	40.40	0.72
Ballinger Creek	3823.04	25-Yr	64.34	319.41	320.46	320.38	320.65	0.022354	3.96	22.44	43.31	0.76
Ballinger Creek	3823.04	100-Yr	97.93	319.41	320.62	320.55	320.88	0.024301	4.66	30.06	48.20	0.82
Ballinger Creek	3586.63	2-Yr	26.10	305.99	306.62	306.62	306.89	0.046359	4.15	6.30	12.11	1.00
Ballinger Creek	3586.63	10-Yr	47.94	305.99	306.90	306.90	307.27	0.039554	4.94	9.85	13.83	0.99
Ballinger Creek	3586.63	25-Yr	64.34	305.99	307.07	307.07	307.51	0.035822	5.37	12.32	14.88	0.97
Ballinger Creek	3586.63	100-Yr	97.93	305.99	307.37	307.37	307.92	0.031399	6.05	17.13	16.81	0.95
Ballinger Creek	3353.31	2-Yr	26.10	286.00	288.59	286.94	288.65	0.001300	2.02	12.93	9.53	0.22
Ballinger Creek	3353.31	10-Yr	47.94	286.00	289.80	287.42	289.90	0.001212	2.52	19.01	11.66	0.23
Ballinger Creek	3353.31	25-Yr	64.34	286.00	291.06	287.73	291.16	0.000841	2.54	25.32	24.55	0.20
Ballinger Creek	3353.31	100-Yr	97.93	286.00	292.43	288.29	292.45	0.000400	1.00	98.02	40.68	0.11
Ballinger Creek	3309.19		Culvert									
Ballinger Creek	3265.07	2-Yr	26.10	284.00	285.10	285.10	285.65	0.035659	5.97	4.37	18.32	1.00
Ballinger Creek	3265.07	10-Yr	47.94	284.00	285.65	285.65	286.48	0.030656	7.28	6.59	21.29	1.00
Ballinger Creek	3265.07	25-Yr	64.34	284.00	286.01	286.01	287.01	0.029065	8.06	7.98	23.12	1.00
Ballinger Creek	3265.07	100-Yr	97.93	284.00	286.66	286.66	287.99	0.026154	9.24	10.60	26.90	1.00
Ballinger Creek	3079.46	2-Yr	26.10	273.00	273.80		274.02	0.031983	3.75	6.95	9.38	0.77
Ballinger Creek	3079.46	10-Yr	47.94	273.00	274.00	274.00	274.45	0.052307	5.44	8.82	9.72	1.01
Ballinger Creek	3079.46	25-Yr	64.34	273.00	274.20	274.20	274.75	0.050188	5.92	10.87	10.08	1.00
Ballinger Creek	3079.46	100-Yr	97.93	273.00	274.57	274.57	275.26	0.047968	6.68	14.66	10.71	1.01
Ballinger Creek	2820.85	2-Yr	26.10	263.00	263.84	263.84	264.18	0.045882	4.67	5.58	8.32	1.01
Ballinger Creek	2820.85	10-Yr	47.94	263.00	264.25	264.25	264.46	0.020759	4.14	23.44	67.78	0.72
Ballinger Creek	2820.85	25-Yr	64.34	263.00	264.36	264.36	264.58	0.020565	4.44	31.67	70.44	0.73
Ballinger Creek	2820.85	100-Yr	97.93	263.00	264.51	264.51	264.79	0.025641	5.35	41.83	73.66	0.83
Ballinger Creek	2472.18	2-Yr	26.10	244.00	246.59	244.95	246.65	0.001300	2.02	12.93	17.93	0.22
Ballinger Creek	2472.18	10-Yr	47.94	244.00	247.80	245.42	247.90	0.001212	2.52	19.02	24.02	0.23
Ballinger Creek	2472.18	25-Yr	64.34	244.00	249.17	245.73	249.27	0.000785	2.49	25.85	31.81	0.19
Ballinger Creek	2472.18	100-Yr	97.93	244.00	250.66	246.29	250.66	0.000076	0.74	158.45	59.44	0.06
Ballinger Creek	2408.66		Culvert									

HEC-RAS Plan: Alt1-MOD2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	2345.13	2-Yr	26.10	242.00	243.02	243.02	243.53	0.036553	5.74	4.55	27.76	1.00
Ballinger Creek	2345.13	10-Yr	47.94	242.00	243.56	243.52	244.29	0.029405	6.86	6.99	37.31	0.97
Ballinger Creek	2345.13	25-Yr	64.34	242.00	243.86	243.86	244.79	0.029522	7.72	8.33	42.55	1.00
Ballinger Creek	2345.13	100-Yr	97.93	242.00	244.46	244.46	245.69	0.027096	8.90	11.00	53.19	1.00
Ballinger Creek	2304.16	2-Yr	26.10	240.00	242.61	240.84	242.65	0.000431	1.67	15.64	45.88	0.18
Ballinger Creek	2304.16	10-Yr	47.94	240.00	243.84	241.25	243.90	0.000401	2.08	23.01	61.86	0.19
Ballinger Creek	2304.16	25-Yr	64.34	240.00	244.15	241.53	244.16	0.000059	0.73	133.87	67.89	0.07
Ballinger Creek	2304.16	100-Yr	97.93	240.00	244.35	242.03	244.37	0.000108	1.03	148.27	73.20	0.09
Ballinger Creek	2212.95		Culvert									
Ballinger Creek	2080.76	2-Yr	26.10	235.00	236.10	236.10	236.65	0.022700	5.95	4.39	18.57	1.00
Ballinger Creek	2080.76	10-Yr	47.94	235.00	236.65	236.65	237.47	0.019689	7.27	6.59	35.64	1.00
Ballinger Creek	2080.76	25-Yr	64.34	235.00	237.00	237.00	238.00	0.018602	8.04	8.00	46.22	1.00
Ballinger Creek	2080.76	100-Yr	97.93	235.00	237.65	237.65	238.98	0.016783	9.22	10.62	65.70	1.00
Ballinger Creek	1962.59	2-Yr	26.10	229.00	229.73	229.73	230.07	0.046747	4.67	5.59	8.34	1.01
Ballinger Creek	1962.59	10-Yr	47.94	229.00	230.08	230.08	230.56	0.042732	5.57	8.61	8.99	1.00
Ballinger Creek	1962.59	25-Yr	64.34	229.00	230.29	230.29	230.87	0.042144	6.09	10.56	9.38	1.01
Ballinger Creek	1962.59	100-Yr	97.93	229.00	230.89	230.89	231.17	0.016684	4.69	30.31	60.00	0.66
Ballinger Creek	1783.23	2-Yr	39.60	223.00	224.26		224.42	0.010314	3.22	12.29	12.47	0.57
Ballinger Creek	1783.23	10-Yr	71.94	223.00	224.68		224.93	0.011734	4.02	17.92	14.29	0.63
Ballinger Creek	1783.23	25-Yr	93.69	223.00	224.91		225.21	0.012351	4.41	21.26	15.27	0.66
Ballinger Creek	1783.23	100-Yr	134.36	223.00	225.27		225.65	0.013027	4.97	27.05	16.83	0.69
Ballinger Creek	1729.65	2-Yr	39.60	222.19	223.13	223.13	223.45	0.038359	4.60	9.56	16.65	0.95
Ballinger Creek	1729.65	10-Yr	71.94	222.19	223.45	223.45	223.90	0.035419	5.61	14.99	17.92	0.97
Ballinger Creek	1729.65	25-Yr	93.69	222.19	223.63	223.63	224.16	0.033823	6.11	18.33	18.66	0.97
Ballinger Creek	1729.65	100-Yr	134.36	222.19	223.93	223.93	224.59	0.031850	6.86	24.22	20.85	0.98
Ballinger Creek	1673.6	2-Yr	39.60	219.14	220.73		220.90	0.010267	3.24	12.80	20.37	0.52
Ballinger Creek	1673.6	10-Yr	71.94	219.14	221.08		221.36	0.013237	4.35	20.20	22.33	0.61
Ballinger Creek	1673.6	25-Yr	93.69	219.14	221.27		221.61	0.014466	4.90	24.46	23.38	0.65
Ballinger Creek	1673.6	100-Yr	134.36	219.14	221.55	221.32	222.01	0.016506	5.78	31.29	24.98	0.71
Ballinger Creek	1620	2-Yr	39.60	218.87	220.21		220.32	0.010658	2.75	17.51	80.45	0.51
Ballinger Creek	1620	10-Yr	71.94	218.87	220.53		220.68	0.010631	3.37	28.81	90.74	0.54

HEC-RAS Plan: Alt1-MOD2   River: Ballinger Creek   Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	1620	25-Yr	93.69	218.87	220.66		220.86	0.012082	3.85	33.85	94.93	0.59
Ballinger Creek	1620	100-Yr	134.36	218.87	220.88	220.60	221.14	0.013753	4.54	42.84	101.92	0.64
Ballinger Creek	1525.96	2-Yr	39.60	217.43	218.79	218.76	218.88	0.023651	2.68	24.89	100.25	0.70
Ballinger Creek	1525.96	10-Yr	71.94	217.43	218.89	218.88	219.03	0.034648	3.66	33.97	101.17	0.87
Ballinger Creek	1525.96	25-Yr	93.69	217.43	218.97	218.93	219.12	0.031083	3.82	42.70	102.09	0.84
Ballinger Creek	1525.96	100-Yr	134.36	217.43	219.10	219.04	219.27	0.029869	4.22	55.54	103.44	0.85
Ballinger Creek	1507.45*	2-Yr	39.60	216.95	218.29	218.29	218.43	0.023897	3.14	18.24	105.83	0.73
Ballinger Creek	1507.45*	10-Yr	71.94	216.95	218.53	218.44	218.63	0.013968	3.02	43.95	109.53	0.59
Ballinger Creek	1507.45*	25-Yr	93.69	216.95	218.60	218.51	218.72	0.015456	3.36	52.13	110.75	0.63
Ballinger Creek	1507.45*	100-Yr	134.36	216.95	218.89	218.62	218.97	0.008679	3.03	84.19	114.89	0.49
Ballinger Creek	1488.95*	2-Yr	39.60	216.48	217.72		217.93	0.029724	3.74	10.58	25.03	0.82
Ballinger Creek	1488.95*	10-Yr	71.94	216.48	218.09	218.07	218.32	0.019025	3.99	25.63	84.05	0.71
Ballinger Creek	1488.95*	25-Yr	93.69	216.48	218.38		218.51	0.009171	3.28	50.88	91.24	0.51
Ballinger Creek	1488.95*	100-Yr	134.36	216.48	218.74		218.84	0.005730	3.07	89.24	121.86	0.42
Ballinger Creek	1470.45*	2-Yr	39.60	216.00	217.26	217.09	217.47	0.021204	3.65	10.84	13.27	0.71
Ballinger Creek	1470.45*	10-Yr	71.94	216.00	217.81	217.42	218.04	0.012502	3.87	20.31	44.37	0.59
Ballinger Creek	1470.45*	25-Yr	93.69	216.00	218.16	217.64	218.34	0.008108	3.63	39.47	72.45	0.49
Ballinger Creek	1470.45*	100-Yr	134.36	216.00	218.61	218.12	218.74	0.004901	3.32	78.40	94.92	0.40
Ballinger Creek	1451.95*	2-Yr	39.60	215.53	216.98		217.16	0.012653	3.37	11.74	10.30	0.56
Ballinger Creek	1451.95*	10-Yr	71.94	215.53	217.61		217.84	0.009299	3.85	20.89	30.68	0.51
Ballinger Creek	1451.95*	25-Yr	93.69	215.53	217.97		218.19	0.007594	3.94	33.99	54.86	0.48
Ballinger Creek	1451.95*	100-Yr	134.36	215.53	218.46		218.64	0.005443	3.83	66.07	78.10	0.42
Ballinger Creek	1433.45	2-Yr	39.60	215.05	216.66		216.90	0.015378	3.94	10.06	7.39	0.58
Ballinger Creek	1433.45	10-Yr	71.94	215.05	217.21		217.60	0.016425	5.06	15.60	17.65	0.64
Ballinger Creek	1433.45	25-Yr	93.69	215.05	217.50	217.06	217.96	0.016580	5.58	20.50	29.81	0.65
Ballinger Creek	1433.45	100-Yr	134.36	215.05	218.13	217.67	218.48	0.010751	5.29	46.71	58.45	0.55
Ballinger Creek	1416.93*	2-Yr	39.60	214.70	216.42		216.64	0.014146	3.82	10.39	7.88	0.58
Ballinger Creek	1416.93*	10-Yr	71.94	214.70	216.96		217.32	0.014757	4.87	15.98	14.08	0.62
Ballinger Creek	1416.93*	25-Yr	93.69	214.70	217.26		217.69	0.014744	5.36	20.55	24.90	0.64
Ballinger Creek	1416.93*	100-Yr	134.36	214.70	217.77	217.31	218.25	0.013176	5.83	35.73	54.49	0.62
Ballinger Creek	1400.42*	2-Yr	39.60	214.35	216.20		216.41	0.012969	3.68	10.78	8.63	0.57

HEC-RAS Plan: Alt1-MOD2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	1400.42*	10-Yr	71.94	214.35	216.75		217.08	0.013167	4.65	16.64	13.30	0.60
Ballinger Creek	1400.42*	25-Yr	93.69	214.35	217.05		217.44	0.012842	5.08	21.32	21.15	0.61
Ballinger Creek	1400.42*	100-Yr	134.36	214.35	217.58	217.00	218.03	0.011771	5.63	34.03	52.90	0.61
Ballinger Creek	1383.91*	2-Yr	39.60	213.99	216.01		216.20	0.011806	3.53	11.28	9.44	0.55
Ballinger Creek	1383.91*	10-Yr	71.94	213.99	216.56		216.86	0.011475	4.38	17.63	13.85	0.57
Ballinger Creek	1383.91*	25-Yr	93.69	213.99	216.88		217.22	0.010864	4.75	22.65	17.77	0.57
Ballinger Creek	1383.91*	100-Yr	134.36	213.99	217.43	216.73	217.83	0.009779	5.25	35.22	52.10	0.56
Ballinger Creek	1367.40*	2-Yr	39.60	213.64	215.83		216.01	0.010820	3.38	11.84	10.16	0.53
Ballinger Creek	1367.40*	10-Yr	71.94	213.64	216.41		216.66	0.009987	4.12	18.79	14.52	0.54
Ballinger Creek	1367.40*	25-Yr	93.69	213.64	216.74	216.06	217.04	0.009161	4.42	24.31	18.22	0.53
Ballinger Creek	1367.40*	100-Yr	134.36	213.64	217.31	216.49	217.65	0.008103	4.86	36.87	51.55	0.52
Ballinger Creek	1350.89	2-Yr	41.16	213.29	215.13	215.13	215.60	0.042529	5.48	7.51	7.97	0.99
Ballinger Creek	1350.89	10-Yr	73.40	213.29	215.58	215.58	216.25	0.037663	6.59	11.28	10.29	0.99
Ballinger Creek	1350.89	25-Yr	95.02	213.29	215.84	215.84	216.62	0.034727	7.12	13.75	11.74	0.98
Ballinger Creek	1350.89	100-Yr	135.36	213.29	216.29	216.29	217.23	0.030826	7.87	18.31	15.39	0.96
Ballinger Creek	1304.66		Culvert									
Ballinger Creek	1258.43	2-Yr	41.16	211.73	213.26	213.01	213.52	0.017981	4.08	10.09	9.02	0.68
Ballinger Creek	1258.43	10-Yr	73.40	211.73	213.78	213.41	214.16	0.016091	4.95	14.84	9.03	0.68
Ballinger Creek	1258.43	25-Yr	95.02	211.73	214.09	213.65	214.54	0.015417	5.40	17.60	9.04	0.68
Ballinger Creek	1258.43	100-Yr	135.36	211.73	214.59	214.05	215.17	0.014865	6.12	22.10	9.05	0.69
Ballinger Creek	1180.73	2-Yr	41.16	210.55	212.33	211.83	212.50	0.009218	3.33	12.36	9.02	0.50
Ballinger Creek	1180.73	10-Yr	73.40	210.55	212.87	212.23	213.15	0.009793	4.25	17.27	9.03	0.54
Ballinger Creek	1180.73	25-Yr	95.02	210.55	213.17	212.47	213.53	0.010167	4.75	19.99	9.04	0.56
Ballinger Creek	1180.73	100-Yr	135.36	210.55	213.35	212.87	213.96	0.016040	6.27	21.59	9.04	0.71
Ballinger Creek	1082.63	2-Yr	41.16	209.05	210.32	210.32	210.76	0.041768	5.29	7.78	9.01	1.00
Ballinger Creek	1082.63	10-Yr	73.40	209.05	210.73	210.73	211.37	0.036604	6.41	11.45	9.02	1.00
Ballinger Creek	1082.63	25-Yr	95.02	209.05	210.97	210.97	211.73	0.034159	6.96	13.64	9.02	1.00
Ballinger Creek	1082.63	100-Yr	135.36	209.05	212.44	211.37	212.84	0.007233	5.04	26.88	9.04	0.51
Ballinger Creek	1039.93		Culvert									
Ballinger Creek	997.22	2-Yr	41.16	207.75	209.31	209.03	209.55	0.016217	3.97	10.37	9.02	0.65

HEC-RAS Plan: Alt1-MOD2   River: Ballinger Creek   Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	997.22	10-Yr	73.40	207.75	209.78	209.43	210.17	0.016420	5.01	14.65	9.03	0.69
Ballinger Creek	997.22	25-Yr	95.02	207.75	210.07	209.67	210.54	0.016218	5.53	17.19	9.03	0.71
Ballinger Creek	997.22	100-Yr	135.36	207.75	210.94	210.07	211.39	0.009517	5.40	25.05	9.05	0.57
Ballinger Creek	993.47	2-Yr	41.16	207.70	209.22	208.98	209.48	0.018669	4.13	9.98	9.02	0.69
Ballinger Creek	993.47	10-Yr	73.40	207.70	209.69	209.38	210.10	0.018278	5.14	14.27	9.03	0.72
Ballinger Creek	993.47	25-Yr	95.02	207.70	209.98	209.62	210.47	0.017798	5.64	16.84	9.03	0.73
Ballinger Creek	993.47	100-Yr	135.36	207.70	210.90	210.02	211.35	0.009671	5.37	25.23	9.05	0.57
Ballinger Creek	991.12	2-Yr	41.16	207.66	208.93	208.93	209.37	0.042162	5.29	7.77	9.01	1.00
Ballinger Creek	991.12	10-Yr	73.40	207.66	209.34	209.34	209.98	0.036648	6.38	11.50	9.02	1.00
Ballinger Creek	991.12	25-Yr	95.02	207.66	209.58	209.58	210.34	0.035080	6.98	13.62	9.02	1.00
Ballinger Creek	991.12	100-Yr	135.36	207.66	210.88	209.99	211.32	0.009130	5.34	25.37	9.05	0.56
Ballinger Creek	957.11		Culvert									
Ballinger Creek	923.1	2-Yr	41.16	206.62	208.22	207.89	208.45	0.014350	3.84	10.71	9.02	0.62
Ballinger Creek	923.1	10-Yr	73.40	206.62	208.72	208.31	209.08	0.014170	4.82	15.22	9.03	0.65
Ballinger Creek	923.1	25-Yr	95.02	206.62	209.00	208.54	209.45	0.014126	5.34	17.78	9.03	0.67
Ballinger Creek	923.1	100-Yr	135.36	206.62	209.58	208.94	210.12	0.012259	5.90	22.94	9.04	0.65
Ballinger Creek	895.61	2-Yr	41.16	206.20	207.87	207.48	208.07	0.012261	3.63	11.34	9.02	0.57
Ballinger Creek	895.61	10-Yr	73.40	206.20	208.35	207.88	208.69	0.013298	4.67	15.73	9.03	0.62
Ballinger Creek	895.61	25-Yr	95.02	206.20	208.63	208.13	209.05	0.013674	5.20	18.26	9.03	0.65
Ballinger Creek	895.61	100-Yr	135.36	206.20	209.28	208.52	209.77	0.011206	5.61	24.11	9.05	0.61
Ballinger Creek	869.95	2-Yr	41.16	205.81	207.08	207.08	207.52	0.041995	5.27	7.81	9.01	1.00
Ballinger Creek	869.95	10-Yr	73.40	205.81	207.49	207.49	208.13	0.037240	6.39	11.50	9.02	1.00
Ballinger Creek	869.95	25-Yr	95.02	205.81	207.73	207.73	208.48	0.035613	6.97	13.63	9.02	1.00
Ballinger Creek	869.95	100-Yr	135.36	205.81	209.06	208.13	209.49	0.009160	5.28	25.65	9.05	0.55
Ballinger Creek	835.76		Culvert									
Ballinger Creek	801.57	2-Yr	44.64	204.77	206.37	206.09	206.62	0.016086	4.07	11.44	14.32	0.66
Ballinger Creek	801.57	10-Yr	80.48	204.77	206.79	206.52	207.23	0.018550	5.36	15.71	15.95	0.74
Ballinger Creek	801.57	25-Yr	105.09	204.77	207.07	206.76	207.61	0.018742	5.97	18.42	16.76	0.77
Ballinger Creek	801.57	100-Yr	151.92	204.77	207.81	207.20	208.38	0.012897	6.18	25.81	18.98	0.67
Ballinger Creek	790.44	2-Yr	44.64	204.60	206.21		206.44	0.014417	3.88	13.30	14.42	0.62

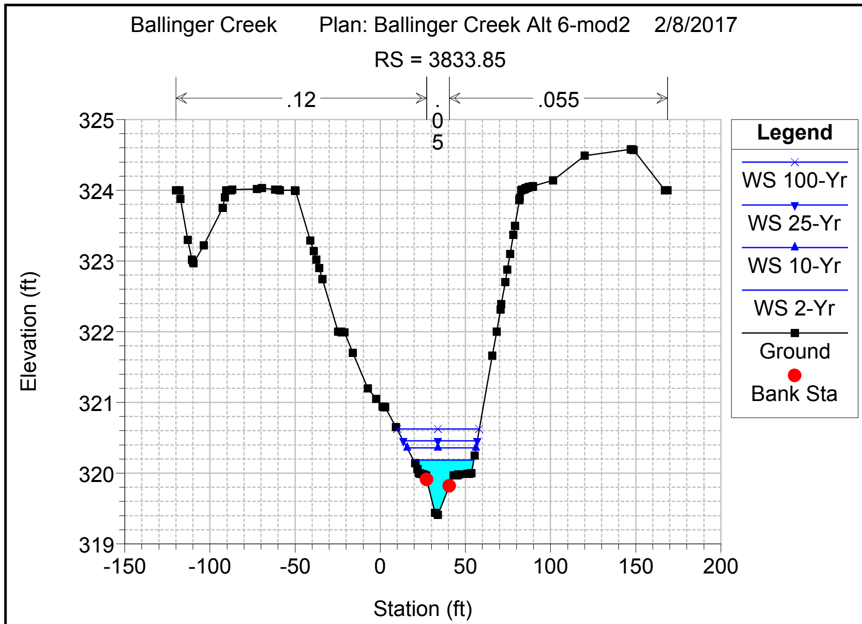
HEC-RAS Plan: Alt1-MOD2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	790.44	10-Yr	80.48	204.60	206.65		207.00	0.015472	4.94	19.99	16.02	0.68
Ballinger Creek	790.44	25-Yr	105.09	204.60	206.96		207.35	0.014182	5.31	25.08	16.95	0.67
Ballinger Creek	790.44	100-Yr	151.92	204.60	207.81		208.15	0.008088	5.10	40.53	19.50	0.54
Ballinger Creek	736.76	2-Yr	44.64	203.79	205.35		205.60	0.016902	4.08	12.54	14.10	0.67
Ballinger Creek	736.76	10-Yr	80.48	203.79	206.09		206.33	0.009256	4.20	24.59	18.53	0.54
Ballinger Creek	736.76	25-Yr	105.09	203.79	206.54		206.78	0.007194	4.27	33.47	21.21	0.49
Ballinger Creek	736.76	100-Yr	151.92	203.79	207.66		207.83	0.003378	3.80	61.00	27.93	0.36
Ballinger Creek	686.18	2-Yr	44.64	203.01	204.77	204.33	204.94	0.009680	3.43	15.42	15.27	0.52
Ballinger Creek	686.18	10-Yr	80.48	203.01	205.91		206.04	0.003298	3.02	36.91	22.16	0.34
Ballinger Creek	686.18	25-Yr	105.09	203.01	206.40		206.53	0.002869	3.17	48.35	25.06	0.32
Ballinger Creek	686.18	100-Yr	151.92	203.01	207.59		207.70	0.001638	3.00	82.54	33.38	0.26
Ballinger Creek	647.82	2-Yr	44.64	202.43	203.75	203.75	204.19	0.039509	5.34	8.66	10.83	0.99
Ballinger Creek	647.82	10-Yr	80.48	202.43	205.80	204.17	205.93	0.002422	2.90	29.16	16.99	0.30
Ballinger Creek	647.82	25-Yr	105.09	202.43	206.25	204.42	206.41	0.002563	3.28	33.70	18.35	0.31
Ballinger Creek	647.82	100-Yr	151.92	202.43	207.42	204.85	207.60	0.001999	3.52	45.59	23.74	0.29
Ballinger Creek	600		Culvert									
Ballinger Creek	556.52	2-Yr	44.64	201.26	203.67	202.59	203.74	0.002478	2.26	22.36	16.10	0.28
Ballinger Creek	556.52	10-Yr	80.48	201.26	205.43	202.98	205.49	0.000933	2.11	43.44	21.39	0.19
Ballinger Creek	556.52	25-Yr	105.09	201.26	205.56	203.22	205.66	0.001413	2.66	45.05	21.83	0.24
Ballinger Creek	556.52	100-Yr	151.92	201.26	205.82	203.61	206.00	0.002379	3.60	48.11	22.67	0.31
Ballinger Creek	500.87	2-Yr	44.64	201.12	203.54		203.61	0.002259	2.16	26.90	19.25	0.27
Ballinger Creek	500.87	10-Yr	80.48	201.12	205.40		205.43	0.000611	1.74	71.36	27.39	0.16
Ballinger Creek	500.87	25-Yr	105.09	201.12	205.52		205.57	0.000925	2.19	74.69	27.78	0.19
Ballinger Creek	500.87	100-Yr	151.92	201.12	205.75		205.85	0.001567	2.95	81.20	28.96	0.25
Ballinger Creek	420.45	2-Yr	44.64	200.93	203.33		203.41	0.002661	2.33	22.26	14.24	0.29
Ballinger Creek	420.45	10-Yr	80.48	200.93	205.32		205.38	0.000753	1.97	59.26	30.01	0.17
Ballinger Creek	420.45	25-Yr	105.09	200.93	205.40		205.49	0.001215	2.53	61.65	33.98	0.22
Ballinger Creek	420.45	100-Yr	151.92	200.93	205.52		205.69	0.002293	3.55	66.19	40.48	0.31
Ballinger Creek	355.7	2-Yr	44.64	200.77	203.15		203.23	0.002740	2.35	22.13	15.84	0.30
Ballinger Creek	355.7	10-Yr	80.48	200.77	205.31		205.33	0.000401	1.47	126.84	101.76	0.13
Ballinger Creek	355.7	25-Yr	105.09	200.77	205.38		205.42	0.000628	1.86	134.13	108.51	0.16

HEC-RAS Plan: Alt1-MOD2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	355.7	100-Yr	151.92	200.77	205.49		205.56	0.001137	2.55	147.09	119.58	0.22
Ballinger Creek	305.28	2-Yr	44.64	200.65	203.04		203.10	0.002219	2.12	31.58	32.73	0.27
Ballinger Creek	305.28	10-Yr	80.48	200.65	205.32		205.32	0.000090	0.71	312.15	177.10	0.06
Ballinger Creek	305.28	25-Yr	105.09	200.65	205.39		205.39	0.000138	0.89	325.15	178.69	0.08
Ballinger Creek	305.28	100-Yr	151.92	200.65	205.51		205.52	0.000243	1.20	347.21	181.81	0.10
Ballinger Creek	251.15	2-Yr	44.64	200.52	203.05		203.05	0.000288	0.80	156.80	185.31	0.10
Ballinger Creek	251.15	10-Yr	80.48	200.52	205.32		205.32	0.000017	0.31	616.65	223.24	0.03
Ballinger Creek	251.15	25-Yr	105.09	200.52	205.39		205.39	0.000027	0.40	633.01	224.65	0.03
Ballinger Creek	251.15	100-Yr	151.92	200.52	205.51		205.51	0.000049	0.55	660.62	227.02	0.05
Ballinger Creek	161.57	2-Yr	44.64	199.22	203.05		203.05	0.000023	0.26	327.80	186.35	0.03
Ballinger Creek	161.57	10-Yr	80.48	199.22	205.32		205.32	0.000006	0.20	796.16	232.18	0.02
Ballinger Creek	161.57	25-Yr	105.09	199.22	205.39		205.39	0.000010	0.26	813.08	233.97	0.02
Ballinger Creek	161.57	100-Yr	151.92	199.22	205.51		205.51	0.000018	0.36	841.62	236.95	0.03
Ballinger Creek	79.36	2-Yr	35.32	198.87	202.95	200.24	203.02	0.000842	2.19	16.14	36.31	0.19
Ballinger Creek	79.36	10-Yr	59.56	198.87	205.31	200.81	205.31	0.000069	0.79	191.03	142.93	0.06
Ballinger Creek	79.36	25-Yr	78.14	198.87	205.37	201.19	205.38	0.000110	1.00	200.70	143.71	0.07
Ballinger Creek	79.36	100-Yr	116.70	198.87	205.48	201.89	205.50	0.000216	1.41	216.28	144.97	0.10
Ballinger Creek	33		Culvert									
Ballinger Creek	0	2-Yr	35.32	196.41	197.90	197.90	198.57	0.033466	6.56	5.38	14.24	1.00
Ballinger Creek	0	10-Yr	59.56	196.41	198.25	198.00	198.44	0.008983	3.55	18.36	15.03	0.52
Ballinger Creek	0	25-Yr	78.14	196.41	198.46	198.01	198.70	0.009612	4.02	21.60	15.53	0.55
Ballinger Creek	0	100-Yr	116.70	196.41	198.83	198.29	199.18	0.010595	4.84	27.53	16.41	0.60
Ballinger Creek	-20	2-Yr	35.32	196.33	197.60	197.41	197.78	0.018220	3.46	10.53	14.51	0.68
Ballinger Creek	-20	10-Yr	59.56	196.33	197.89	197.68	198.16	0.018203	4.24	14.90	15.45	0.71
Ballinger Creek	-20	25-Yr	78.14	196.33	198.08	197.85	198.41	0.018205	4.71	17.86	16.01	0.73
Ballinger Creek	-20	100-Yr	116.70	196.33	198.42	198.17	198.87	0.018228	5.51	23.44	17.02	0.76

Appendix M.3
Alternative 6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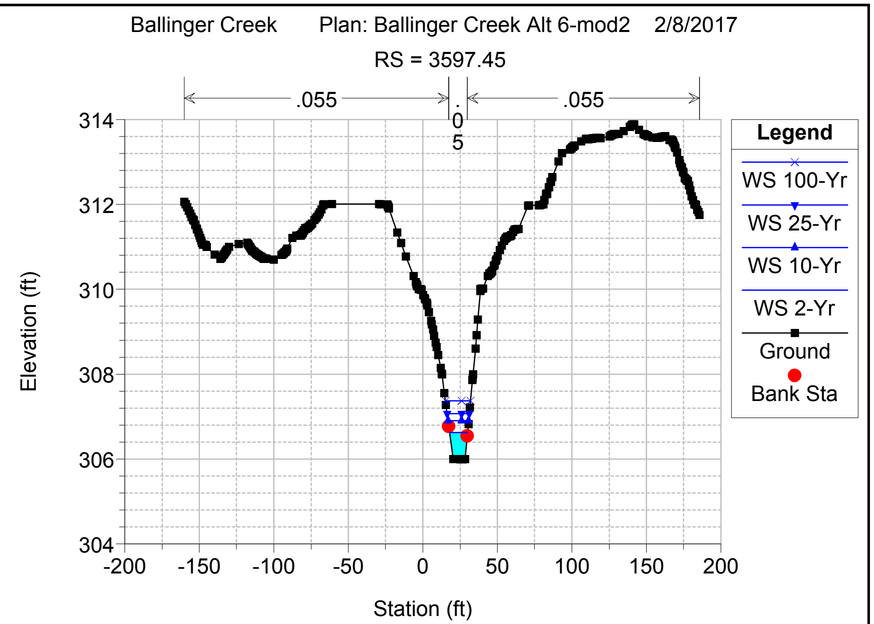
RS = 3833.85
.12
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta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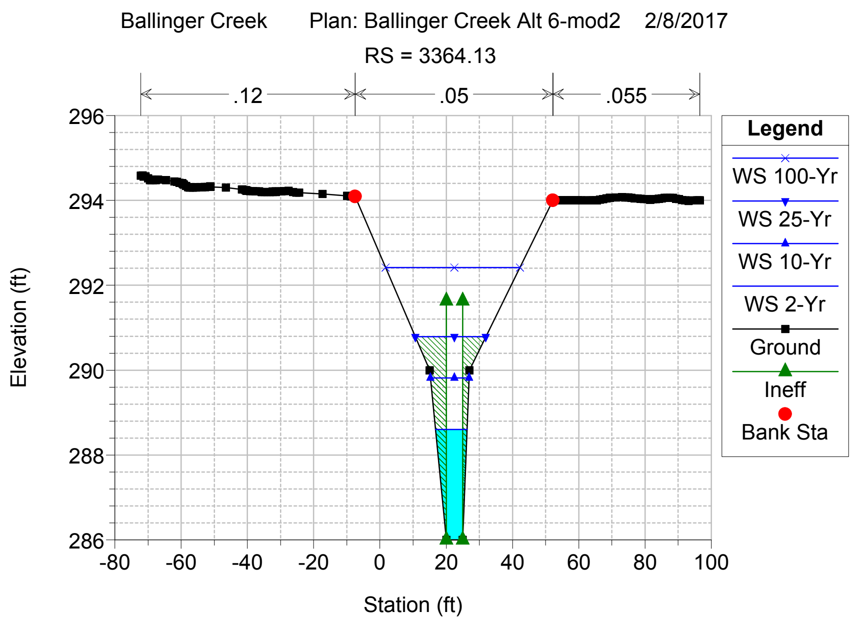
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta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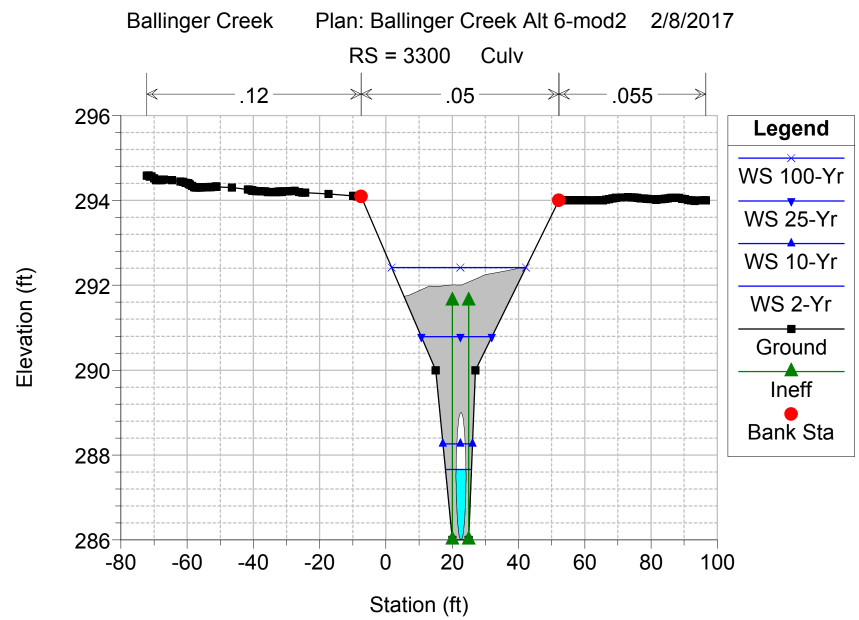
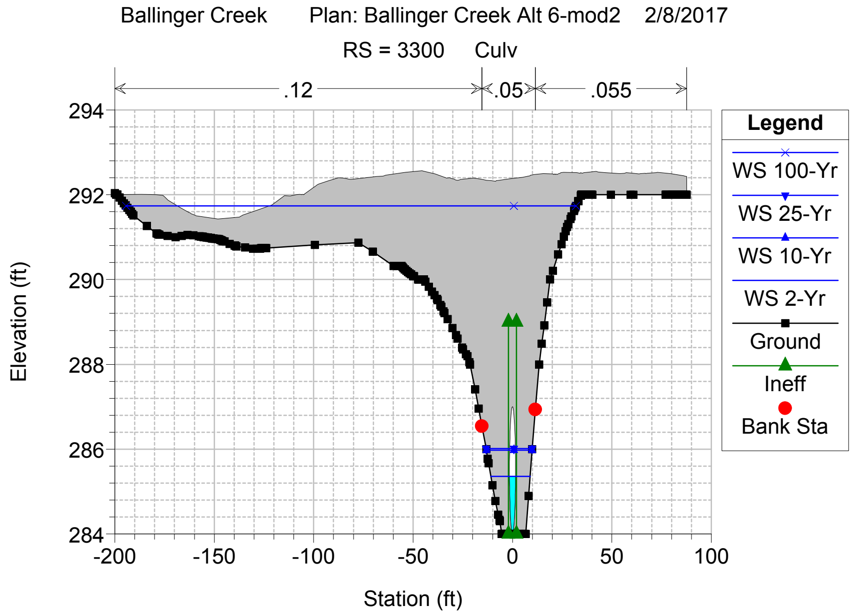
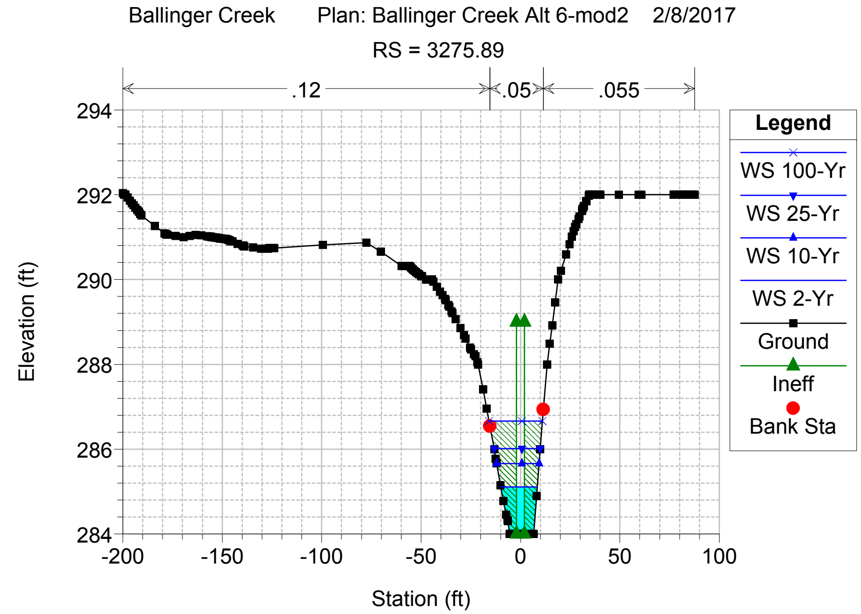
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 3300 Culv
.12
.05
.055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 3300 Culv
.12
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
294
292
290
288
286
284
-200
-150
-100
-50
0
50
100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RS = 3275.89
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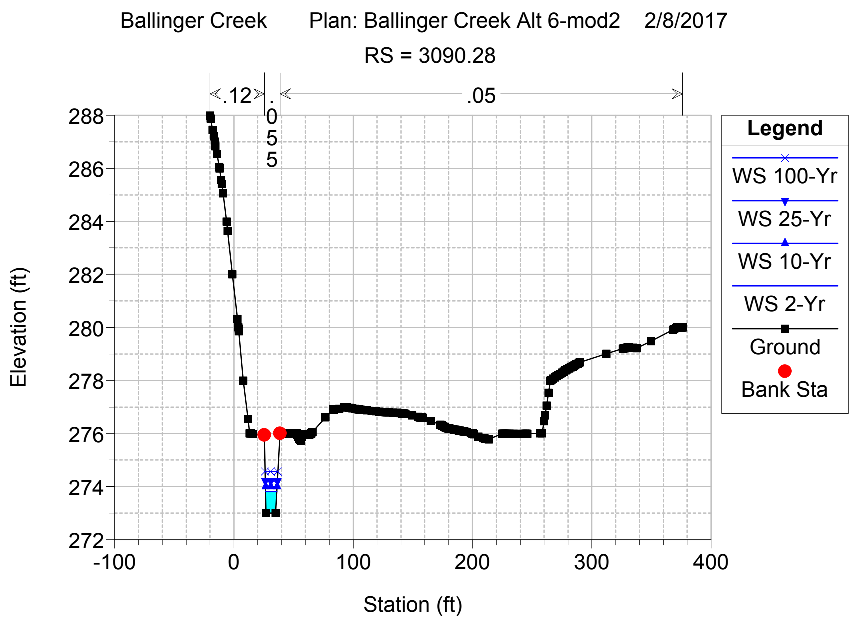
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
294
292
290
288
286
284
-200
-150
-100
-50
0
50
100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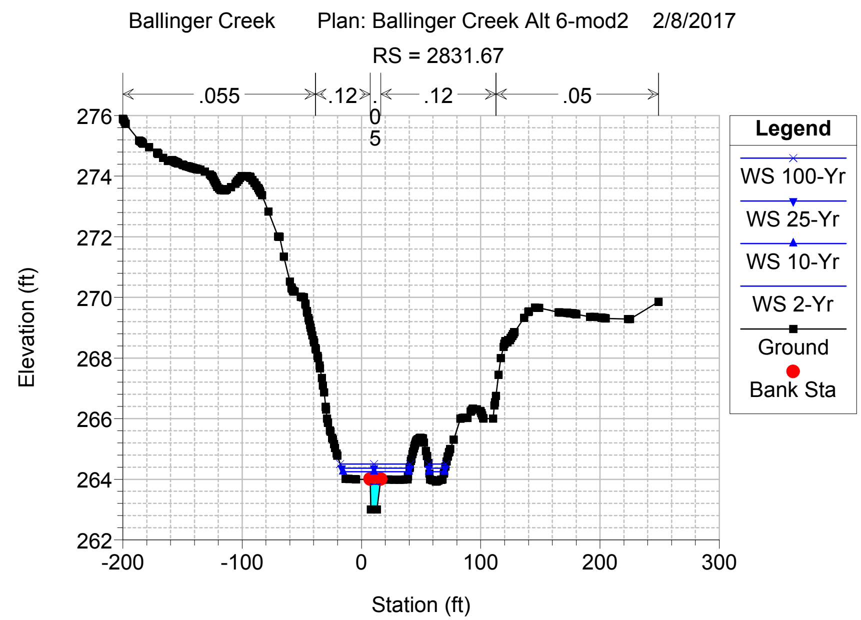
.12
.055
.05
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
288
286
284
282
280
278
276
274
272
-100
0
100
200
300
400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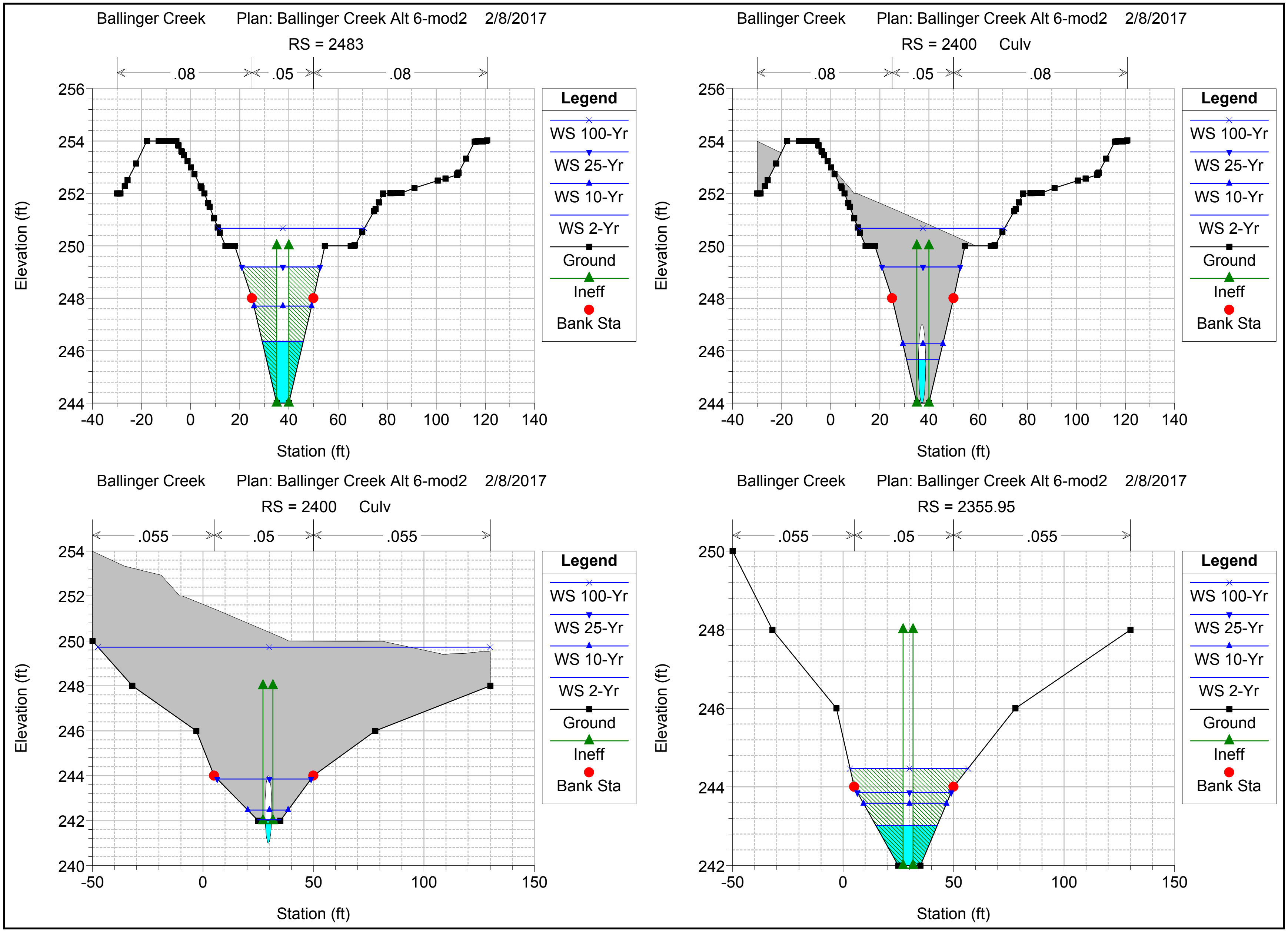
RS = 2831.67
.055
.12
.055
.12
.05
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
276
274
272
270
268
266
264
262
-200
-100
0
100
200
300



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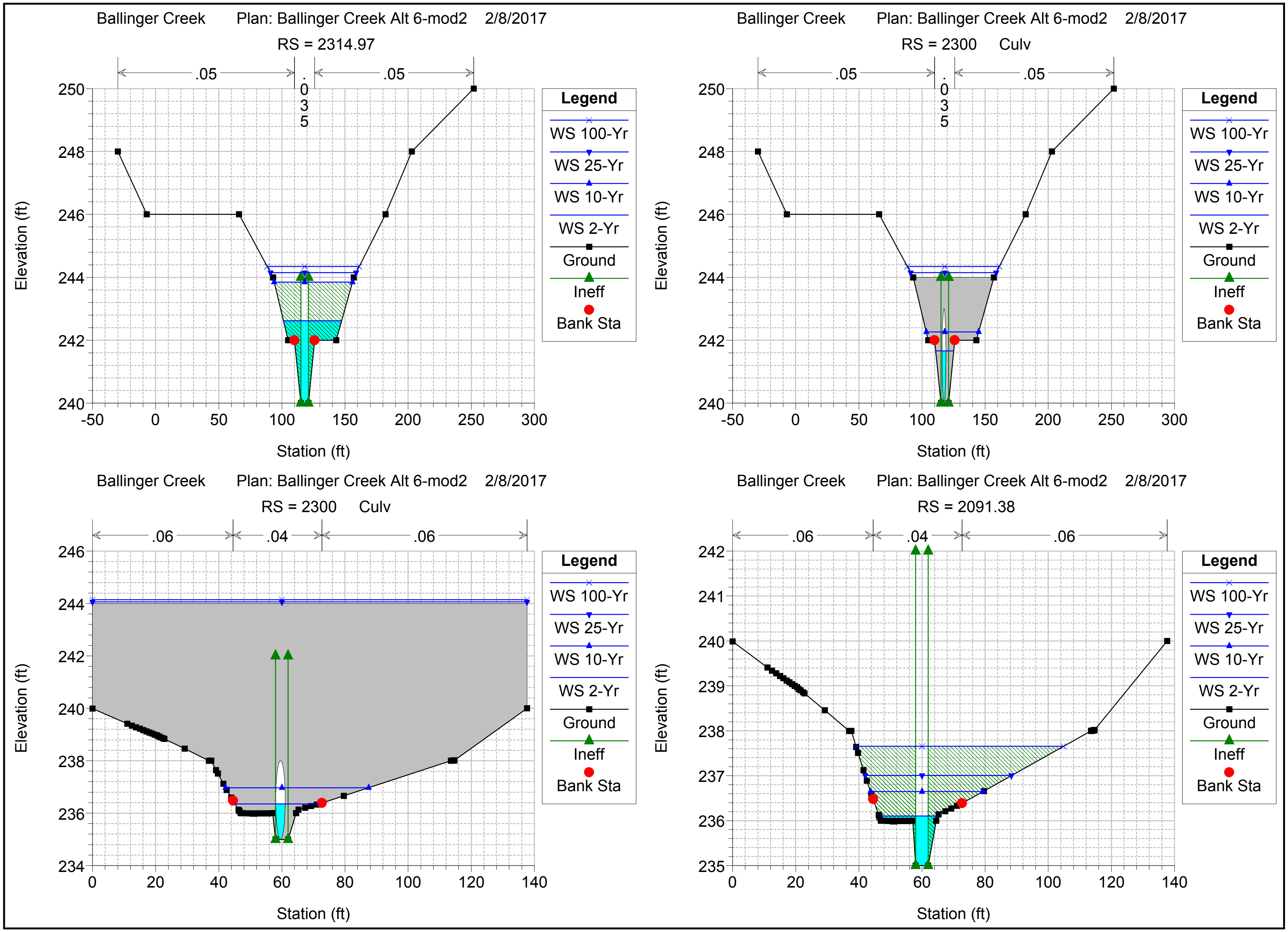
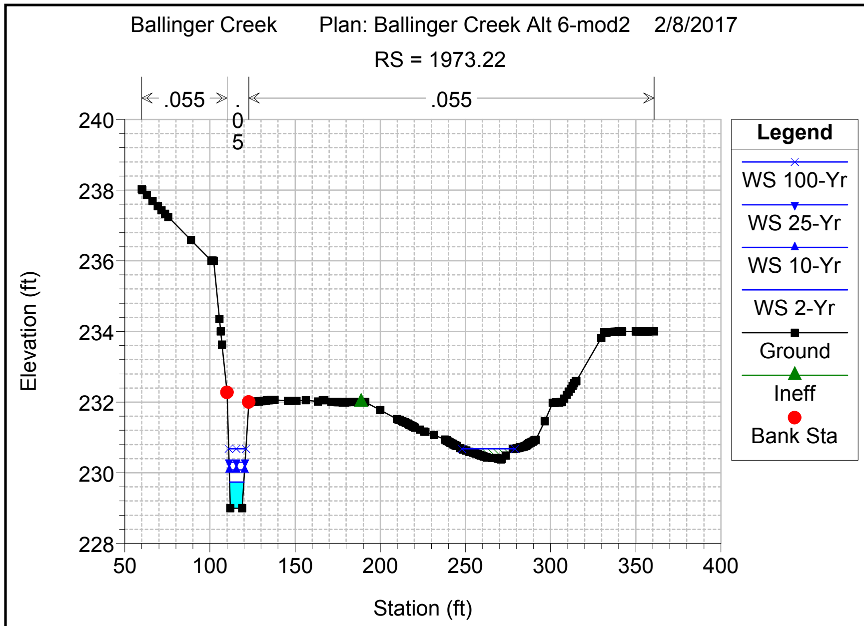
RS = 2483
.08 .05 .08
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2400 Culv
.08 .05 .08
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2400 Culv
.055 .05 .055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2355.95
.055 .05 .055
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2314.97
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2300 Culv
.05
.035
.05
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2300 Culv
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 2091.38
.06
.04
.06
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta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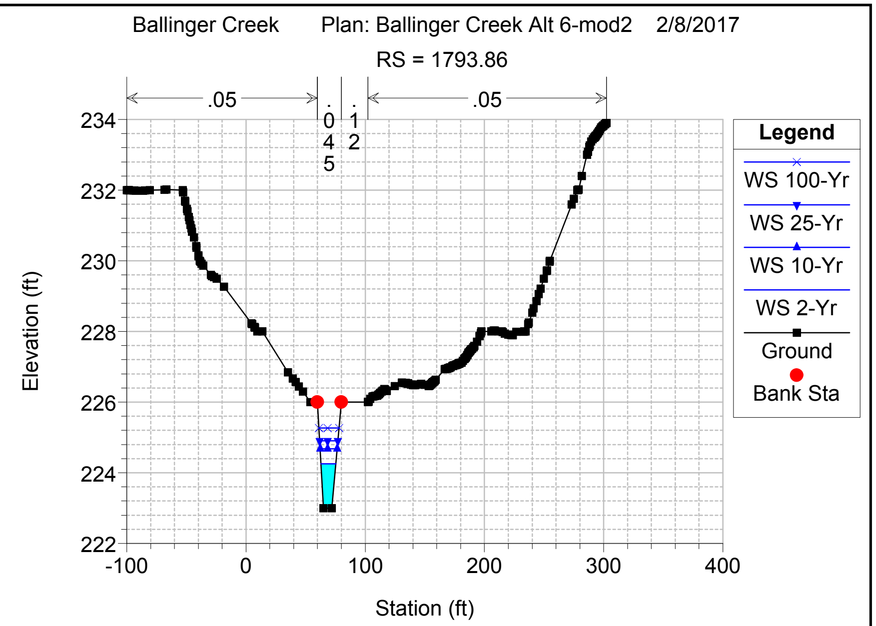
RS = 1973.22
.055
.05
.055
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)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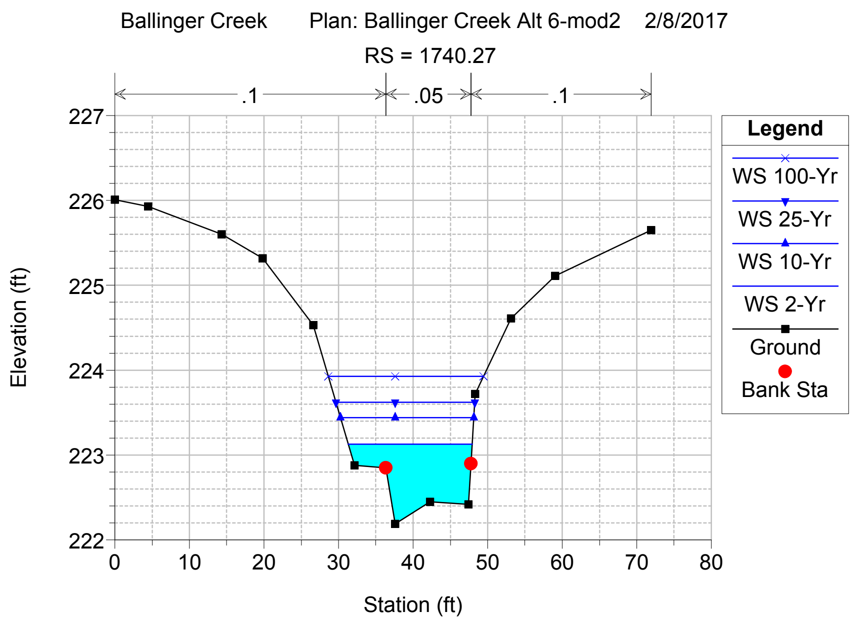
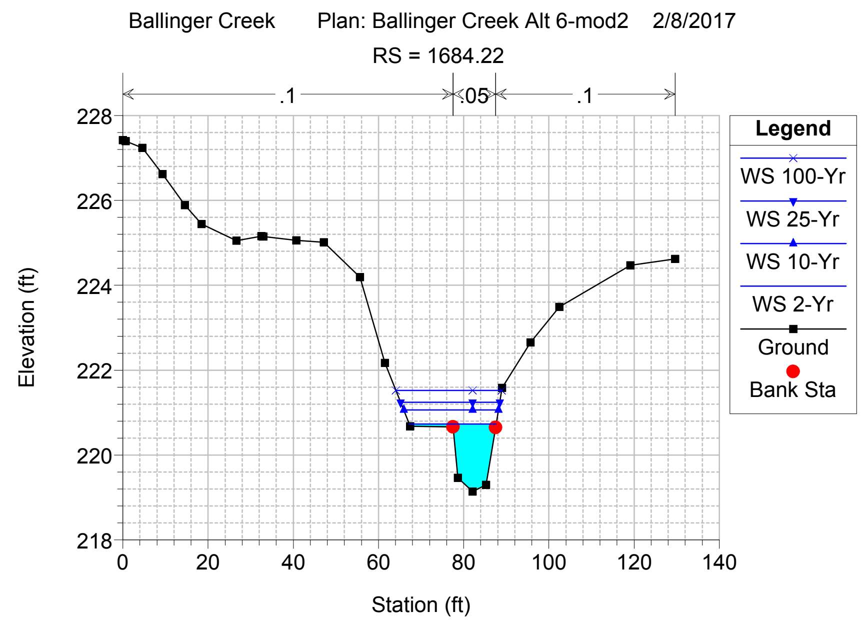
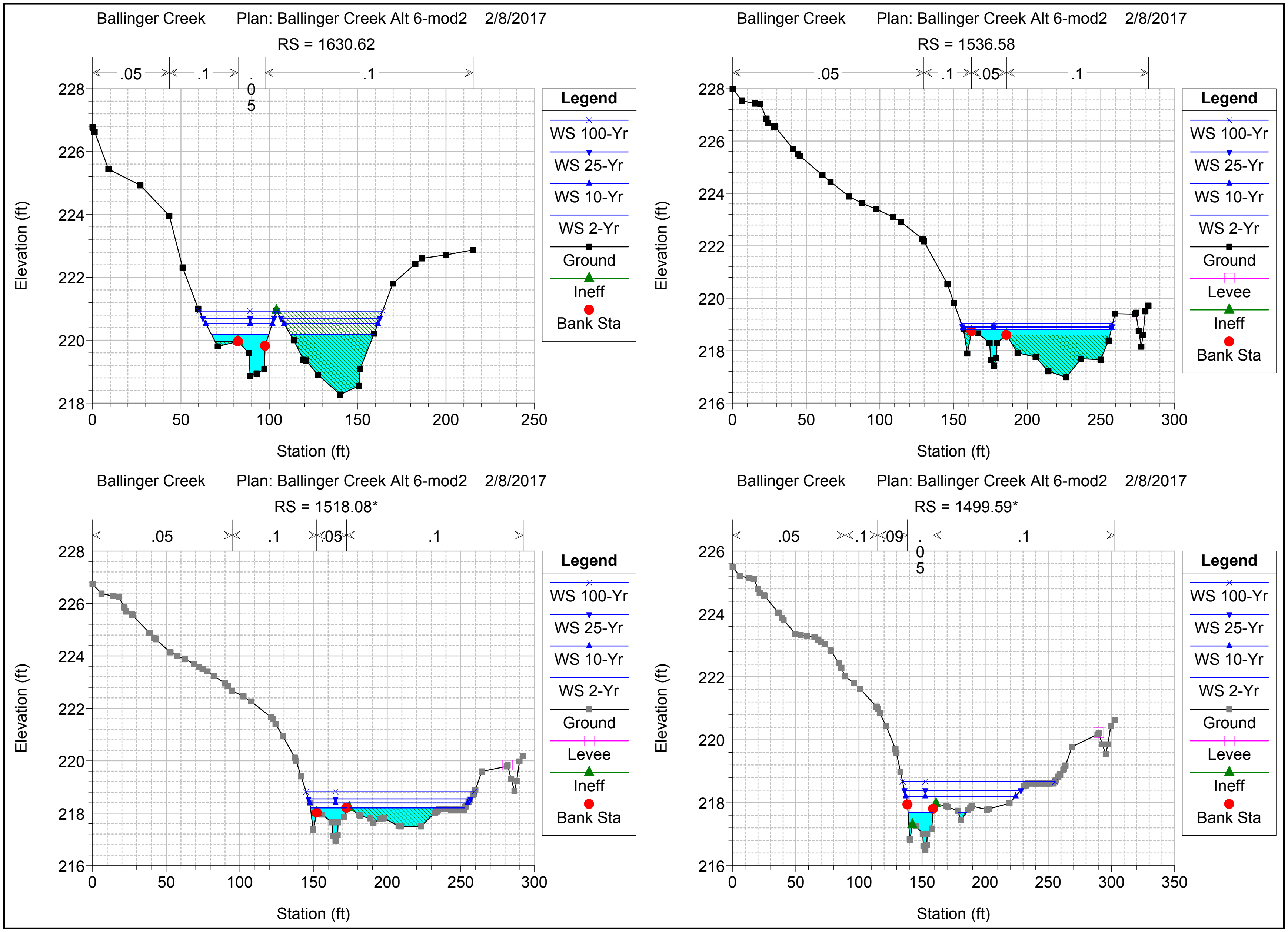
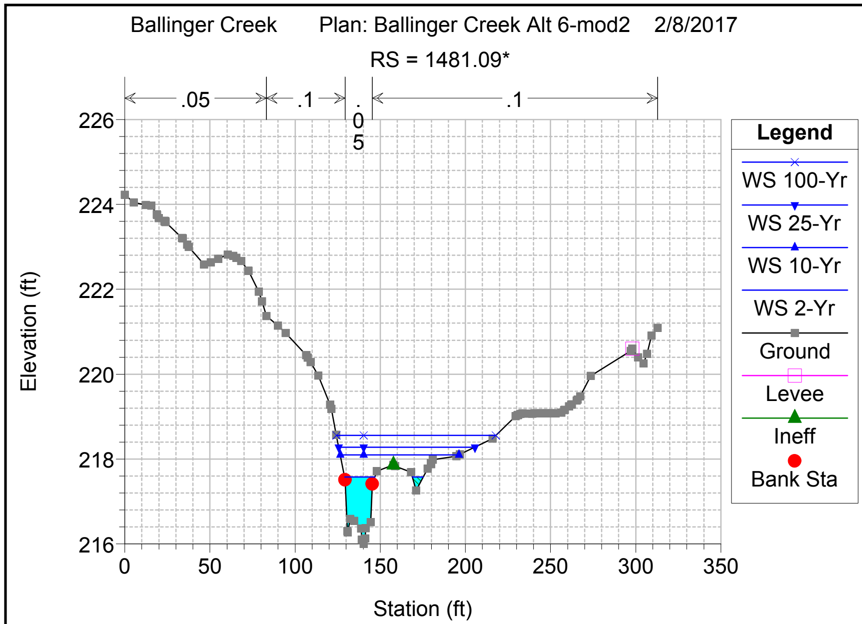
RS = 1793.86
.05
.045
.12
.05
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1740.27
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1684.22
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1630.62
.05
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1536.58
.05
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1518.08*
.05
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1499.59*
.05
.1
.09
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)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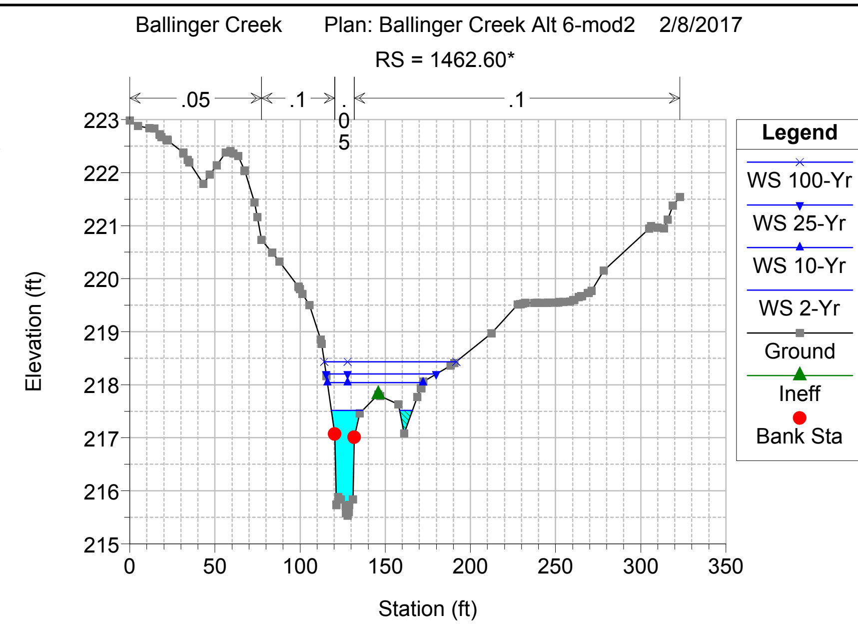
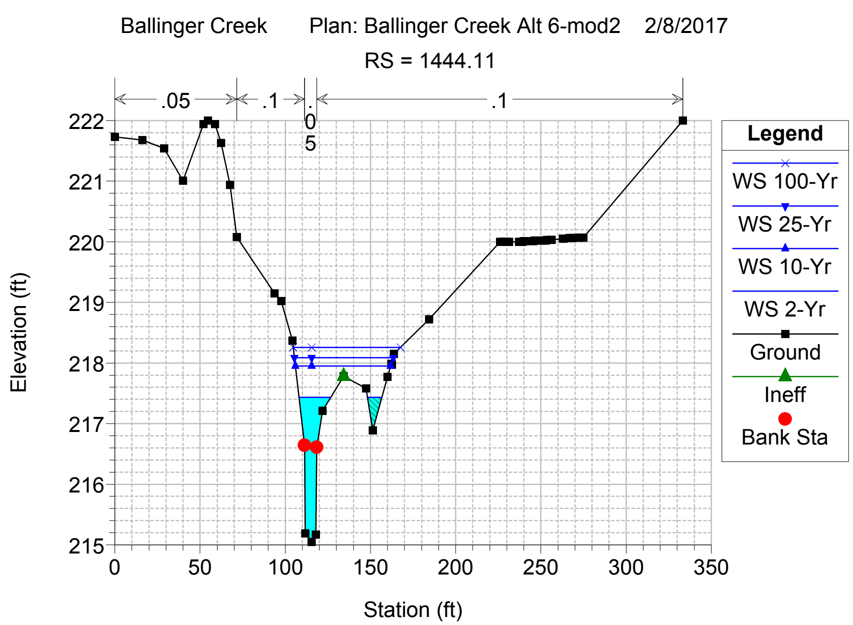
RS = 1481.09*
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1462.60*
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta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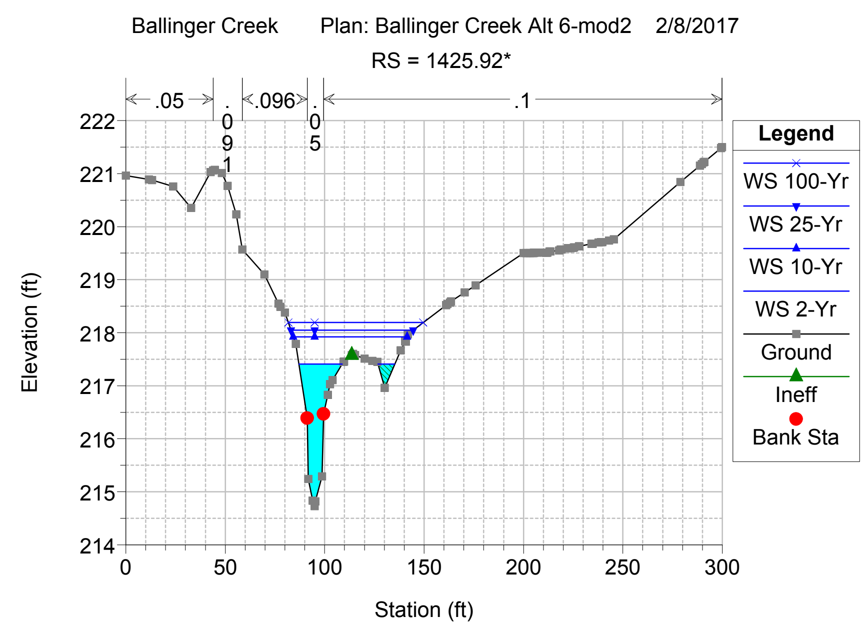
RS = 1444.11
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1425.92*
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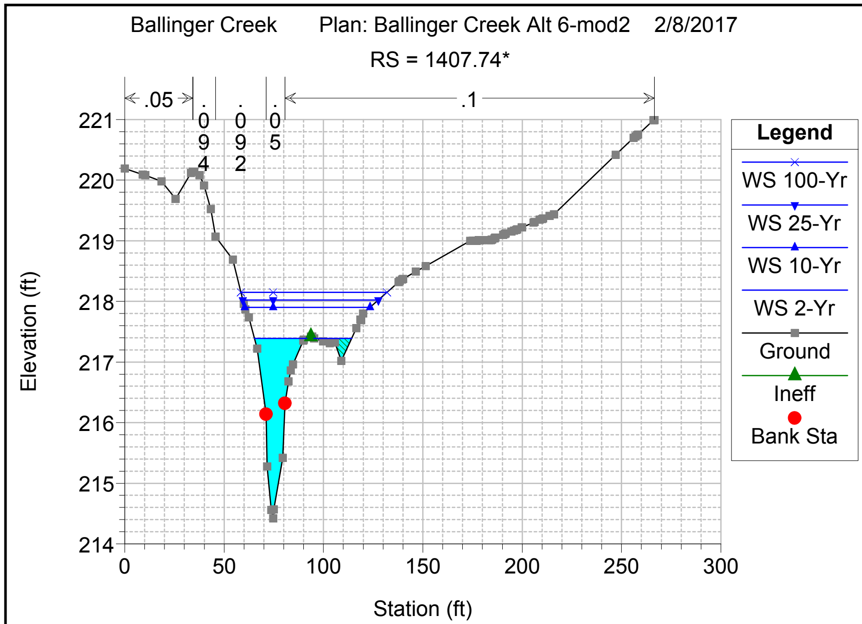
.091
.096
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta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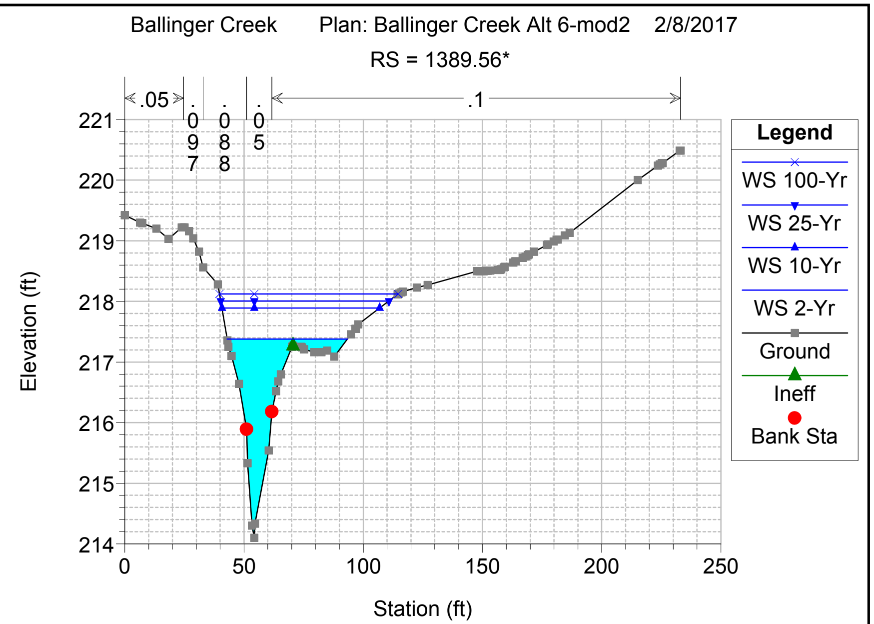
.094
.092
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta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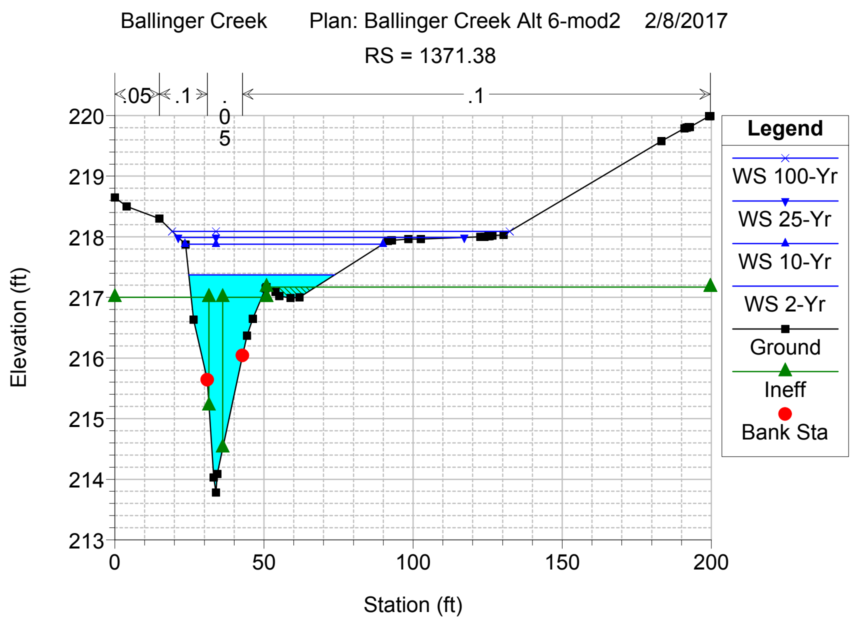
.097
.088
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta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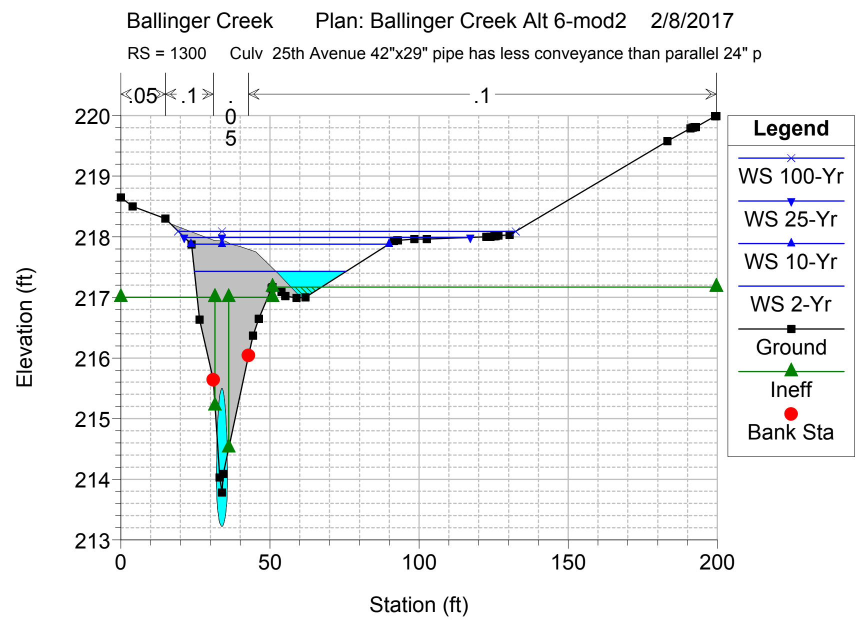
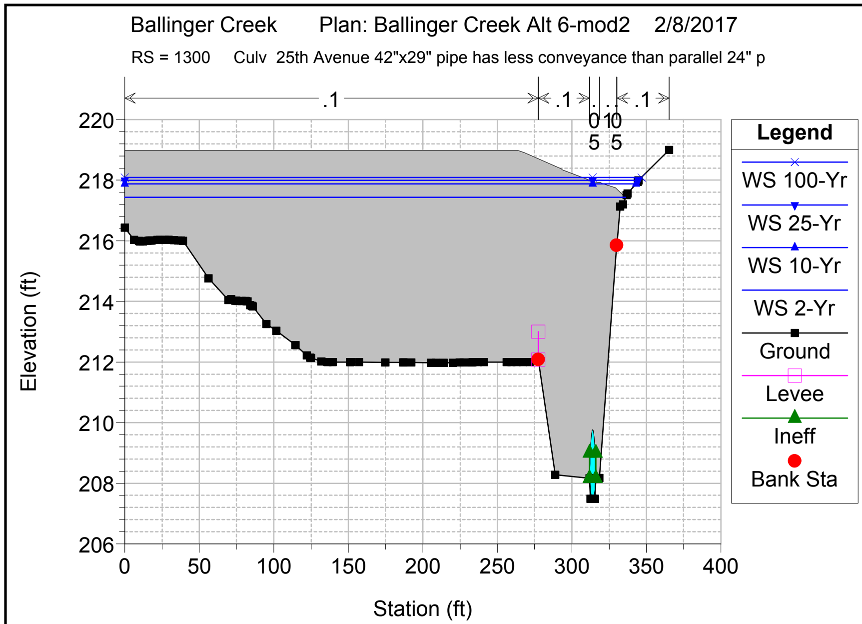
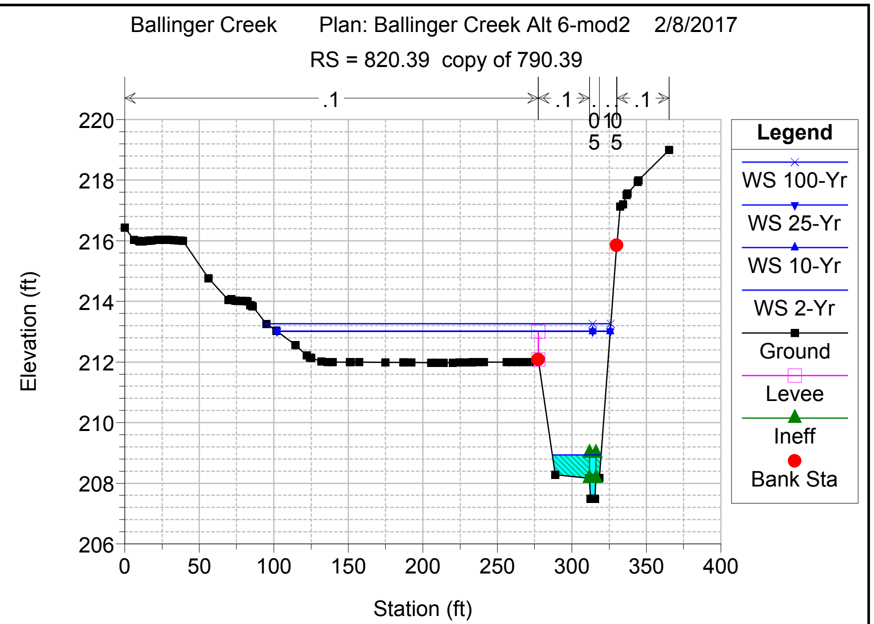
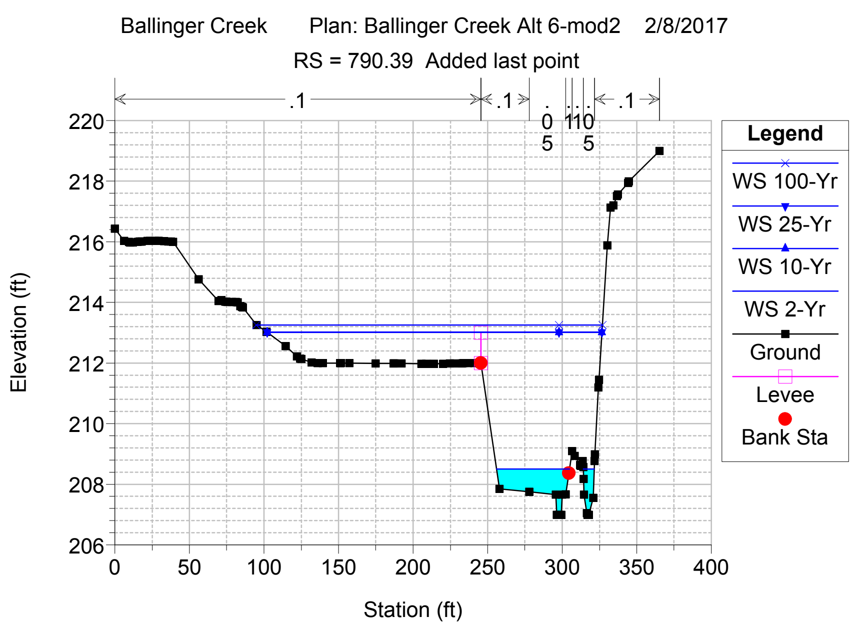
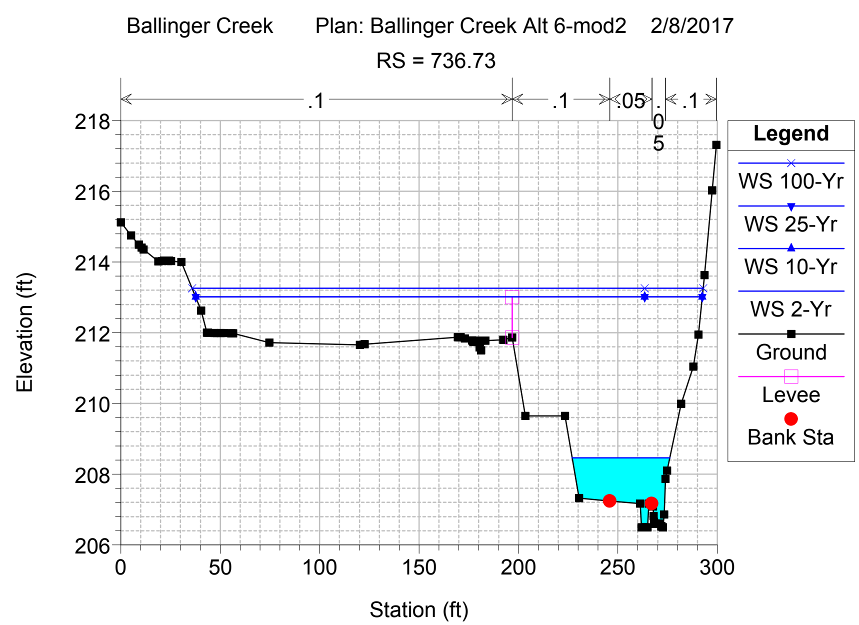
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

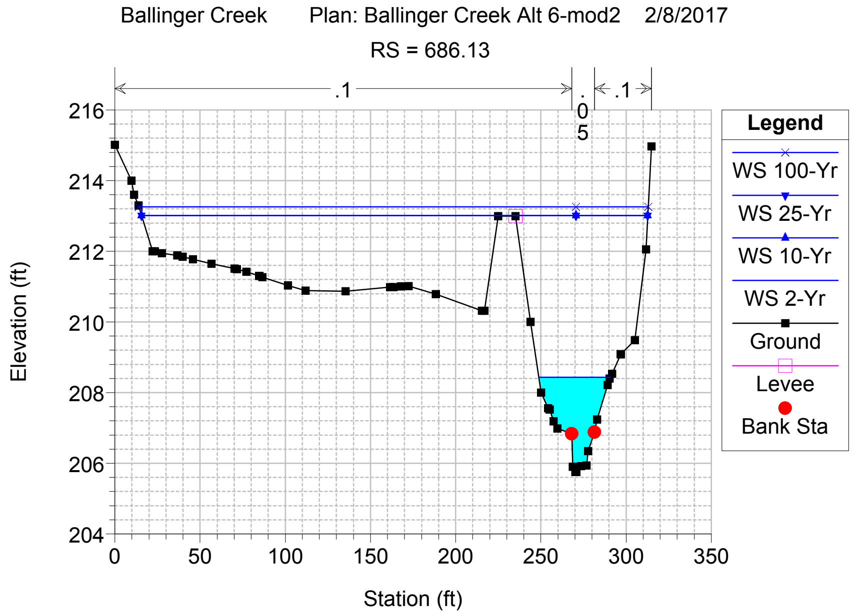

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1300 Culv 25th Avenue 42"x29" pipe has less conveyance than parallel 24" p
.05
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

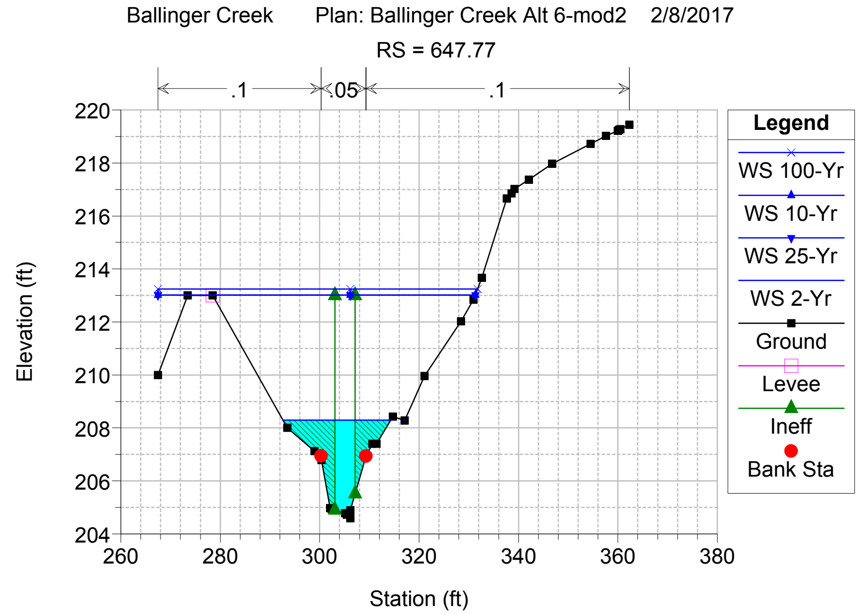

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 1300 Culv 25th Avenue 42"x29" pipe has less conveyance than parallel 24" p
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

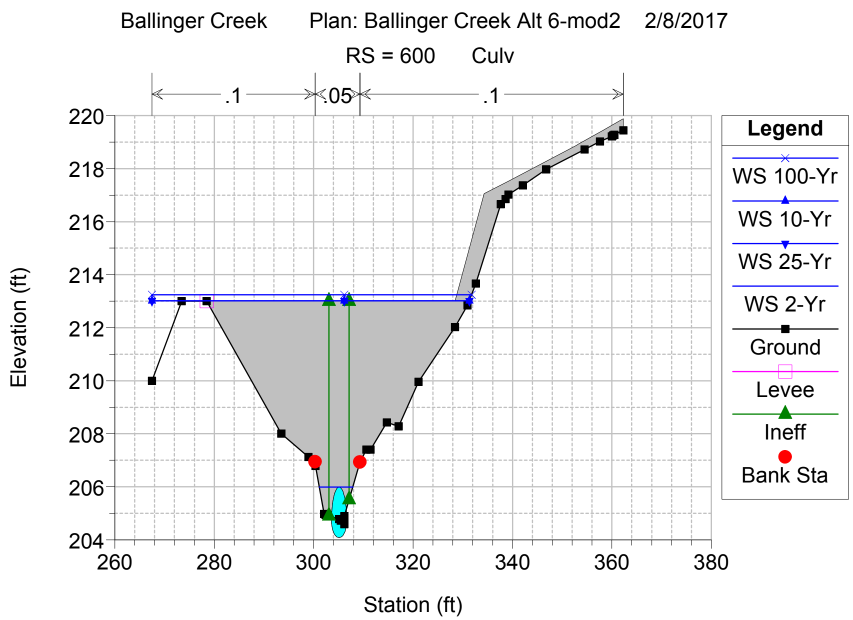

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 820.39 copy of 790.39
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

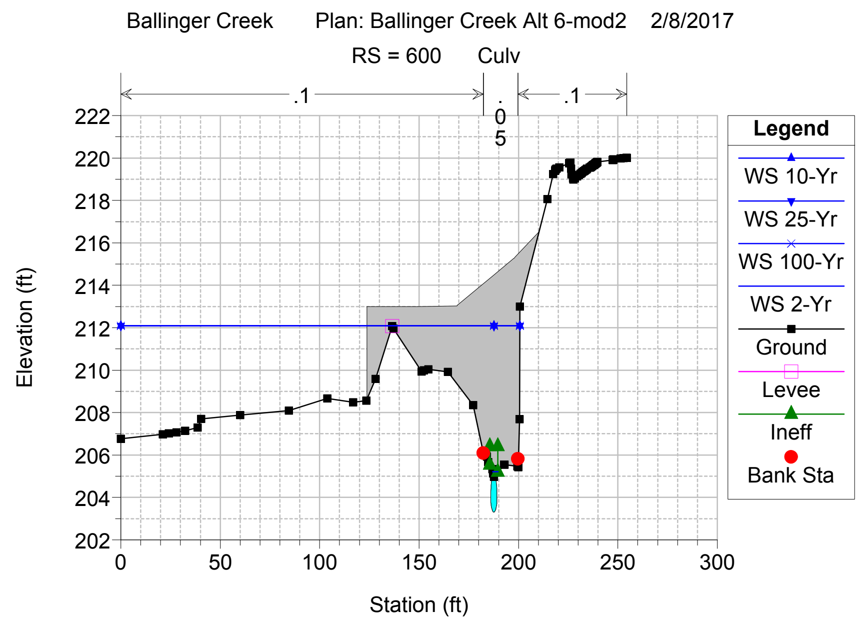

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 790.39 Added last point
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta

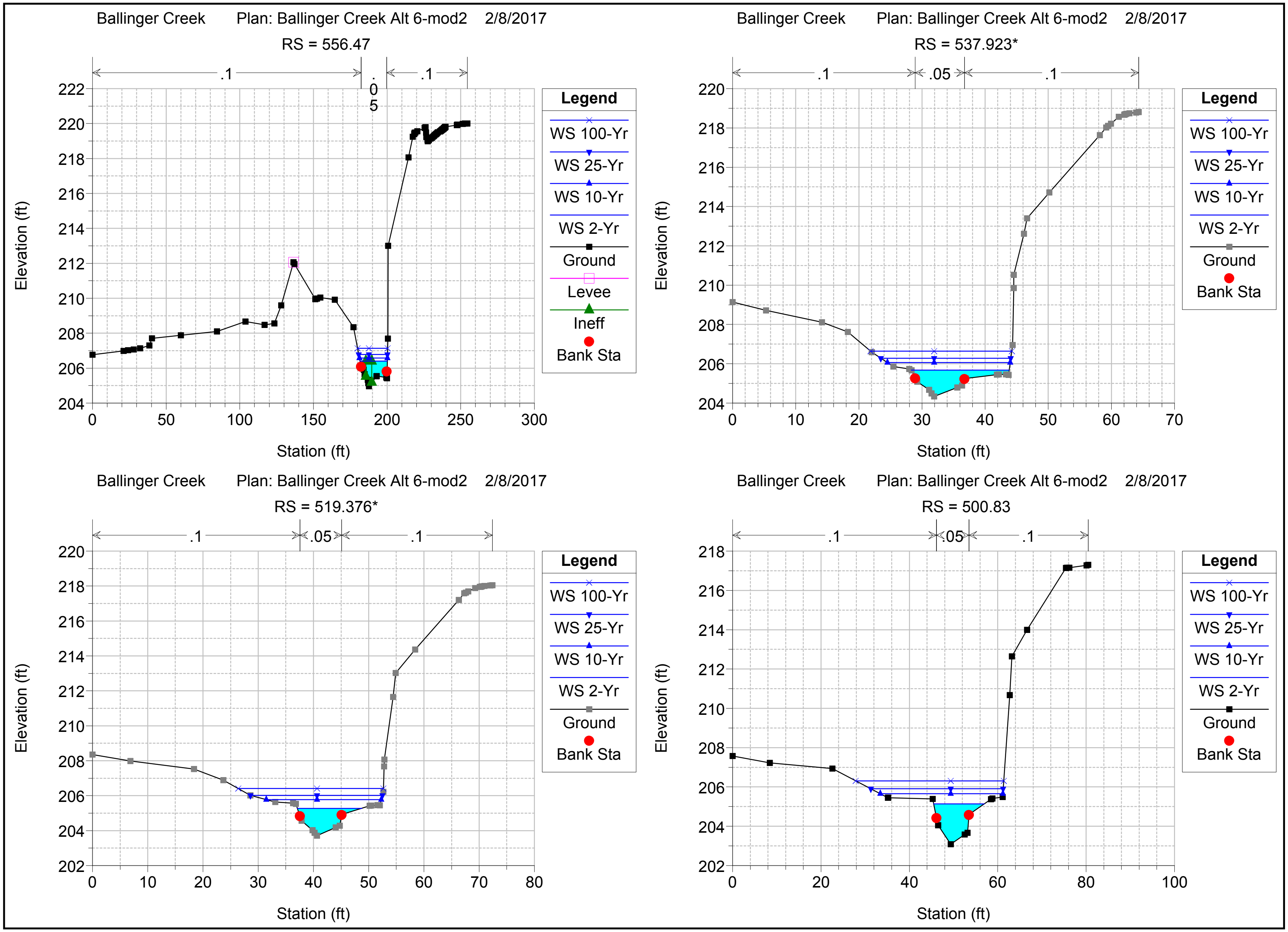

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 736.73
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 686.13
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta

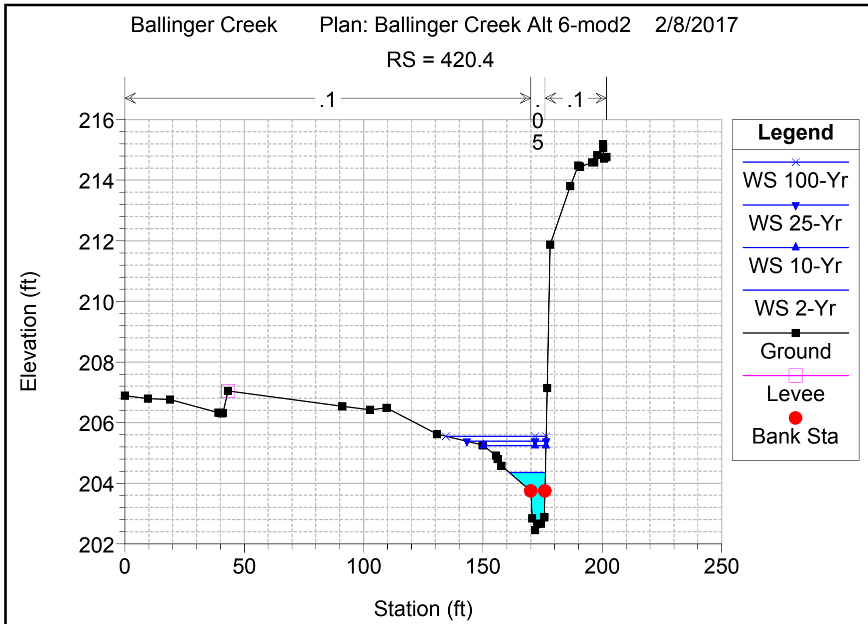

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 647.77
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 10-Yr
WS 25-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

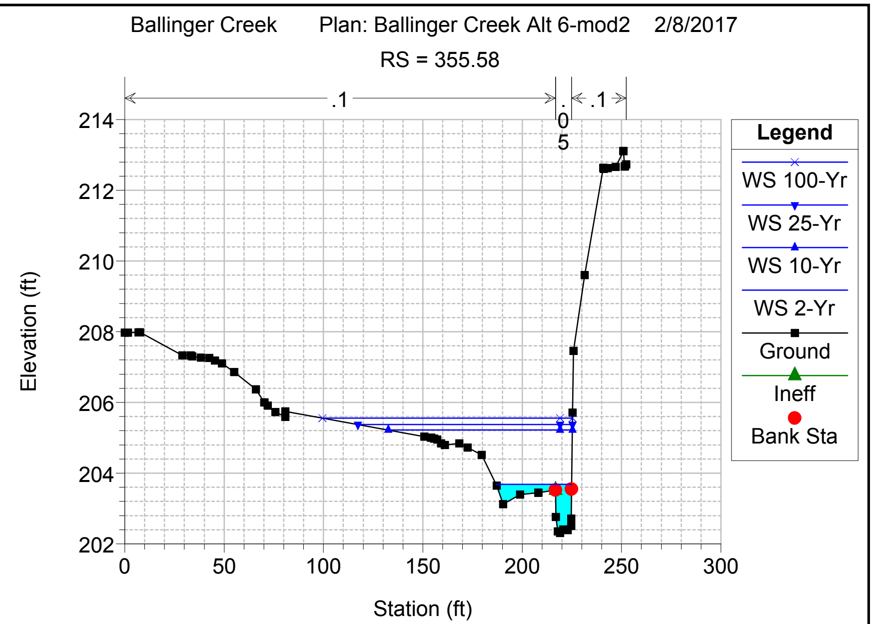

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 600 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 10-Yr
WS 25-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

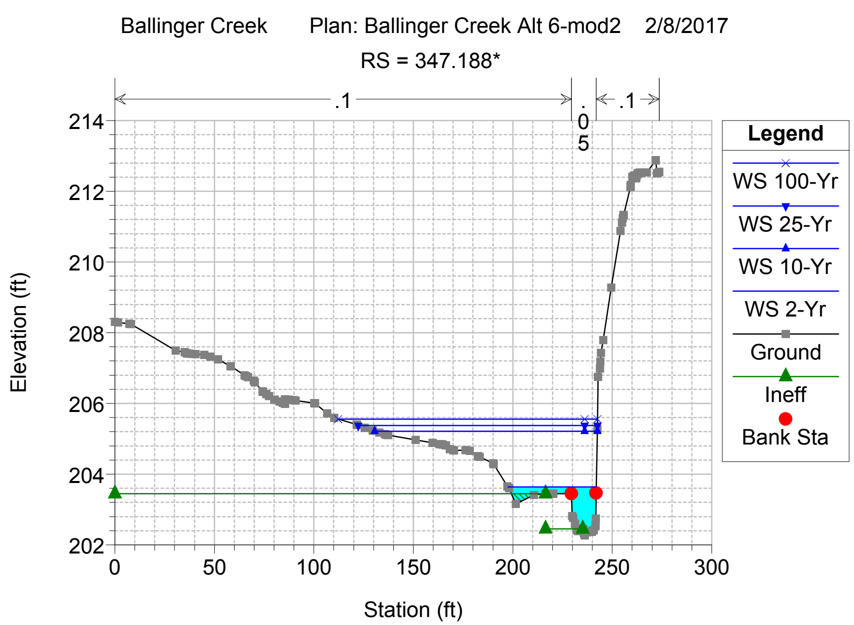

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 600 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 10-Yr
WS 25-Yr
WS 100-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta

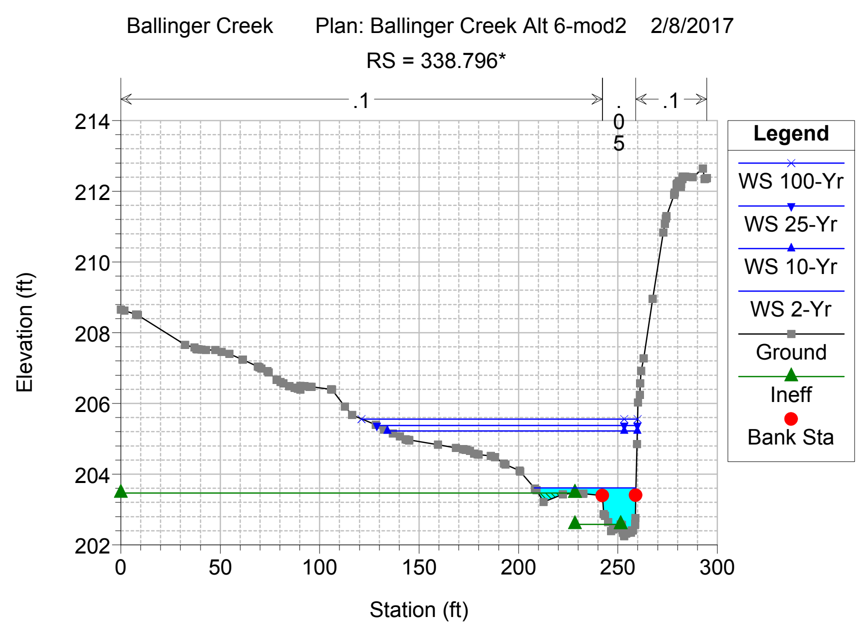


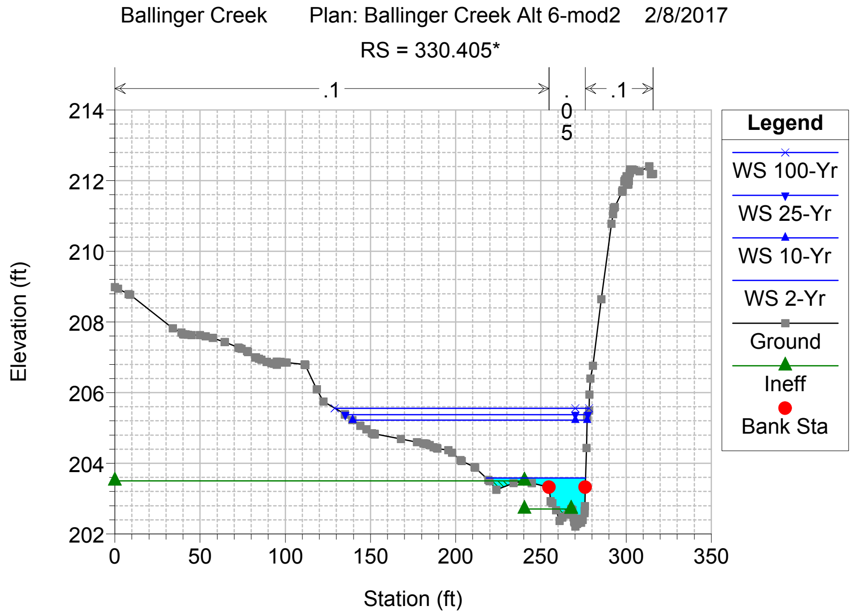
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 556.47
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 537.923*
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 519.376*
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 500.83
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta
Elevation (ft)
Station (ft)

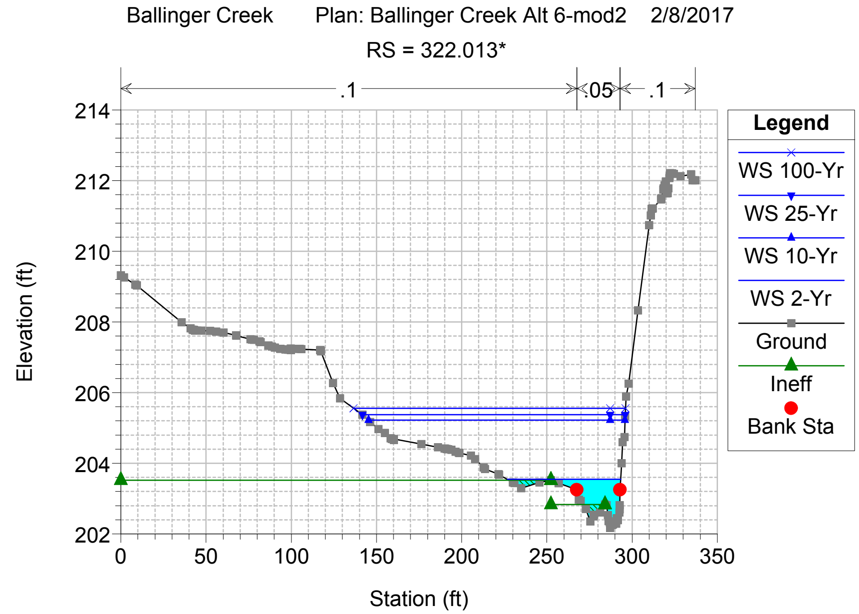

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 420.4
.1
.05
.1
Elevation (ft)
216
214
212
210
208
206
204
202
0
50
100
150
200
250
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Levee
Bank Sta

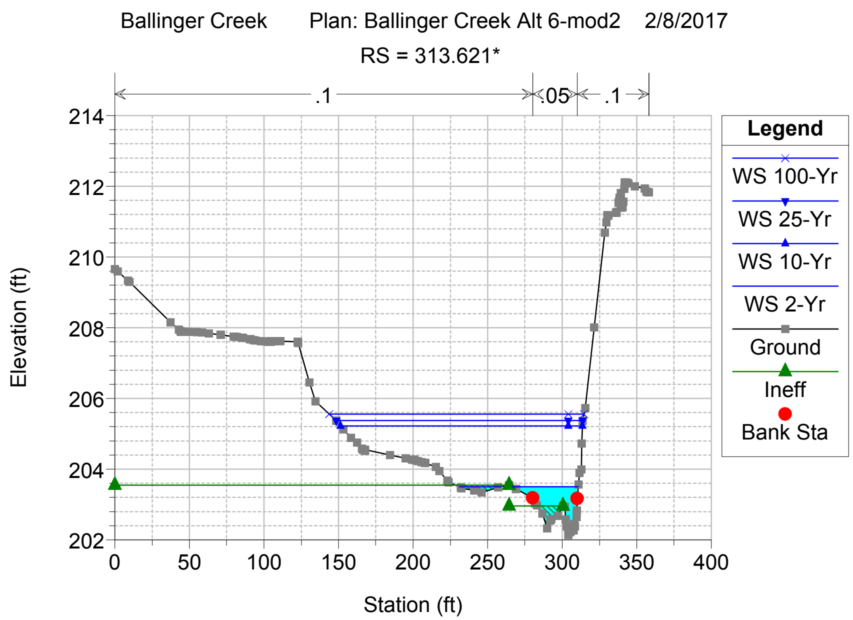

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 355.58
.1
.05
.1
Elevation (ft)
214
212
210
208
206
204
202
0
50
100
150
200
250
300
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

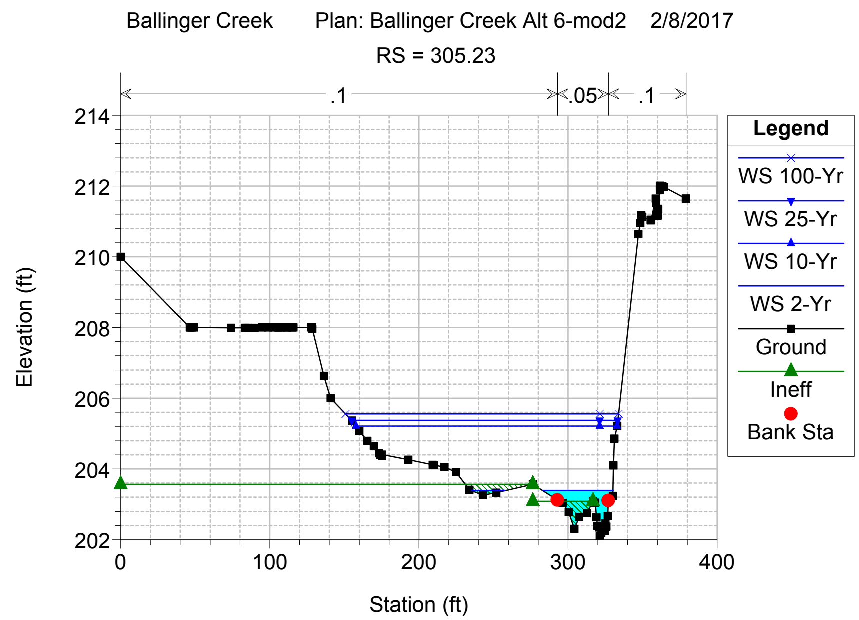

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 347.188*
.1
.05
.1
Elevation (ft)
214
212
210
208
206
204
202
0
50
100
150
200
250
300
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta

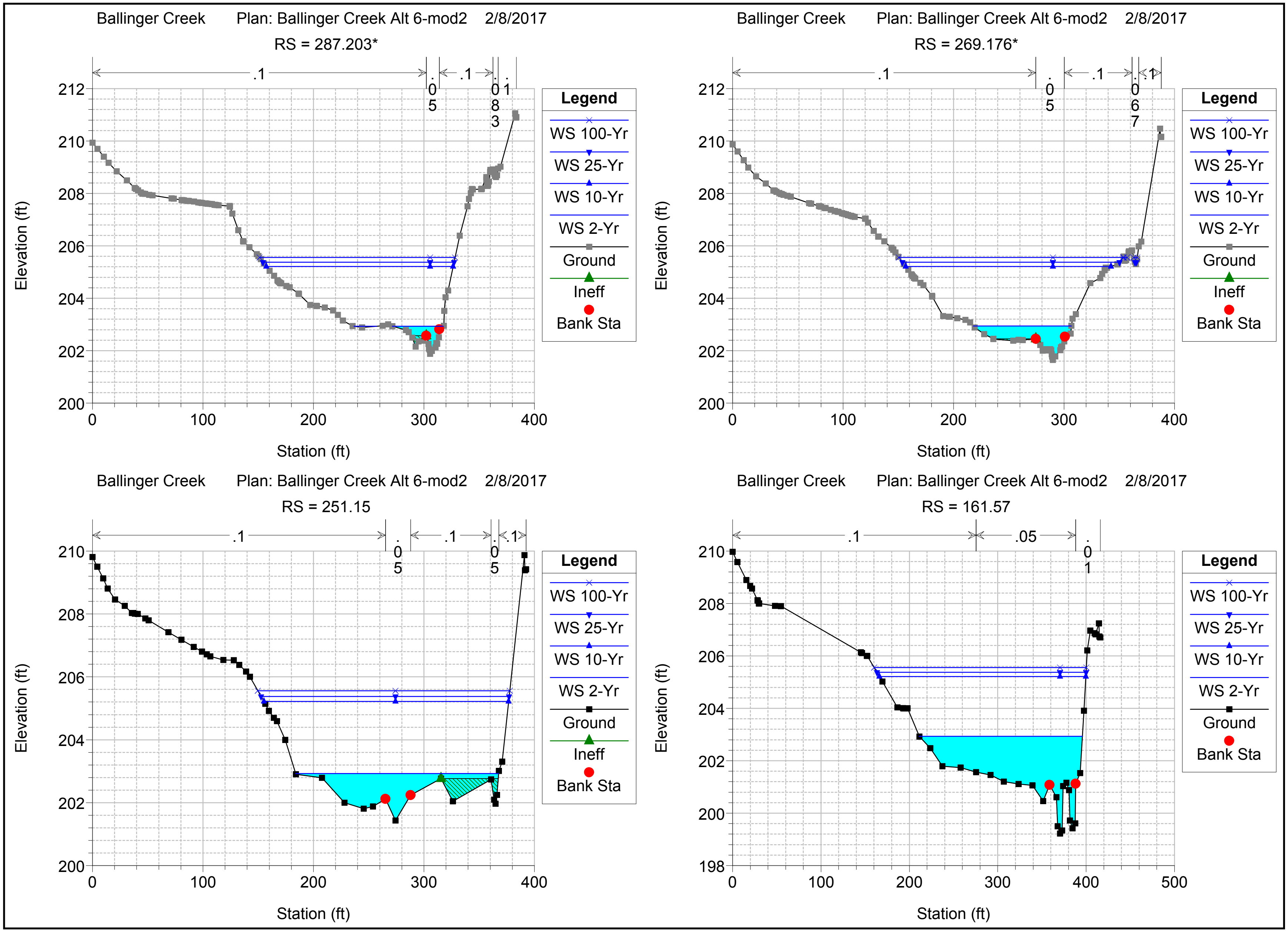

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 338.796*
.1
.05
.1
Elevation (ft)
214
212
210
208
206
204
202
0
50
100
150
200
250
300
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 330.405*
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

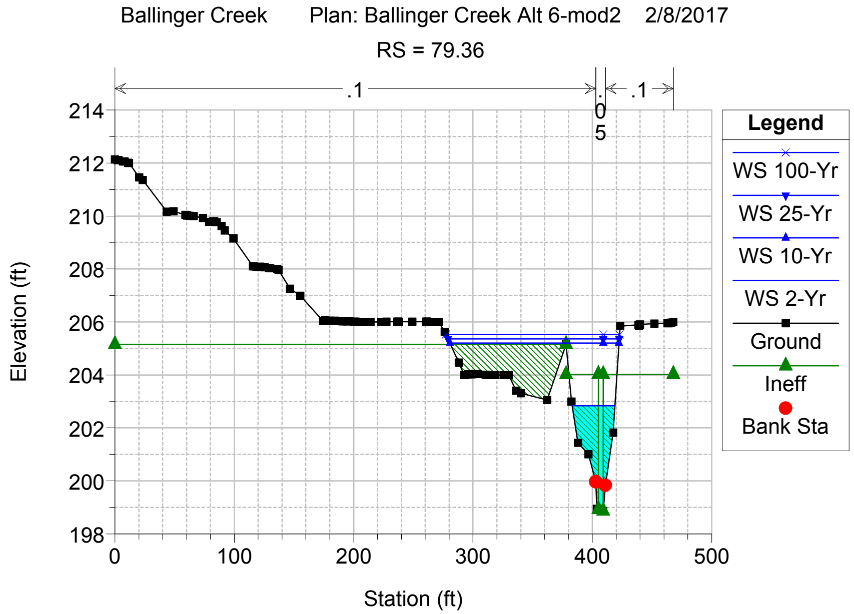

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 322.013*
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 313.621*
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

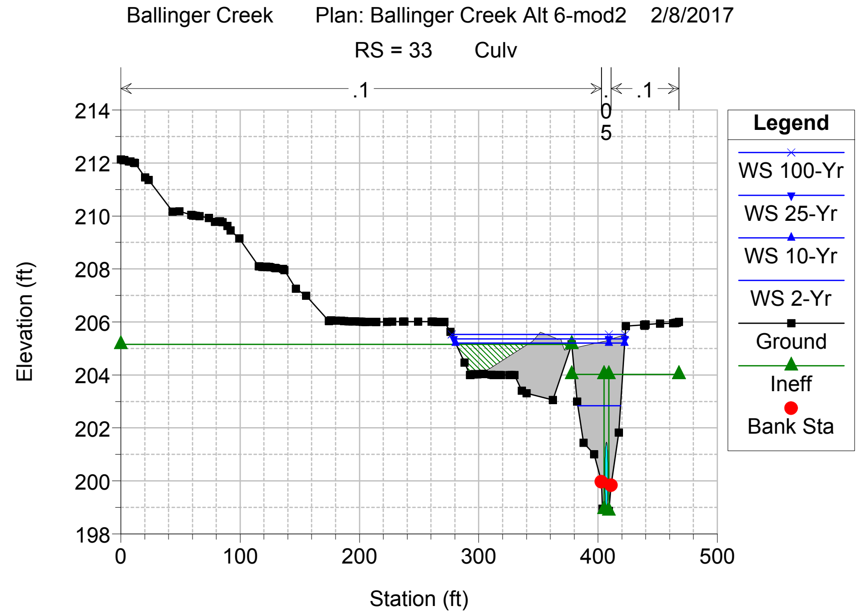

Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 305.23
.1
.05
.1
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



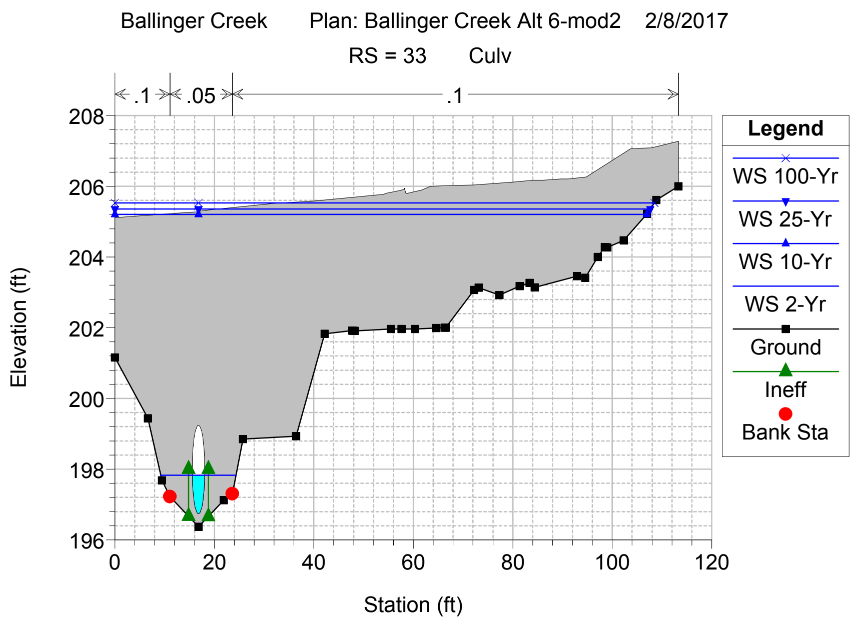
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 287.203*
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 269.176*
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 251.15
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 161.57



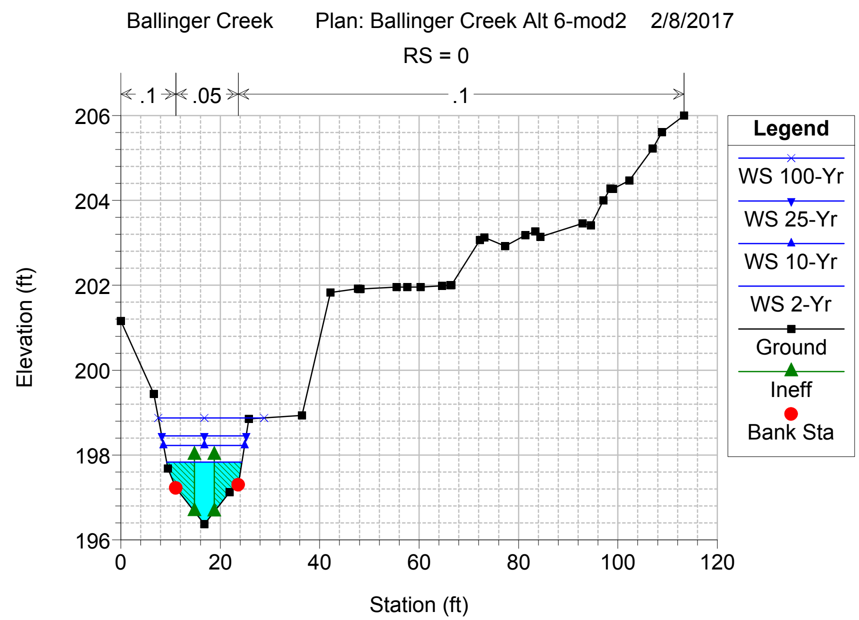
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 79.36
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta



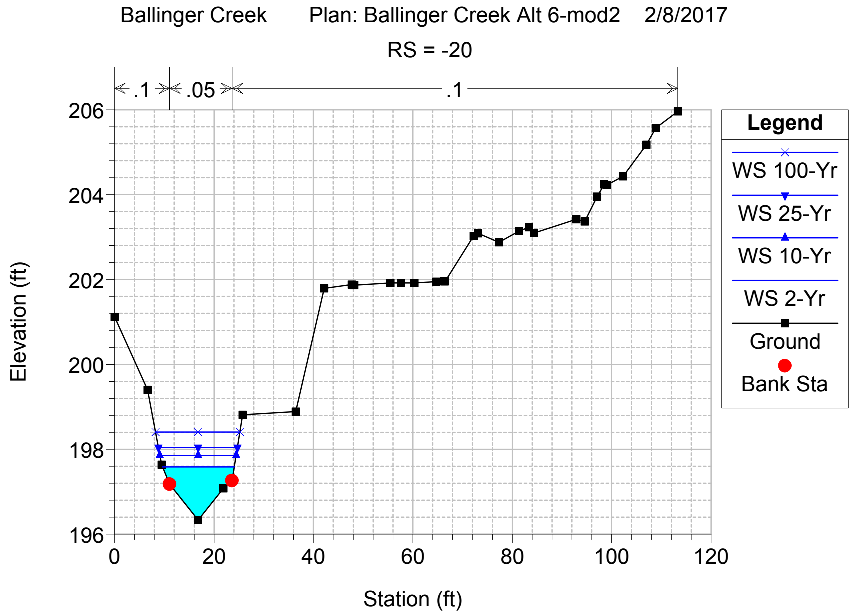
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 33 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta



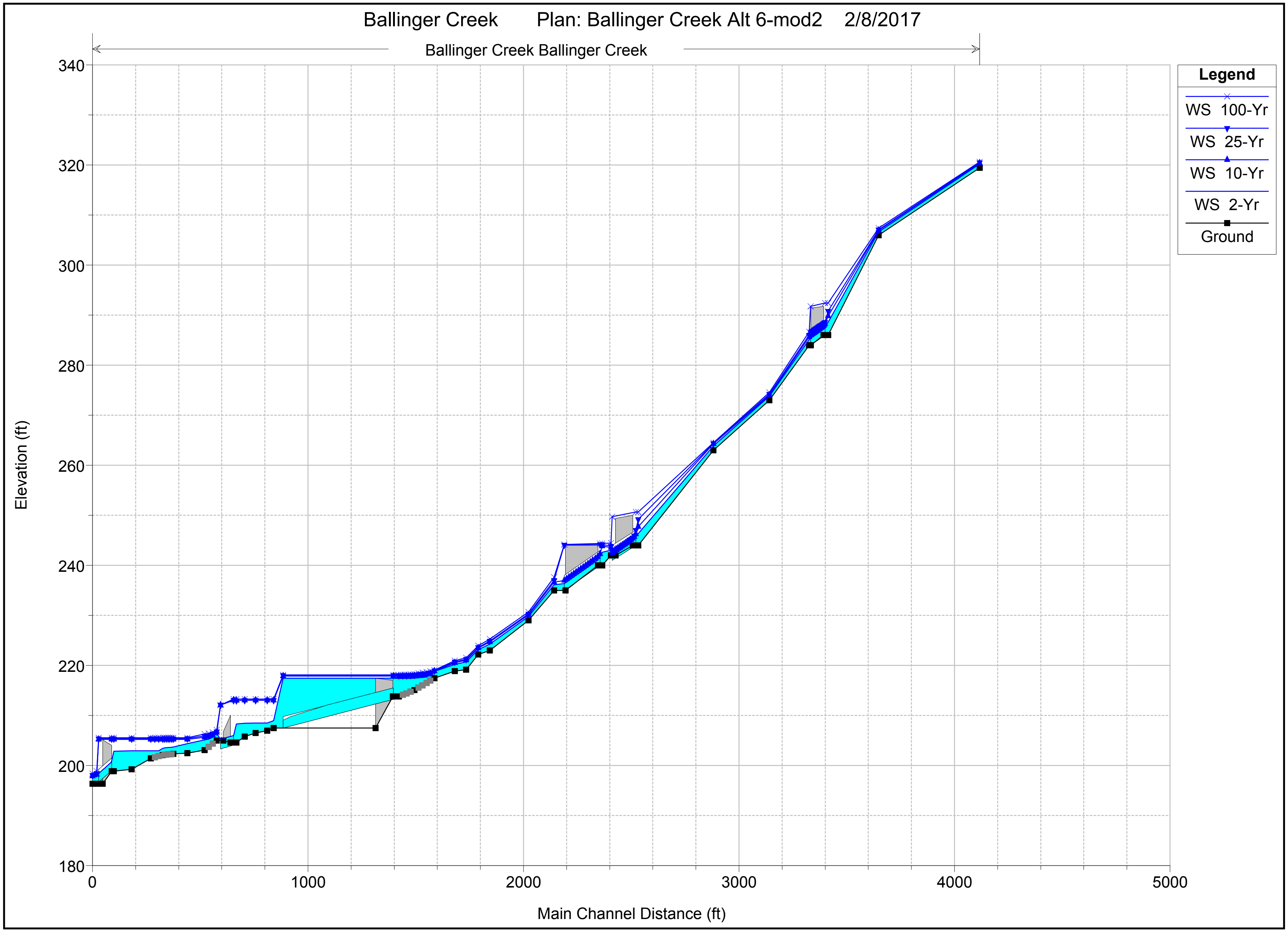
Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 33 Culv
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta



Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = 0
.1
.05
.1
Elevation (ft)
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Ineff
Bank Sta



Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
RS = -20
.1
.05
.1
Elevation (ft)
206
204
202
200
198
196
0
20
40
60
80
100
120
Station (ft)
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Bank Sta


Ballinger Creek Plan: Ballinger Creek Alt 6-mod2 2/8/2017
Ballinger Creek Ballinger Creek
Legend
WS 100-Yr
WS 25-Yr
WS 10-Yr
WS 2-Yr
Ground
Elevation (ft)
180
200
220
240
260
280
300
320
340
Main Channel Distance (ft)
0
1000
2000
3000
4000
5000

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	3833.85	2-Yr	26.34	319.41	320.19	320.12	320.30	0.019291	2.85	11.86	35.40	0.66
Ballinger Creek	3833.85	10-Yr	48.17	319.41	320.36	320.28	320.52	0.021056	3.55	18.37	40.44	0.72
Ballinger Creek	3833.85	25-Yr	64.54	319.41	320.46	320.38	320.65	0.022394	3.97	22.48	43.33	0.76
Ballinger Creek	3833.85	100-Yr	98.02	319.41	320.62	320.55	320.88	0.024336	4.66	30.06	48.21	0.82
Ballinger Creek	3597.45	2-Yr	26.34	305.99	306.63	306.63	306.90	0.046221	4.16	6.35	12.13	1.00
Ballinger Creek	3597.45	10-Yr	48.17	305.99	306.90	306.90	307.28	0.039474	4.94	9.88	13.85	0.99
Ballinger Creek	3597.45	25-Yr	64.54	305.99	307.07	307.07	307.51	0.035782	5.38	12.35	14.89	0.97
Ballinger Creek	3597.45	100-Yr	98.02	305.99	307.37	307.37	307.93	0.031378	6.05	17.14	16.82	0.95
Ballinger Creek	3364.13	2-Yr	26.34	286.00	288.60	286.95	288.66	0.001300	2.03	13.00	9.55	0.22
Ballinger Creek	3364.13	10-Yr	48.17	286.00	289.82	287.42	289.91	0.001210	2.52	19.08	11.68	0.23
Ballinger Creek	3364.13	25-Yr	64.54	286.00	290.79	287.73	290.90	0.001021	2.70	23.93	21.28	0.22
Ballinger Creek	3364.13	100-Yr	98.02	286.00	292.42	288.29	292.43	0.000405	1.00	97.55	40.54	0.11
Ballinger Creek	3300		Culvert									
Ballinger Creek	3275.89	2-Yr	26.34	284.00	285.11	285.11	285.66	0.035113	5.97	4.41	18.39	1.00
Ballinger Creek	3275.89	10-Yr	48.17	284.00	285.66	285.66	286.49	0.030579	7.29	6.61	21.32	1.00
Ballinger Creek	3275.89	25-Yr	64.54	284.00	286.01	286.01	287.02	0.028861	8.05	8.02	23.17	1.00
Ballinger Creek	3275.89	100-Yr	98.02	284.00	286.66	286.66	287.99	0.026181	9.24	10.61	26.90	1.00
Ballinger Creek	3090.28	2-Yr	26.34	273.00	273.80		274.02	0.031928	3.76	7.00	9.39	0.77
Ballinger Creek	3090.28	10-Yr	48.17	273.00	274.00	274.00	274.46	0.052308	5.45	8.85	9.72	1.01
Ballinger Creek	3090.28	25-Yr	64.54	273.00	274.20	274.20	274.75	0.050198	5.93	10.89	10.08	1.00
Ballinger Creek	3090.28	100-Yr	98.02	273.00	274.57	274.57	275.26	0.047952	6.68	14.67	10.71	1.01
Ballinger Creek	2831.67	2-Yr	26.34	263.00	263.84	263.84	264.18	0.045928	4.69	5.62	8.34	1.01
Ballinger Creek	2831.67	10-Yr	48.17	263.00	264.25	264.25	264.46	0.020789	4.15	23.54	67.81	0.72
Ballinger Creek	2831.67	25-Yr	64.54	263.00	264.37	264.37	264.59	0.020637	4.45	31.72	70.46	0.73
Ballinger Creek	2831.67	100-Yr	98.02	263.00	264.51	264.51	264.80	0.025656	5.36	41.85	73.67	0.83
Ballinger Creek	2483	2-Yr	26.34	244.00	246.34	244.96	246.42	0.001836	2.25	11.72	16.72	0.26
Ballinger Creek	2483	10-Yr	48.17	244.00	247.71	245.43	247.81	0.001334	2.60	18.53	23.53	0.24
Ballinger Creek	2483	25-Yr	64.54	244.00	249.19	245.73	249.29	0.000779	2.49	25.95	31.93	0.19
Ballinger Creek	2483	100-Yr	98.02	244.00	250.67	246.29	250.68	0.000076	0.73	159.26	59.59	0.06
Ballinger Creek	2400		Culvert									

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	2355.95	2-Yr	26.34	242.00	243.02	243.02	243.54	0.036693	5.77	4.57	27.84	1.01
Ballinger Creek	2355.95	10-Yr	48.17	242.00	243.58	243.53	244.30	0.028671	6.82	7.07	37.60	0.96
Ballinger Creek	2355.95	25-Yr	64.54	242.00	243.86	243.86	244.79	0.029814	7.75	8.32	42.51	1.00
Ballinger Creek	2355.95	100-Yr	98.02	242.00	244.47	244.47	245.69	0.026787	8.88	11.04	53.37	1.00
Ballinger Creek	2314.97	2-Yr	26.34	240.00	242.62	240.84	242.66	0.000431	1.68	15.72	46.07	0.18
Ballinger Creek	2314.97	10-Yr	48.17	240.00	243.85	241.26	243.92	0.000400	2.09	23.09	62.03	0.19
Ballinger Creek	2314.97	25-Yr	64.54	240.00	244.15	241.53	244.16	0.000059	0.73	133.96	67.92	0.07
Ballinger Creek	2314.97	100-Yr	98.02	240.00	244.34	242.02	244.36	0.000109	1.03	147.61	72.97	0.09
Ballinger Creek	2300		Culvert									
Ballinger Creek	2091.38	2-Yr	26.34	235.00	236.11	236.11	236.66	0.022506	5.96	4.42	18.66	1.00
Ballinger Creek	2091.38	10-Yr	48.17	235.00	236.65	236.65	237.48	0.019878	7.31	6.59	35.64	1.00
Ballinger Creek	2091.38	25-Yr	64.54	235.00	237.00	237.00	238.01	0.018593	8.05	8.02	46.34	1.00
Ballinger Creek	2091.38	100-Yr	98.02	235.00	237.65	237.65	238.98	0.016819	9.23	10.61	65.69	1.00
Ballinger Creek	1973.22	2-Yr	26.34	229.00	229.74	229.74	230.07	0.045232	4.63	5.68	8.36	0.99
Ballinger Creek	1973.22	10-Yr	48.17	229.00	230.08	230.08	230.56	0.042829	5.58	8.63	8.99	1.00
Ballinger Creek	1973.22	25-Yr	64.54	229.00	230.30	230.30	230.87	0.041321	6.06	10.65	9.39	1.00
Ballinger Creek	1973.22	100-Yr	98.02	229.00	230.68	230.68	231.40	0.039917	6.82	14.36	41.23	1.01
Ballinger Creek	1793.86	2-Yr	39.28	223.00	224.26		224.42	0.010297	3.21	12.23	12.45	0.57
Ballinger Creek	1793.86	10-Yr	71.20	223.00	224.67		224.92	0.011718	4.00	17.79	14.26	0.63
Ballinger Creek	1793.86	25-Yr	92.94	223.00	224.90		225.20	0.012277	4.39	21.18	15.25	0.66
Ballinger Creek	1793.86	100-Yr	134.03	223.00	225.27		225.65	0.013019	4.96	27.01	16.82	0.69
Ballinger Creek	1740.27	2-Yr	39.28	222.19	223.13	223.13	223.44	0.038342	4.58	9.51	16.63	0.95
Ballinger Creek	1740.27	10-Yr	71.20	222.19	223.44	223.44	223.89	0.035486	5.59	14.87	17.89	0.97
Ballinger Creek	1740.27	25-Yr	92.94	222.19	223.62	223.62	224.15	0.034136	6.11	18.17	18.62	0.98
Ballinger Creek	1740.27	100-Yr	134.03	222.19	223.93	223.93	224.58	0.031864	6.85	24.18	20.83	0.98
Ballinger Creek	1684.22	2-Yr	39.28	219.14	220.73		220.89	0.010092	3.22	12.80	20.37	0.51
Ballinger Creek	1684.22	10-Yr	71.20	219.14	221.06		221.34	0.013441	4.36	19.86	22.24	0.62
Ballinger Creek	1684.22	25-Yr	92.94	219.14	221.24		221.59	0.014988	4.95	23.91	23.24	0.66
Ballinger Creek	1684.22	100-Yr	134.03	219.14	221.52	221.32	222.00	0.017215	5.86	30.68	24.83	0.73
Ballinger Creek	1630.62	2-Yr	39.28	218.87	220.18		220.29	0.011632	2.82	16.66	79.41	0.53
Ballinger Creek	1630.62	10-Yr	71.20	218.87	220.53	220.22	220.68	0.010222	3.32	28.97	90.71	0.53

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	1630.62	25-Yr	92.94	218.87	220.70	220.36	220.87	0.010461	3.66	35.57	96.15	0.55
Ballinger Creek	1630.62	100-Yr	134.03	218.87	220.93	220.59	221.17	0.011849	4.32	45.31	103.61	0.60
Ballinger Creek	1536.58	2-Yr	39.28	217.43	218.81	218.76	218.89	0.019326	2.49	26.80	100.40	0.63
Ballinger Creek	1536.58	10-Yr	71.20	217.43	218.88	218.88	219.03	0.036821	3.72	32.97	101.06	0.89
Ballinger Creek	1536.58	25-Yr	92.94	217.43	218.93	218.93	219.11	0.041939	4.22	38.18	101.62	0.97
Ballinger Creek	1536.58	100-Yr	134.03	217.43	219.04	219.04	219.26	0.041456	4.71	49.57	102.82	0.99
Ballinger Creek	1518.08*	2-Yr	39.28	216.95	218.20	218.15	218.38	0.037432	3.57	12.10	102.46	0.89
Ballinger Creek	1518.08*	10-Yr	71.20	216.95	218.39	218.21	218.42	0.008129	2.06	61.61	107.26	0.44
Ballinger Creek	1518.08*	25-Yr	92.94	216.95	218.55	218.21	218.58	0.006440	2.10	78.80	110.03	0.40
Ballinger Creek	1518.08*	100-Yr	134.03	216.95	218.82	218.25	218.85	0.004855	2.19	109.12	114.30	0.37
Ballinger Creek	1499.59*	2-Yr	39.28	216.48	217.70	217.56	217.85	0.021823	3.15	12.47	26.55	0.70
Ballinger Creek	1499.59*	10-Yr	71.20	216.48	218.20	217.81	218.28	0.006665	2.53	45.86	86.98	0.42
Ballinger Creek	1499.59*	25-Yr	92.94	216.48	218.39	218.05	218.47	0.005389	2.53	63.23	92.20	0.39
Ballinger Creek	1499.59*	100-Yr	134.03	216.48	218.67	218.21	218.76	0.005049	2.79	91.41	120.70	0.39
Ballinger Creek	1481.09*	2-Yr	39.28	216.00	217.58	217.02	217.65	0.005315	2.22	17.79	24.20	0.37
Ballinger Creek	1481.09*	10-Yr	71.20	216.00	218.10	217.31	218.19	0.003957	2.48	42.26	69.75	0.34
Ballinger Creek	1481.09*	25-Yr	92.94	216.00	218.28	217.49	218.38	0.004140	2.72	55.83	79.97	0.36
Ballinger Creek	1481.09*	100-Yr	134.03	216.00	218.55	217.80	218.67	0.004334	3.06	79.83	93.51	0.37
Ballinger Creek	1462.60*	2-Yr	39.28	215.53	217.52	216.54	217.58	0.002760	2.03	20.54	26.00	0.28
Ballinger Creek	1462.60*	10-Yr	71.20	215.53	218.04	216.91	218.12	0.002801	2.45	45.54	56.13	0.29
Ballinger Creek	1462.60*	25-Yr	92.94	215.53	218.20	217.12	218.31	0.003436	2.85	55.16	64.54	0.33
Ballinger Creek	1462.60*	100-Yr	134.03	215.53	218.43	217.48	218.58	0.004494	3.47	71.79	77.38	0.38
Ballinger Creek	1444.11	2-Yr	39.28	215.05	217.44	216.20	217.52	0.003252	2.43	19.25	27.12	0.29
Ballinger Creek	1444.11	10-Yr	71.20	215.05	217.95	216.70	218.06	0.003700	2.97	43.75	55.91	0.32
Ballinger Creek	1444.11	25-Yr	92.94	215.05	218.09	217.04	218.23	0.004671	3.45	51.69	58.03	0.36
Ballinger Creek	1444.11	100-Yr	134.03	215.05	218.26	217.67	218.47	0.006946	4.38	61.90	63.04	0.44
Ballinger Creek	1425.92*	2-Yr	39.28	214.73	217.41	215.99	217.47	0.001870	1.99	24.13	30.14	0.23
Ballinger Creek	1425.92*	10-Yr	71.20	214.73	217.92	216.46	218.00	0.002251	2.50	51.00	57.23	0.26
Ballinger Creek	1425.92*	25-Yr	92.94	214.73	218.05	216.74	218.16	0.003017	2.98	58.57	61.55	0.31
Ballinger Creek	1425.92*	100-Yr	134.03	214.73	218.19	217.25	218.37	0.004864	3.91	67.79	67.85	0.39
Ballinger Creek	1407.74*	2-Yr	39.28	214.42	217.39	215.82	217.43	0.001181	1.67	29.53	45.34	0.19

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	1407.74*	10-Yr	71.20	214.42	217.90	216.25	217.96	0.001474	2.13	59.84	63.03	0.22
Ballinger Creek	1407.74*	25-Yr	92.94	214.42	218.02	216.52	218.10	0.002022	2.57	67.85	68.15	0.26
Ballinger Creek	1407.74*	100-Yr	134.03	214.42	218.15	216.96	218.29	0.003369	3.41	76.87	73.49	0.34
Ballinger Creek	1389.56*	2-Yr	39.28	214.10	217.38	215.67	217.41	0.000768	1.40	40.05	50.43	0.16
Ballinger Creek	1389.56*	10-Yr	71.20	214.10	217.89	216.09	217.93	0.001000	1.82	69.39	66.13	0.19
Ballinger Creek	1389.56*	25-Yr	92.94	214.10	218.01	216.32	218.07	0.001396	2.20	77.45	70.53	0.22
Ballinger Creek	1389.56*	100-Yr	134.03	214.10	218.13	216.72	218.23	0.002399	2.96	85.91	74.98	0.29
Ballinger Creek	1371.38	2-Yr	39.28	213.78	217.37	215.62	217.39	0.000563	1.23	44.85	48.94	0.14
Ballinger Creek	1371.38	10-Yr	71.20	213.78	217.88	216.26	217.91	0.000791	1.65	74.11	66.45	0.17
Ballinger Creek	1371.38	25-Yr	92.94	213.78	217.99	216.63	218.05	0.001223	2.10	82.25	95.86	0.21
Ballinger Creek	1371.38	100-Yr	134.03	213.78	218.09	217.00	218.19	0.002183	2.86	93.07	113.11	0.28
Ballinger Creek	1300		Culvert									
Ballinger Creek	820.39	2-Yr	38.22	207.49	208.94	208.94	209.60	0.038565	6.56	5.83	32.62	1.00
Ballinger Creek	820.39	10-Yr	62.96	207.49	213.01	209.00	213.01	0.000042	0.25	358.81	223.53	0.02
Ballinger Creek	820.39	25-Yr	80.57	207.49	213.02	209.00	213.02	0.000068	0.32	359.42	223.61	0.03
Ballinger Creek	820.39	100-Yr	114.97	207.49	213.26	209.01	213.26	0.000100	0.39	414.62	231.24	0.03
Ballinger Creek	790.39	2-Yr	38.22	206.99	208.50	207.98	208.51	0.001999	0.73	46.11	56.25	0.14
Ballinger Creek	790.39	10-Yr	62.96	206.99	213.01	208.09	213.01	0.000008	0.15	511.54	224.54	0.01
Ballinger Creek	790.39	25-Yr	80.57	206.99	213.02	208.16	213.02	0.000014	0.19	512.13	224.61	0.02
Ballinger Creek	790.39	100-Yr	114.97	206.99	213.26	208.27	213.26	0.000022	0.25	567.51	232.18	0.02
Ballinger Creek	736.73	2-Yr	38.22	206.50	208.46	207.17	208.47	0.000430	0.75	61.90	49.14	0.11
Ballinger Creek	736.73	10-Yr	62.96	206.50	213.01	207.55	213.01	0.000005	0.21	616.33	254.82	0.02
Ballinger Creek	736.73	25-Yr	80.57	206.50	213.02	207.63	213.02	0.000008	0.27	616.93	254.85	0.02
Ballinger Creek	736.73	100-Yr	114.97	206.50	213.26	207.77	213.26	0.000013	0.36	678.88	257.05	0.03
Ballinger Creek	686.13	2-Yr	38.22	205.76	208.44	206.72	208.45	0.000368	0.97	59.66	41.91	0.11
Ballinger Creek	686.13	10-Yr	62.96	205.76	213.01	207.04	213.01	0.000006	0.25	736.20	297.08	0.02
Ballinger Creek	686.13	25-Yr	80.57	205.76	213.02	207.21	213.02	0.000009	0.32	736.85	297.10	0.02
Ballinger Creek	686.13	100-Yr	114.97	205.76	213.26	207.46	213.26	0.000015	0.41	808.92	298.95	0.03
Ballinger Creek	647.77	2-Yr	38.22	204.59	208.29	206.29	208.41	0.001958	2.76	13.83	21.88	0.26
Ballinger Creek	647.77	10-Yr	62.96	204.59	213.01	206.84	213.01	0.000030	0.56	224.98	63.86	0.04
Ballinger Creek	647.77	25-Yr	80.57	204.59	213.01	207.19	213.01	0.000050	0.72	224.98	63.86	0.05

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	647.77	100-Yr	114.97	204.59	213.25	207.81	213.26	0.000087	0.97	240.20	64.34	0.06
Ballinger Creek	600		Culvert									
Ballinger Creek	556.47	2-Yr	38.22	204.97	206.40	206.40	206.49	0.007298	2.37	16.36	18.51	0.44
Ballinger Creek	556.47	10-Yr	62.96	204.97	206.58	206.40	206.75	0.010747	3.25	19.81	18.98	0.55
Ballinger Creek	556.47	25-Yr	80.57	204.97	206.78	206.41	206.97	0.010111	3.52	23.61	19.48	0.54
Ballinger Creek	556.47	100-Yr	114.97	204.97	207.13	206.59	207.37	0.009258	3.94	30.54	20.36	0.54
Ballinger Creek	537.923*	2-Yr	38.22	204.34	205.68	205.65	206.01	0.027955	4.74	9.82	15.50	0.85
Ballinger Creek	537.923*	10-Yr	62.96	204.34	206.07	205.95	206.42	0.020877	5.12	16.70	19.46	0.78
Ballinger Creek	537.923*	25-Yr	80.57	204.34	206.28	206.13	206.66	0.019080	5.41	21.07	20.58	0.76
Ballinger Creek	537.923*	100-Yr	114.97	204.34	206.64		207.08	0.017500	5.93	28.74	22.38	0.75
Ballinger Creek	519.376*	2-Yr	38.22	203.71	205.28		205.56	0.019125	4.30	9.53	11.67	0.70
Ballinger Creek	519.376*	10-Yr	62.96	203.71	205.78		206.09	0.013730	4.63	17.50	20.83	0.63
Ballinger Creek	519.376*	25-Yr	80.57	203.71	206.02		206.35	0.012891	4.92	22.92	23.89	0.63
Ballinger Creek	519.376*	100-Yr	114.97	203.71	206.41		206.78	0.011920	5.35	32.74	26.29	0.62
Ballinger Creek	500.83	2-Yr	38.22	203.08	205.14		205.29	0.007220	3.19	12.96	11.43	0.44
Ballinger Creek	500.83	10-Yr	62.96	203.08	205.66		205.86	0.006852	3.74	22.73	27.75	0.45
Ballinger Creek	500.83	25-Yr	80.57	203.08	205.91		206.13	0.006822	4.02	29.95	29.96	0.46
Ballinger Creek	500.83	100-Yr	114.97	203.08	206.31		206.55	0.006791	4.45	42.66	33.49	0.47
Ballinger Creek	420.4	2-Yr	38.22	202.45	204.36	203.86	204.57	0.011282	3.81	12.34	15.16	0.53
Ballinger Creek	420.4	10-Yr	62.96	202.45	205.24	204.36	205.38	0.004900	3.36	30.31	26.20	0.38
Ballinger Creek	420.4	25-Yr	80.57	202.45	205.39	204.66	205.58	0.006499	4.03	34.67	33.26	0.44
Ballinger Creek	420.4	100-Yr	114.97	202.45	205.55	204.94	205.88	0.010207	5.26	40.96	42.14	0.55
Ballinger Creek	355.58	2-Yr	38.22	202.31	203.68	203.33	203.82	0.011238	3.23	18.66	38.05	0.51
Ballinger Creek	355.58	10-Yr	62.96	202.31	205.22	203.75	205.24	0.000795	1.47	99.05	92.65	0.16
Ballinger Creek	355.58	25-Yr	80.57	202.31	205.37	203.86	205.40	0.000997	1.71	114.80	107.96	0.18
Ballinger Creek	355.58	100-Yr	114.97	202.31	205.56	204.06	205.59	0.001466	2.16	136.29	125.88	0.22
Ballinger Creek	347.188*	2-Yr	38.22	202.27	203.64		203.73	0.006547	2.50	20.25	44.35	0.41
Ballinger Creek	347.188*	10-Yr	62.96	202.27	205.22		205.23	0.000417	1.12	122.80	111.99	0.12
Ballinger Creek	347.188*	25-Yr	80.57	202.27	205.37		205.39	0.000507	1.28	141.14	120.18	0.13
Ballinger Creek	347.188*	100-Yr	114.97	202.27	205.56		205.58	0.000744	1.62	164.17	130.48	0.16

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	338.796*	2-Yr	38.22	202.24	203.61		203.68	0.004735	2.06	23.09	51.10	0.35
Ballinger Creek	338.796*	10-Yr	62.96	202.24	205.22		205.23	0.000250	0.87	149.55	125.63	0.09
Ballinger Creek	338.796*	25-Yr	80.57	202.24	205.38		205.39	0.000304	1.00	169.84	131.04	0.10
Ballinger Creek	338.796*	100-Yr	114.97	202.24	205.56		205.57	0.000452	1.27	194.73	138.86	0.13
Ballinger Creek	330.405*	2-Yr	38.22	202.21	203.58		203.63	0.004320	1.85	24.45	58.14	0.33
Ballinger Creek	330.405*	10-Yr	62.96	202.21	205.22		205.22	0.000168	0.71	176.63	137.73	0.08
Ballinger Creek	330.405*	25-Yr	80.57	202.21	205.38		205.38	0.000206	0.82	198.74	142.43	0.09
Ballinger Creek	330.405*	100-Yr	114.97	202.21	205.56		205.57	0.000308	1.04	225.66	149.29	0.11
Ballinger Creek	322.013*	2-Yr	38.22	202.17	203.55		203.60	0.004687	1.77	24.41	66.57	0.34
Ballinger Creek	322.013*	10-Yr	62.96	202.17	205.22		205.22	0.000122	0.59	205.20	150.50	0.07
Ballinger Creek	322.013*	25-Yr	80.57	202.17	205.38		205.38	0.000150	0.69	229.25	154.03	0.07
Ballinger Creek	322.013*	100-Yr	114.97	202.17	205.56		205.57	0.000225	0.88	258.18	159.54	0.09
Ballinger Creek	313.621*	2-Yr	38.22	202.14	203.50		203.55	0.006330	1.82	22.81	72.30	0.39
Ballinger Creek	313.621*	10-Yr	62.96	202.14	205.22		205.22	0.000094	0.51	233.00	162.23	0.06
Ballinger Creek	313.621*	25-Yr	80.57	202.14	205.38		205.38	0.000116	0.59	258.86	165.35	0.07
Ballinger Creek	313.621*	100-Yr	114.97	202.14	205.56		205.57	0.000174	0.76	289.85	170.83	0.08
Ballinger Creek	305.23	2-Yr	38.22	202.10	203.39	203.25	203.47	0.015814	2.26	18.40	70.01	0.58
Ballinger Creek	305.23	10-Yr	62.96	202.10	205.22		205.22	0.000076	0.45	259.82	175.18	0.05
Ballinger Creek	305.23	25-Yr	80.57	202.10	205.38		205.38	0.000094	0.52	287.71	178.33	0.06
Ballinger Creek	305.23	100-Yr	114.97	202.10	205.56		205.56	0.000142	0.67	321.01	183.03	0.07
Ballinger Creek	287.203*	2-Yr	38.22	201.88	202.93	202.93	203.11	0.024219	3.71	16.27	66.68	0.76
Ballinger Creek	287.203*	10-Yr	62.96	201.88	205.22		205.22	0.000060	0.48	310.19	169.25	0.05
Ballinger Creek	287.203*	25-Yr	80.57	201.88	205.37		205.38	0.000078	0.56	337.15	172.86	0.06
Ballinger Creek	287.203*	100-Yr	114.97	201.88	205.56		205.56	0.000123	0.73	369.30	176.95	0.07
Ballinger Creek	269.176*	2-Yr	38.22	201.65	202.94		202.96	0.002123	1.22	49.02	88.56	0.23
Ballinger Creek	269.176*	10-Yr	62.96	201.65	205.22		205.22	0.000030	0.34	365.08	185.80	0.03
Ballinger Creek	269.176*	25-Yr	80.57	201.65	205.37		205.37	0.000041	0.41	395.41	197.78	0.04
Ballinger Creek	269.176*	100-Yr	114.97	201.65	205.56		205.56	0.000065	0.54	432.70	209.11	0.05
Ballinger Creek	251.15	2-Yr	38.22	201.43	202.93		202.94	0.000670	0.83	95.56	183.77	0.14
Ballinger Creek	251.15	10-Yr	62.96	201.43	205.22		205.22	0.000012	0.23	555.47	221.45	0.02
Ballinger Creek	251.15	25-Yr	80.57	201.43	205.37		205.37	0.000016	0.28	590.58	224.50	0.03
Ballinger Creek	251.15	100-Yr	114.97	201.43	205.56		205.56	0.000026	0.37	632.09	228.04	0.03

HEC-RAS Plan: Alt6-mod2 River: Ballinger Creek Reach: Ballinger Creek (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Ballinger Creek	161.57	2-Yr	38.22	199.22	202.93		202.93	0.000008	0.15	295.63	184.70	0.02
Ballinger Creek	161.57	10-Yr	62.96	199.22	205.22		205.22	0.000001	0.10	771.05	233.57	0.01
Ballinger Creek	161.57	25-Yr	80.57	199.22	205.37		205.37	0.000002	0.12	808.03	236.60	0.01
Ballinger Creek	161.57	100-Yr	114.97	199.22	205.56		205.56	0.000004	0.16	851.67	240.13	0.01
Ballinger Creek	79.36	2-Yr	34.09	198.87	202.83	200.22	202.91	0.000861	2.17	15.69	35.78	0.19
Ballinger Creek	79.36	10-Yr	56.37	198.87	205.21	200.73	205.21	0.000070	0.78	176.92	141.78	0.06
Ballinger Creek	79.36	25-Yr	74.89	198.87	205.36	201.13	205.37	0.000103	0.96	198.84	143.56	0.07
Ballinger Creek	79.36	100-Yr	115.88	198.87	205.53	201.87	205.55	0.000200	1.37	223.71	145.56	0.09
Ballinger Creek	33		Culvert									
Ballinger Creek	0	2-Yr	34.09	196.37	197.83	197.83	198.49	0.033794	6.51	5.24	15.16	1.00
Ballinger Creek	0	10-Yr	56.37	196.37	198.22	198.00	198.37	0.007258	3.13	19.54	16.32	0.47
Ballinger Creek	0	25-Yr	74.89	196.37	198.45	198.00	198.64	0.007604	3.55	23.34	17.00	0.49
Ballinger Creek	0	100-Yr	115.88	196.37	198.87	198.21	199.15	0.008238	4.31	30.84	21.32	0.53
Ballinger Creek	-20	2-Yr	34.09	196.33	197.58	197.40	197.76	0.018222	3.41	10.29	14.43	0.68
Ballinger Creek	-20	10-Yr	56.37	196.33	197.85	197.65	198.12	0.018204	4.15	14.36	15.35	0.71
Ballinger Creek	-20	25-Yr	74.89	196.33	198.05	197.82	198.37	0.018205	4.64	17.36	15.92	0.73
Ballinger Creek	-20	100-Yr	115.88	196.33	198.41	198.16	198.86	0.018228	5.49	23.33	17.00	0.76

Appendix N
Constructability Review

Draft Technical Memorandum

Shoreline Phase 1 – 25th Avenue NE Flood Reduction Project
City of Shoreline Public Works Department
Shoreline, Washington

Submitted to

Louis Berger
Seattle, Washington

2 December 2016

Submitted by

BergerABAM
33301 Ninth Avenue South, Suite 300
Federal Way, Washington 98003

A16.0261.00, Task 171

DRAFT TECHNICAL MEMORANDUM
SHORELINE PHASE 1 – 25th AVENUE NE FLOOD REDUCTION PROJECT
SHORELINE DEPARTMENT OF PUBLIC WORKS
SHORELINE, WASHINGTON

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1.0 INTRODUCTION

The City of Shoreline (City) is preparing a predesign study for the 25th Avenue NE Flood Reduction Project (project) to assess options to reduce flooding of Ballinger (West Lyon) Creek in the vicinity of 25th Avenue NE, NE 195th St, and Ballinger Way NE (State Route 104 [SR 104]). The study area includes portions of both cities of Shoreline and Lake Forest Park.

The study area is generally defined as the Ballinger Creek system from the southeast corner of Brugger's Bog Park to approximately 300 feet south of NE 195th Street. From the southeast corner of the park, the creek enters a 24-inch-diameter storm drain pipe system at the southeast corner of the park, crosses under 25th Avenue NE, and continues southward in 24-inch and 30-inch diameter pipes. A 24-inch diameter high flow bypass system runs parallel along the west side of 25th Avenue NE. Both pipes combine into a 36-inch by 48-inch corrugated metal pipe (CMP) arch just south of NE 195th Place. Ballinger Creek then daylights to a City of Shoreline drainage easement within private property and extends approximately 150 feet before entering a 36-inch by 48-inch CMP arch culvert crossing under NE 195th Street. The creek continues south along the east side of Ballinger Way NE within a large wetland.

BergerABAM is part of the design team and is tasked with providing a constructability review for the preferable conceptual alternatives being developed for the City's review. The following technical memorandum outlines the alternatives being considered and the constructability concerns that effect all or some of the alternatives. Based on the findings of this study and the requirement throughout to gain additional information, a preferred alternative recommendation is not included at this time. Cost is referred to throughout the document, but only in terms of a comparison between concepts considered. It is not intended that any cost inputs or comments developed to a level of detail that an estimate can be generated. This document is intended to assist the design team in furthering discussions on a preferred alternative.

2.0 ALTERNATIVES

The design team has evaluated multiple drainage alignments that could meet the City's goal of improving drainage in this area. Several concepts were evaluated by the design team and determined to be impractical from a construction, cost, or goal-achieving standpoint. Only the alternatives that may have merit for a final construction project were submitted to BergerABAM for review. The following alternative descriptions outline the differences in each.

2.1 Alternative 1

This alternative involves daylighting Ballinger Creek within the 25th Avenue NE right-of-way (ROW) and replacing the NE 195th Street Culvert. This alternative focuses on trying to keep most of the improvements on the west side of the ROW to avoid loss of parking (that occurs on the east side of the street) and also reduce the number of utility conflicts because of the large number of overhead utilities on the east side of the street. This option includes four new fish-passable box culverts in addition to the culvert replacement at NE 195th Street.

2.2 Alternative 2

This alternative is similar to Alternative 1; however the channel crosses 25th Avenue NE diagonally just north of NE 195th Place. From there, it runs along the east side of the road and crosses two driveways before daylighting into the existing channel north of NE 195th Street. This alternative focused on keeping the open channel on the west side of the ROW along the north maintenance facility and transitioning to the east side of the ROW at NE 195th Place to have shorter culverts (benefiting fish passage) and avoid having construction activities close to an existing building that was constructed on the west ROW line at 19518 25th Avenue NE for condominiums.

2.3 Alternative 3

This alternative will daylight the creek in the north maintenance facility property and transition to either Alternative 1 or Alternative 2 south of the facility. This alternative would only be feasible if the north maintenance site development does not move forward as currently envisioned, and if the City develops a future maintenance facility at an alternative location. If this were to be the case, the City-owned site could be used for storm drainage, park uses, and possibly mitigation for other City projects. It was assumed that this alternative would include floodplain storage and also fish habitat enhancements.

2.4 Alternative 4

BergerABAM proposes this fourth alternative to help mitigate utility conflicts at the east side of 25th Avenue NE near NE 195th Place. This option is similar to Alternative 2, with the exception that the crossing of 25th Avenue NE is shifted just south of the access driveway between the north maintenance facility and the building for condominiums. This alternative eliminates a conflict with one of the utility poles, located in the northeast quadrant of 25th Avenue NE and NE 195th Place.

3.0 CONSTRUCTABILITY

3.1 Schedule

3.1.1 In-Water Work Constraints

This project involves the installation of up to five box culverts, regrading of the existing Ballinger Creek, new channel construction, wall construction, and removal of the existing drainage conveyance system and roadway reconstruction. From a construction standpoint, it is desirable to perform the work during the drier months of April through mid-October. It is our assumption that any work at or below the ordinary high water mark will be subject to an in-water work window constraint. From our experience, these work windows range from one month to three to six months, depending upon the stream location. In checking with our in-house environmental staff, it is anticipated expected that the in-water work window will be from 1 July through 31 August, based on the creek being tributary to north Lake Washington. However, this needs to be verified by Louis Berger Group's environmental lead. From review of Alternatives 1 through 3, it is our opinion that the following work for any of the alternatives will be subject to an in-water work window.

- Stream regrading work of Ballinger Creek south of NE 195th Street
- Box Culvert Installation at NE 195th Street
- Stream Regrading of Ballinger Creek between 25th Avenue NE and NE 195th Street

For Alternative 1, the installation of the box culvert crossing 25th Avenue NE may be able to be done outside of an in-water work window. However, it may be difficult to install the east end of the box and associated headwalls without some creative construction sequencing, temporary isolation walls, and possible long-term diversion of the creek under the driveway. Channel construction upstream of that location could be done outside of the in-water window, since it is a new alignment not connected to the creek. The connections upstream and downstream, including headwalls, will take place during the in-water work window. A closer review of the creek hydraulics would be needed since this will also take the existing 24-inch high-flow bypass out of service, which is probably not desirable during the wet season.

For Alternative 2, the installation of two driveway culverts on the east side of 25th Avenue NE will more than likely be subject to an in-water work window. Installation of these box culverts will require diversion of the piped stream, which would trigger in-water work requirements. The installation of the culvert at the upstream connection of the box culvert at the north maintenance facility will be under the same timing as Alternative 1.

Alternative 3, which involves meandering the stream through the existing north maintenance facility, would involve all of the downstream constraints as Alternative 1 and 2. However, the stream work, site regrading, and installation of the south driveway box culvert could be done outside of the in-water work window with the exception of the upstream channel tie-in. BergerABAM's proposed Alternative 4 is also similar to this.

Given the amount of overall contract work and in water constraints, it is not likely this project could be completed in one season. Any temporary or permanent utility relocation could be done ahead of construction to minimize the duration of the channel and roadway work. It is our opinion that the work would need to be phased over two seasons to allow successful completion of the project, given the environmental constraints. During the next phase of the project, we recommend producing conceptual construction schedules for the different alternatives to help better understand the merits or downside of each alternative schedule.

3.2 Existing Drainage System

From the southeast corner of the Bruggers Bog Park, Ballinger Creek enters a 24-inch diameter storm drain pipe system, crosses under 25th Avenue NE, and continues southward in 24- inch and 30-inch diameter pipes. A 24-inch diameter high-flow bypass system runs parallel along the west side of 25th Avenue NE. Both pipes combine into a 36-inch by 48-inch CMP arch just south of NE 195th Place. Ballinger Creek then daylights to a City of Shoreline drainage easement within private property and extends approximately 150 feet before entering a 36-inch by 48-inch CMP arch culvert crossing under NE 195th Street. The west high-flow bypass also collects offsite drainage near the south boundary of the north maintenance facility and the north boundary of the condominiums.

A drainage system also runs along the north side of Ballinger Way west of 25th Avenue NE and turns north onto 25th Avenue NE and runs along the west shoulder then crosses the street and outfalls adjacent to the outfall of the 36-inch by 48-inch CMP arch into Ballinger Creek.

There are no tie-ins from the east shown on the RFQ Project Area Map; however, this should be verified.

During construction, this system and side connections will need to be kept operational or bypassed. It is our opinion that using the existing system as the bypass is the most economical and has the least impact. A stream diversion will be required for the open channel regrading downstream of NE 195th Place and for the installation of the box culvert at NE 195th Street in all the alternatives.

Alternative 1 would allow the existing trunk line along the east side of 25th Avenue NE to remain operational during construction and serve as a bypass for work being done on the west side of the street. The high-flow bypass would be blocked at the upstream end, and the box culverts and open channel to the new crossing near the south end of the condominiums could be constructed. It is our opinion that the crossing of 25th Avenue

NE also could be constructed if temporary shoring and a diversion of the existing driveway culvert could be accommodated. The side drains between the north maintenance facility and condominiums could be temporarily diverted to the east trunk line or possibly tied into the new channel within a short period of time. The headwalls at the upstream and downstream box culverts could be installed by isolating the creek from the work area. If the high-flow bypass is taken out of service for an extended time, additional analysis may be needed to determine if a temporary bypass is needed during flood events. The box culvert headwalls at the crossing of 25th Avenue NE will also need to accommodate the existing pipe conveying stormwater from Ballinger Way.

Alternative 2 will require a temporary bypass of the existing 36-inch by 48-inch CMP, since the segment south of NE 195th Place will be replaced by two box culverts and a segment of open channel in the same alignment. Dependent upon flow, the diversion could be extensive, expensive, and time consuming to construct. Existing utilities may also present challenges in determining a route for a diversion pipe or channel.

Alternative 3 is similar to Alternative 1 or 2 downstream of the north maintenance facility. However, the high-flow bypass, or a large portion of it, could be left in service since the new channel meanders west of the existing pipe. The southern portion could be relocated east to facilitate construction of the box culvert between the north maintenance facility and condominiums. Since there is no box culvert or headwalls at the upstream tie in the Ballinger Creek, the cut over of the stream would be fairly simple and of short duration. Alternative 4 is a hybrid of the other three alternatives.

3.3 High Ground Water

The geotechnical report prepared by Terracon for the project shows that groundwater was observed around 2 feet below surface along 25th Avenue NE to approximately 5 feet to 7 feet below the surface at higher ground near NE 195th Street. The ground water elevations recorded in the report are from the drier months of June and July, so it will be a construction issue regardless of the time of the year the work is performed. The geotechnical report concludes that any excavations deeper than 2 feet below surface will require an intensive dewatering effort. The estimated rate of dewatering that may be required ranges from 60 gpm to 250 gpm. If the dewatering is on the high end, then disposal will need to be evaluated for the large quantity of dewatering that will be generated over a few months.

All of the alternatives will require dewatering to construct, particularly to install the culverts and the head walls. If the north maintenance facility is abandoned and utilized as a site to meander the stream and create flood storage, a thorough review of the ground water elevations and proposed grading will be needed. Proposed grading below the ground water elevation may require a more extensive dewatering plan since the area is fairly large. However, the extent of dewatering should be less for Alternative 3 since a portion of the day-lighted creek is proposed to be constructed on the north maintenance facility site and therefore does not require walls for this section

As the project is progressed to the next phase, it is recommended that the geotechnical engineer perform a pump test to help better understand the dewatering effort needed to draw the ground water down 2 feet below the lowest excavation. This will also aid in evaluating dispersal and or disposal options and potential settlement to adjacent structures. Because of settlement concerns, groundwater cutoff walls may be required as part of the dewatering plan.

3.4 Potentially Contaminated Soil and Groundwater

The geotechnical report document investigations conducted on existing site soils and groundwater for potential contamination. Oil and diesel hydrocarbons were detected in bore B-4, and elevated levels of arsenic were found in the groundwater at two of the groundwater monitoring wells at the north maintenance facility.

At bore B-4 the levels of oil and diesel hydrocarbons were below Model Toxic Cleanup Act (MTCA). The bore log notes state that at 3.3 feet below the surface, the soil had an oily feel and a hydrocarbon odor. This bore is located on 25th Avenue NE approximately 50 feet north of Ballinger Way. The material was tested and it is above detectable limits but below MTCA cleanup levels. However, the report states that during excavation additional area could be encountered that may be above MTCA levels. Given that the material felt oily and was detectable by smell, it is likely that higher levels may be encountered. Excavations near the intersection of 25th Avenue NE and Ballinger Way may encounter areas of contaminated soils and it is recommended that additional field investigation be performed as the design progresses to establish the probable perimeter of the potentially contaminated area.

The geotechnical report also discusses sampling of groundwater monitoring wells installed in the north maintenance facility. The total petroleum hydrocarbon (TPH) and volatile organic compounds (VOC) results were below the laboratory method reporting limits (MRLs). Arsenic was detected in both samples; one sample contained 5.7 ug/L, which is slightly above the 5 ug/L MTCA Method A cleanup level that is protective of groundwater as a potable drinking water source. The report states that this is likely due to the background levels of arsenic in the glacially-derived sediment, and does not appear to be an indication of the presence of contaminant released to the environment, based on the lack of other contaminants detected in the sample.

The known presence of these contaminates on a typical roadway project can be mitigated by including the soils and ground water information in the contract. The contract would also include specifications and payment vehicles to remove soils that are above MTCA cleanup levels and to also provide disposal methods for contaminated materials that are below MTCA cleanup levels. It has been our experience that these soils will also need to be disposed of at a permitted site, since most pits and waste sites have adopted a clean soils policy. In other words, if any contaminated material is detected, they will not receive it.

However, this is a flood reduction and environmental project that includes a new stream channel adjacent the roadway and a potential regrading of the north maintenance facility to include a new meandering stream and new floodplain storage. The roadway work is a secondary component of this project. On a recent Pierce County wetland mitigation/stream realignment project that BergerABAM was involved in, contaminated materials were encountered during excavation of the wetland and stream. In consultation with regulatory agencies, and in particular the Department of Ecology, it was determined that all contaminated materials—regardless of whether they were below or above MTCA levels—with any potential for exposure to the stream or groundwater needed be removed until no detection of contaminants were obtained. In addition, any materials above MTCA levels, even if not exposed to groundwater, still needed to be removed. The responsibility to ensure all contaminates on the site were removed belong to Pierce County and the project, with oversite from the regulatory agency. This added substantial cost to the project and also added a groundwater monitoring plan for a minimum of one year. It is our recommendation that additional soil and groundwater testing be conducted in the area of proposed new channels for contaminants. It is also recommended that the project environmental engineer be consulted regarding the extent of contaminated soil, water removal, and treatment in areas where the new channel or floodplain grading is in an area of known contaminates, even if it is below MTCA cleanup levels.

A construction project similar to the City of Shoreline project was designed by BergerABAM, as described in the Wall section below. The high ground water and contaminated soils situation described herein were also part of that project. Our experience recognizes that a collaborative effort is essential for the design team—especially the environmental, drainage, structural, and geotechnical engineers—to evaluate the alternatives and understand the potential impacts from contaminated soils and high ground water in regards to all the disciplines.

3.5 Utilities

The utilities on this project will need to be examined for easements or other encumbrances that would reveal the existence and location of water lines, conduits, sewer lines, drainage, or irrigation lines, etc. Easements that identify other affected ownerships should be considered. Easements and permits should be planned to accommodate activities outside of the right of way, if needed.

The ownership of the utilities, such as Seattle City Light, should be determined in order to make arrangements for necessary adjustments, including relocation of portions of the utility. Obligation of expenses should be considered for relocation and adjustments.

The overhead power lines on this project run on the east side of 25th Avenue NE. There are two affected power poles. These power poles have power, communication, and cable. It is assumed that the power and communication lines may have to be relocated, as the elevation and location of the lines may not allow for safe excavation. The pole across the street from the condominiums has several risers. These risers take overhead power and communications down the pole into the ground. From there, the conduits run west under 25th Avenue NE into the condominiums. Any of the alternatives will require a rerouting or relocation of these conduits since the new channel crosses through them. As the project is progressed, options will need to be evaluated for temporary rerouting so as not to interrupt service to the condominiums.

Another critical utility that needs to be considered during evaluation of alternative improvements is a 66-inch-diameter steel waterline owned by SPU that runs along NE 195th Street. The existing culvert on 195th Street crosses directly underneath the 66-inch waterline. There is also a potential conflict with the existing waterlines on 25th Avenue NE. These lines will have to be located and possibly rerouted prior to excavation.

Alternative 1 plan is believed to have a moderate impact on the power lines. The excavation is primarily on the west side of 25th Avenue NE.

Alternative 2 plan is believed to have an extensive impact on the power lines. The excavation is on the same (east) side of the power lines.

Alternate 3 plan is believed to have a low impact on the power lines. The excavation is through the north maintenance facility property and along the existing building for condominiums.

Alternative 3.2.5 plan is believed to have a low/moderate impact on the power lines. The excavation is through the north maintenance facility property and a portion on the east side. Only one power pole will be affected.

3.6 Local Buildings

There are five general structural building locations along this project that will affect the constructability of the project. The first location is the north maintenance facility on the west side of 25th Avenue NE, on the north end of the project; Alternatives 1 and 2 run parallel with this property, and Alternative 3 runs through this property. This area will be affected in all the alternatives, and the construction techniques vary whether the creek runs along the side of the property or through it, but all are feasible. The second location is the school property on the east side of 25th Avenue NE, on the project's north end, and all the alternatives stay away from this property. The other three building groups are all residential, but with different configurations and impacts.

The local homes built away from 25th Avenue NE, on the west side, between the north maintenance facility and the existing building for condominiums, will have the creek located either under or adjacent to the driveway. In either case, there will be periods of construction where access to this residents is blocked. This is true whether the culvert runs perpendicular under the driveway or skewed to the driveway crossing 25th Avenue NE.

The local homes on the east side of 25th Avenue NE are affected more with Alternative 2, but will have significant impacts with any of the alternatives as the roadway sections are reconstructed and closures are required for the culvert crossing of 25th Avenue NE. Alternative 2 will require additional utility work, as discussed previously, as well as a longer section of the three-sided open channel adjacent to these residents.

The existing building at 19518 25th Avenue NE is for condominiums, and the structure is constructed on the west ROW line of the City property. This complicates the construction of the open three-sided channel in Alternative 1. Additional research is needed to understand the foundation type, size, and location relative to the channel. If possible, it will be beneficial to acquire the geotechnical recommendations for the building construction. This information will aid a geotechnical engineer in evaluating and providing recommendations for wall configurations adjacent to this structure to limit impacts on the building due to settlement. Most walls are designed to resist the lateral loads after the wall deflects enough to engage the passive resistance pressures that hold and stabilize the wall systems. This initial displacement is often acceptable for most transportation projects, but it may not be acceptable when supporting an existing building. The types of walls that are often used in building construction to limit displacements and settlements are soldier pile walls with permanent ground anchors or secant pile walls. These systems are relatively expensive compared with the other wall types proposed for this project and may be avoided with better information on the buildings design and foundation capacity. If it is determined the walls are placed far enough away from the existing building or that settlement of the building is not a concern, it will still be likely that a cantilever soldier pile wall is the only type of wall that can be built adjacent to this building.

3.7 Walls

Walls will be required to create the open channel stretches for all of the creek alignment alternatives. The roadway cross-sections require sidewalks, barriers and handrails, vehicular lanes, and even parking in several locations. There are four main cross-sections for this open channel. Open cuts can be used when the creek meanders through the north maintenance facility (Alternative 3 only) and in the open channel section downstream from NE 195th Place. Open cuts may also be used in in short stretches along 25th Avenue NE and along most of the residential side of the creek paralleling Ballinger Way NE. When walls are required, the type of wall will likely be controlled by construction access, whether open cuts can be made, and what is adjacent to the cut.

As discussed previously, all the walls constructed against the existing building for condominiums will likely be soldier pile or secant pile walls, possibly with permanent ground anchors. Other locations without room to lay back the soil to construct a spread footing for a cast-in-place (CIP) concrete retaining wall, or to lay in the reinforcing straps for a structural earth wall (SEW), will also require a soldier pile wall. SEW walls tend to be less expensive and can accelerate construction with the use of precast fascia panels, but they require the largest footprint for temporary cuts. CIP concrete cantilever walls may utilize special designs to eliminate the heal of the footing and reduce the temporary excavation limits, but CIP concrete takes longer in the construction schedule to complete. All of these wall types will be considered and compared with precast three-sided (open top) culvert sections. There will be project constraints, such as ROW, movement of traffic (MOT), staging limits, utilities, existing structures, etc., that will make some wall types impractical.

An open three-sided channel is proposed along the edge of the north maintenance facility, adjacent to the existing building for condominiums in Alternative 1 and along the residential homes in Alternative 2. It is worth noting that a recent project in the City of Bothell, the Horse Creek Drainage Improvements Project, was designed by BergerABAM and uses several wall types to create an open channel similar to what is being proposed on this project (see Photo 1). The photos show how a traffic barrier and pedestrian fence/railing are used to protect the traveling public and how a vibrant environmentally friendly stream can meander in a dense urban environment.

Photo 1. Example of 3-Sided Open Channel

The walls for the Horse Creek project used sections of SEW wraps with precast panels in some areas, soldier pile cantilever walls with CIP fascia panels in others, and even some CIP cantilever concrete walls were the geometric constraints permitted. A geotechnical engineer will provide recommendations for what wall type are applicable on this project. The adjacent vehicular or building surcharges will also impact the wall selection. Oversized CIP roadway or sidewalk sections are required to transfer the impact forces of the barriers and railings to the wall system. These oversized reinforced roadway/sidewalk/curb sections are often referred to as moment slabs and are relatively expensive to construct. The benefit of these moment slab sections it that they resist the vehicular impact forces on the barrier system, thus reducing the demand and size of structural walls needed and decrease the wall costs. The design loading for the vehicular barriers will be TL-2 loading, based on the local residential traffic using this project area, and this will allow for more aesthetically pleasing barrier shapes as seen in the photo above.

As discussed previously, some utilities will be required to cross these open channel sections. Where possible, these utilities should be routed around the walls. There may be some situations on this project where the utilities will have to be placed underneath the walls and channel, or even across the channel. Crossing the channel requires special coordination with the utility owner and the City to develop a plan that protects the utilities, make the crossing aesthetically pleasing, and ensure safety.

3.8 Buried Culverts

The culverts are assumed to be precast sections with water stops and wraps, as required. This construction methodology is selected to accommodate the high water tables, deep excavations, narrow work areas, and short construction windows where the creek channel is directly impacted (in-water work windows). Where possible, CIP construction may be used, as it is often less expressive than precast, though it takes additional construction time. Several of the driveway locations may utilize the lid of the culvert as the driving surface, or with shallow soil cover; however, this type of construction is not recommended for street crossings with heavier Average Daily Traffic (ADT). There is also an alternative design that utilizes the wall of a three-sided channel to support a driveway slab bridge, but only if a robust wall system is already planned for the driveway location. Headwalls will be required at all the culvert locations, and special details will be required to match the various channel sections that will likely be part of this project. The skewed crossings will also impact the phasing of the road closures. It is recommended that a full closure be used during construction of the culverts under both the 25th Avenue NE and NE 195th Street locations. To accommodate the in-water work windows for this project, both of these closures will likely occur at the same time. See the Maintenance of Traffic Section for more information.

See the Wall Section for a discussion on open top creek channels. These sections are often considered an open culvert and are designed structurally in a similar manner to box culverts in some situations.

3.9 Existing Walls Along Ballinger Way NE

The culvert at NE 95th Street is to be replaced, in all the alternatives, with a 10-foot-wide by 3.5-foot-deep concrete box culvert. The invert profile of the creek channel is being lowered to clear under an existing 66-inch steel waterline that extends along NE 95th Street. There is currently a failing WSDOT gabion basket wall that extends a long way down the creek and supports Ballinger Way NE. A recent project, completed by WSDOT in early 2016, replaced a portion of the gabion wall at the Ballinger Creek and NE 195th

Street culvert outlet that had failed. Excessive material piping occurred in between the gabion wall and the NE 195th Street roadway embankment such that a vertical face of the roadway embankment was completely exposed. The City coordinated with WSDOT on the design and provided input so that the replacement wall could more easily accommodate a future NE 195th Street culvert replacement designed and meet the Washington Department of Fish and Wildlife (WDFW) fish passage criteria. WSDOT completed emergency repairs in October 2016. The replacement wall utilizes drilled soldier pile shafts and steel plates for lagging to straddle the existing culvert and accommodate the future concrete box culvert as seen in Photo 2.

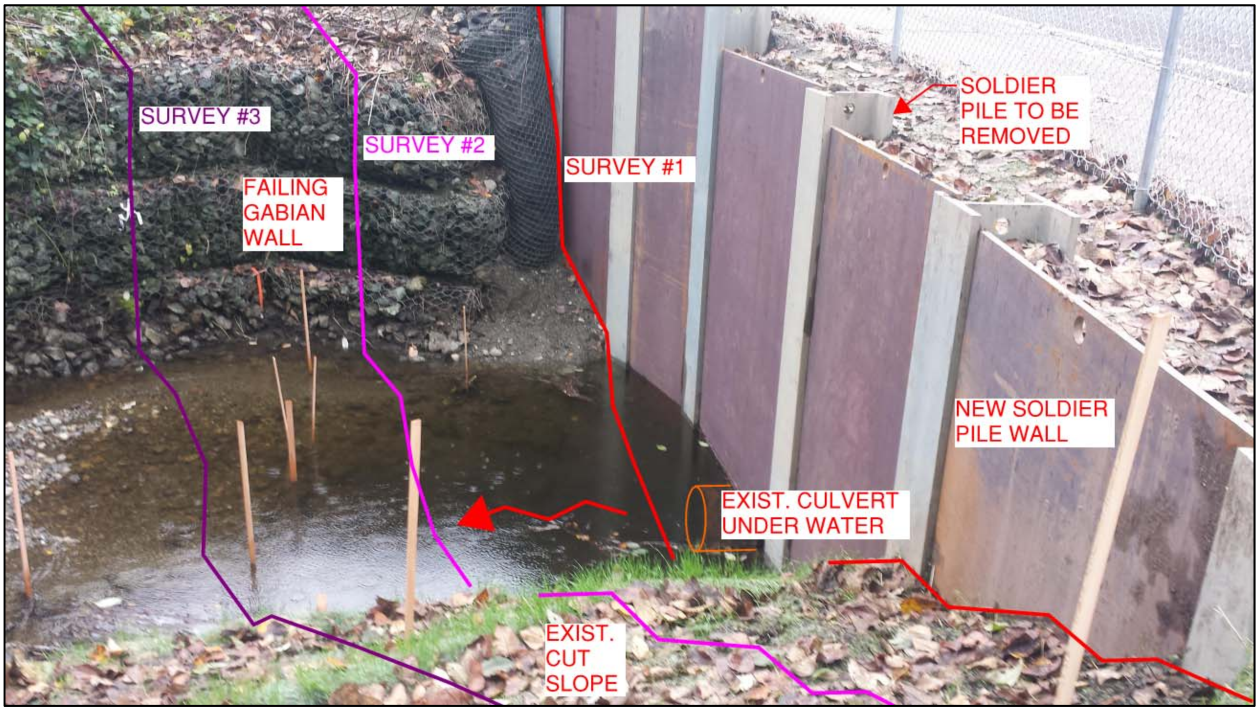


Photo 2. Culvert Outfall and Walls at NE 195th Street

The proposed profile for all the alternatives lowers the culvert depth at NE 195th St. The lowering of the culvert and proposed culvert size will present some major challenges to the City's project because the channel immediately downstream of the culvert has aggraded (raised) the creek bed. The lowered profile will require channel excavation and grading along a significant length of the failing WSDOT gabion basket wall. The three survey lines shown in Photo 2 are recommended to better understand the culvert construction and creek grading impacts on the current channel and walls adjacent to the culvert. Additional survey cross-sections are also recommended further down the creek alignment. The excavation, permanent side slope grade, and temporary construction cuts will have a significant impact on the failing gabion walls. Moving the creek alignment away from the wall may allow the gabion wall repair to be accomplished under a separate WSDOT project, but will add complications with ROW and the newly installed soldier pile wall.

Image 1 is taken from the WSDOT contract for the wall construction (soldier pile type, size, and location need to be verified) and modified to represent the current plan for the new box culvert location. This image shows the approximate amount of excavation required to construct the new box culvert. It also shows the overall geometry of the outfall location with regard to creek alignment and wall location.

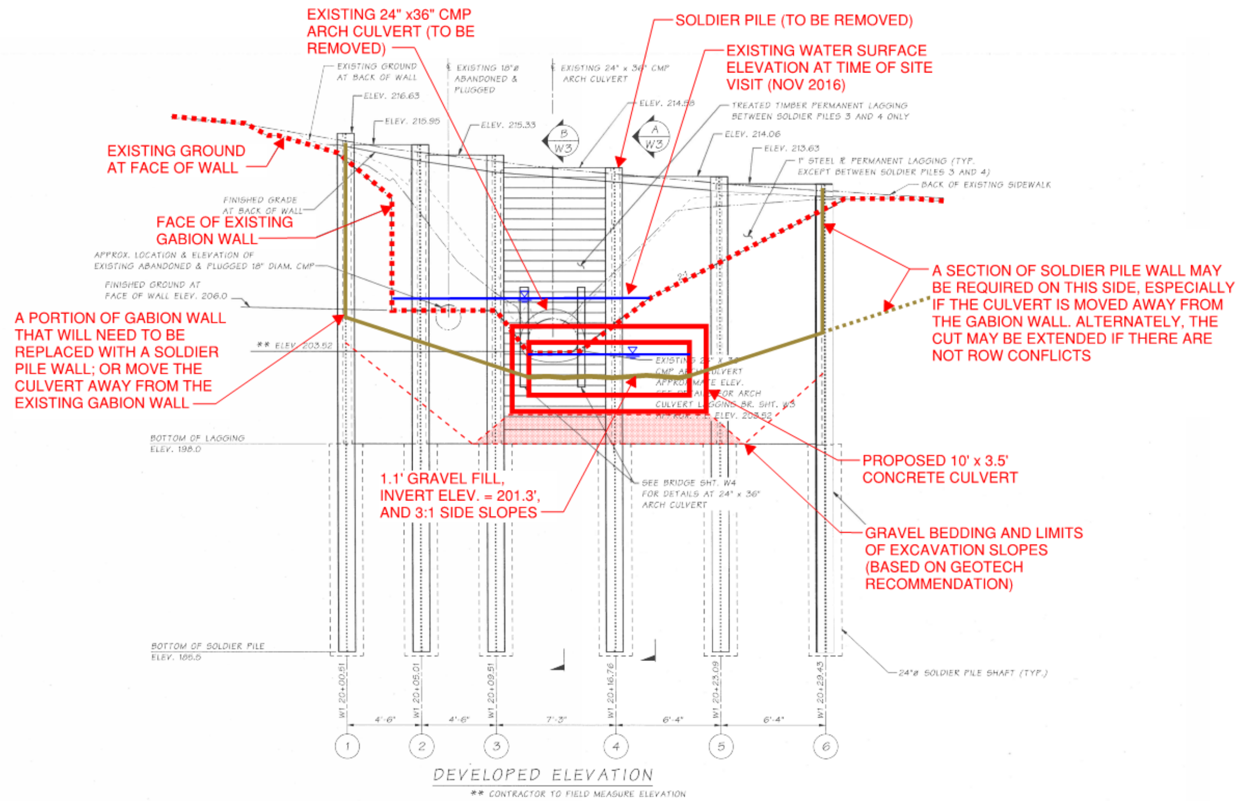


Image 1. WSDOT Wall and Culvert Outfall

The existing rockery near the outfall of the 25th Avenue NE pipe system is over steepened, and it was noted that a few rocks have been dislodged from the slope. Consideration should be given to replacing a portion of the rockery with an extension of the soldier pile wall where it is over steepened and adjacent to the creek. Depending on the permanent slope, easements, construction methods, and final creek alignment, an additional extension of the soldier pile wall may be needed on the opposite side of the creek from the failing gabion wall.

3.10 Maintenance of Traffic

Some of the work zone safety and mobility areas to consider on this project are as follows.

- Accommodations for pedestrian and bicycle traffic
- Consideration for schools, emergency services, and postal delivery
- Parking for the 25th Avenue NE residents
- Work vehicles and equipment in work area

- Notices to residents and businesses
- Driveway access for local residents
- One lane closures on 25th Avenue NE, NE 195th Street, and possibly Ballinger Way
- Staging area for equipment and materials

A short–term stationary work zone should be considered. This work will occupy a location for more than one hour within a single day. At these locations, all devices are placed and removed during the single period, although, "No Parking" signs may need to remain for the duration of the project.

A one-lane closure with a flagger at each end can control work activities at the north end of 25th Avenue NE, or where permitted elsewhere. When the work activities move closer to the intersection, consider a combination of law enforcement and flaggers. One-lane closures on 25th Avenue NE and NE 195th Street may be needed during excavation of the side channels. A one-lane closure may be needed to build the wall on Ballinger Way. In all alternatives, full road closures on 25th Avenue NE and NE 195th Street may be necessary to excavate the culverts.

Depending on which alternative will be used, impacts on street parking will be low to extensive. The driveways need to remain open and maintained for the duration of the project. Limited closures may need to be negotiated with the local residents. It is not known at this time if there are other entrances that can be used for the north maintenance facility and local residents.

If the excavation allows for narrower lanes, two lanes can remain open with proper channelization devices. The lanes can also be shifted onto the shoulders if the existing catch basins allow traffic loads or if those catch basins are modified.

Alternative 1 will have a moderate impact on traffic. The work is in the shoulder in front of the north maintenance facility, the residents further back, and along the building for condominiums. The wall type selected may increase the impacts to Traffic if extra excavation is required into 25th Avenue NE. The driveways will have to remain open and maintained as much as practical. The street parking on the west side cannot remain open during construction if deemed unsafe. The street parking on the east side will have minimal impacts, unless this area is utilized by the contractor for staging equipment and materials.

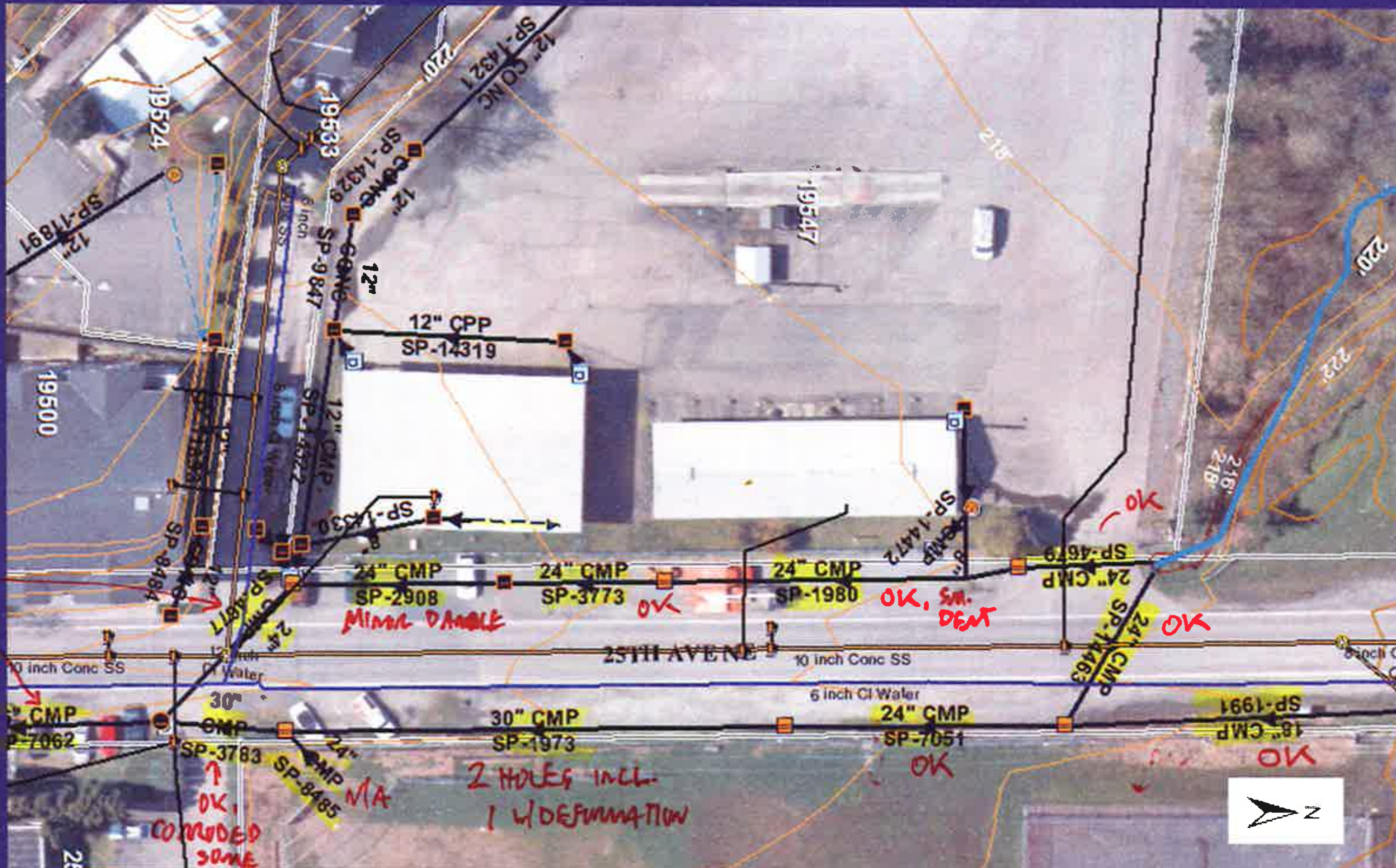
Alternative 2 will have an extensive impact on traffic. The driveways for the north maintenance facility and residents on the east side of 25th Avenue NE will have to remain open and maintained as much as practical. The driveway access and street parking on the west side will have to be closed for an extended period of time.

Alternative 3 will reduce some of the impacts on traffic. The excavation through the north maintenance facility will not impact 25th Avenue NE. The work south of the north maintenance facility will be similar to Alternative 1. Alternative 4 is a hybrid of the other three alternatives.

4.0 SUMMARY

The constructability review identified questions that still need to be vetted in most of the areas discussed. Recommendations for the design team to consider while moving forward with the development of this project are included throughout this memorandum, but no recommendations for a preferred alternative or specific construction methodology is made at this time.

Appendix O
Storm Pipe (CCTV) Inspection Reports



OK - PIPE ARCH MISLABELED AS DEFORMED
SOME CORROSION
(SP-4677, SP-7062, SP-9016

25th Ave NE existing system – north project area

CITY OF SHORELINE

25th Ave NE Flood Reduction Project

25th Ave NE existing system – south project area

CITY OF SHORELINE

25th Ave NE Flood Reduction Project

INNOVATIVE VACUUM SERVICES

Innovac
20909 70th Ave W
Edmonds, WA 98026
Tel: 206-.783.3317
Fax: 206.783.9109
E-mail: service@innovac.com

Inspection Report

Date	P/O. No.	Weather	Surveyor's Name	Pipe Segment Reference	Section No.
10/21/2016		**Light Rain**	**Clayton Northington**	**SP-9319**	**1**
Certificate No.	Survey Customer	System Owner	Date Cleaned	Pre-Cleaning	Sewer Category
U-815-07001018			**10/20/2016**	**Heavy Cleaning**	

Street123	**2518 NE 195th ST**	Use of Sewer	**Stormwater**	Upstream MH	**PI-7**
City	**Shoreline**	Drainage Area		Dowstream MH	**FT-268**
Loc. details		Flow Control	**Bypassed**	Dir. of Survey	**Downstream**
Location Code	**Light highway**	Length surveyed	**60.76 ft**	Section Length	**60.76 ft**

Purpose of Survey	**Maintenance Related**	Joint Length	
Year Laid		Dia./Height	**24 inch**
Year Rehabilitated		Material	**Corrugated Metal Pipe**
Tape / Media No.		Lining Method	

Add. Information :

1:154	Position		Observation	Photo
PI-7	0.00		Water Level, 5 %of cross sectional area	
	0.00		End of Pipe / PI-7	
	4.00	S1	Hole Soil Visible, from 04 to 08 o'clock, within 8 inches of joint: YES, Start	PI-7FT-26824102016_065845.jpg
	45.98	S2	Water Level, Sag in pipe, 5 %of cross sectional area, Start	
	60.76	F1	Hole Soil Visible, from 04 to 08 o'clock, within 8 inches of joint: YES, Finish	PI-7FT-26824102016_070008.jpg
	60.76	F2	Water Level, Sag in pipe, 5 %of cross sectional area, Finish	
FT-268	60.76		End of Pipe / FT-268	

QSR	QMR	SPR	MPR	OPR	SPRI	MPRI	OPRI
5121	**0000**	**7**	**0**	**7**	**3.5**	**0**	**3.5**

INNOVAC
INNOVATIVE VACUUM SERVICES

Innovac
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Edmonds, WA 98026
Tel: 206-.783.3317
Fax: 206.783.9109
E-mail: service@innovac.com

Inspection photos

City :	Street :	Date :	Pipe Segment Reference :	Section No :
Shoreline	**2518 NE 195th ST**		**SP-9319**	**1**

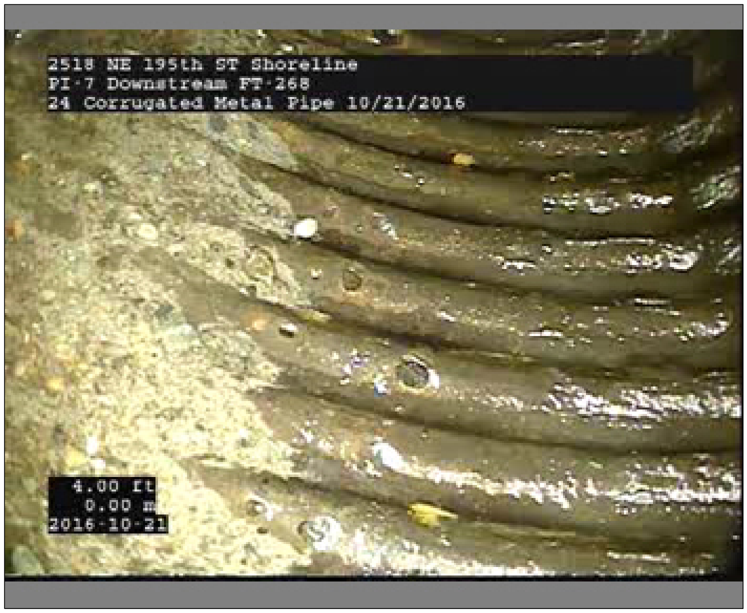

Photo: PI-7FT-26824102016_065845.jpg
4FT, Hole Soil Visible, from 04 to 08 o'clock, within 8 inches of joint: YES, Start

Photo: PI-7FT-26824102016_070008.jpg
60.76FT, Hole Soil Visible, from 04 to 08 o'clock, within 8 inches of joint: YES, Finish

Everson's Econ-Vac
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Orting, WA 98360
econovac.cctv@gmail.com
253 405-1048

EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage Area:	Sheet Number:
Josh Graves 253 405-1048	03-2109				

Work order:	Pipeline Segment Ref:	Start date/time:		Street:	City:
	SP-1973	2014/05/13	09:44	19824 25th Ave NE	Shoreline

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	CB-3313			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow Control:	Height:
CB-3312					D		30

Width:	Shape:	Material:	Ln. Method:	Pipe Joint Length:	Total length:	Length surveyed:	Year Laid:	Year renewed:	Media Label:
	C	CMP				171.9			

Purpose:	Sewer Category:	Pre-Cleaning	Date Cleaned:	Weather:	Location Code:	Additional info:
		N		1		SP-1973

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	11	5132	3.666667	0	0	79	3B2B	2.46875	90	2.571429
2	0	0				17	34					
3	2	6				2	45					
4	0	0				0	0					
5	1	5				0	0					

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EVERSON'S ECONO VAC (253) 848-5250

Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	CB-3313	SP-1973	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	%	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	12	ACB													CB-3313
0.0	28	MWL						20							
14.6	92	IS		S01						3	9				defect wanders
14.9	128	OBR		S02				10		5	7		O&M	2	
44.2	250	IS		F01						3	9				
80.0	292	OBR		F02				10		5	7		O&M	2	
83.4	384	DAE						5		3	6		O&M	2	
83.5	395	IW								3	6		O&M	2	
101.9	466	OBR		S03				10		5	7		O&M	2	
103.8	495	IW								4	8		O&M	2	
123.0	568	H								9			S	3	
123.1	581	ID								8			O&M	3	
128.9	621	IW								3	9		O&M	2	
140.9	670	H								12			S	3	
140.9	685	D						15					S	5	
171.9	823	ACB													CB-3312
171.9	836	OBR		F03				15		5	7		O&M	3	

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(253) 848-5250

PACP Sewer Report

Surveyed by: Josh Graves 253 405-1048
Certificate No: 03-2109
Owner:
Survey Customer
Drainage Area:
Sheet Number:

Work order:
Pipeline Segment Ref: SP-1980
Start date/time: 2014/05/13 12:11
Street: 19824 25th Ave NE
City: Shoreline

Location details:
Upstream manhole No: CB-9171
Rim to invert:
Grade to invert:
Rim to grade:

Downstream manhole No: CB-2700
Rim to invert:
Grade to invert:
Rim to grade:
Sewer use:
Direction: U
Flow Control:
Height: 24

Width:
Shape: C
Material: CMP
Ln. Method:
Pipe Joint Length:
Total length:
Length surveyed: 121.4
Year Laid:
Year renewed:
Media Label:

Purpose:
Sewer Category:
Pre-Cleaning: N
Date Cleaned:
Weather: 1
Location Code:
Additional info: SP-1980

Starting access point:
Easting:
Northing:
Elevation:
Coordinate system:
GPS accuracy:

	Structural						O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	4	4100	4	0	0	7	3122	2.333333	11	2.75
2	0	0				2	4					
3	0	0				1	3					
4	1	4				0	0					
5	0	0				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	CB-9171	SP-1980	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	%	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	16	ACB													CB-2700
0.0	31	MWL						5							
13.4	69	D						5					S	4	small dent
20.6	103	IW								5	7		O&M	2	
80.7	257	IW								3	9		O&M	2	
101.3	354	TBI				8	5			8			O&M	3	
121.4	451	ACB													CB-9171

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage Area:	Sheet Number:
Josh Graves 253 405-1048	03-2109				

Work order:	Pipeline Segment Ref:	Start date/time:		Street:	City:
	SP-1991	2014/05/09	13:19	19824 25th Ave NE	Shoreline

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	CB-544			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow Control:	Height:
CB-9537					U		18

Width:	Shape:	Material:	Ln. Method:	Pipe Joint Length:	Total length:	Length surveyed:	Year Laid:	Year renewed:	Media Label:
	C	CMP				111.2			

Purpose:	Sewer Category:	Pre-Cleaning	Date Cleaned:	Weather:	Location Code:	Additional info:
		N		1		SP-1991

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

	Structural					O&M					Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	0	0000	0	0	0	55	423A	2.75	55	2.75
2	0	0				7	14					
3	0	0				11	33					
4	0	0				2	8					
5	0	0				0	0					

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EVERSON'S ECONO VAC (253) 848-5250

Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/09	CB-544	SP-1991	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	12	ACB													CB-9537
0.0	28	MWL						5							
10.7	56	IS								3	6				
11.7	74	DSGV		S01				20		5	7		O&M	3	
21.5	132	IW								2			O&M	2	
21.5	138	DAE						5		2	6		O&M	2	
30.2	212	IW								3	9		O&M	2	
50.5	281	IR								3	9		O&M	4	
54.2	315	DSGV		F01				20		4	8		O&M	3	
70.4	398	ID								2	10		O&M	3	
70.4	415	DAE						5		2	10		O&M	2	from inflow
90.6	527	IR								2	10		O&M	4	
94.4	572	DSGV						10		5	7		O&M	2	
111.0	638	TBA				8				3					
111.0	648	TBI				8	5			3			O&M	3	
111.0	686	IW								6	10		O&M	2	
111.0	698	DAE						5		6	10		O&M	2	from inflow
111.2	774	MSA													Due to intruding lateral

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PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage Area:	Sheet Number:
Josh Graves 253 405-1048	03-2109				

Work order:	Pipeline Segment Ref:	Start date/time:		Street:	City:
	SP-2908	2014/05/13	11:56	19824 25th Ave NE	Shoreline

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	CB-2701			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow Control:	Height:
CB-9172					D		24

Width:	Shape:	Material:	Ln. Method:	Pipe Joint Length:	Total length:	Length surveyed:	Year Laid:	Year renewed:	Media Label:
	C	CMP				71.1			

Purpose:	Sewer Category:	Pre-Cleaning	Date Cleaned:	Weather:	Location Code:	Additional info:
		N		1		SP-2908

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

		Structural					O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	16	5232	4	0	0	11	3124	2.2	27	3
2	0	0				4	8					
3	2	6				1	3					
4	0	0				0	0					
5	2	10				0	0					

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EVERSON'S ECONO VAC (253) 848-5250

Surveyed by: Josh Graves 253 405-1048

Owner:

Start date/time: 2014/05/13

Upstream manhole No: CB-2701

Pipeline Segment Ref: SP-2908

Sheet Number:

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	%	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	43	ACB													CB-2701 is not a catch basin - it is a hole cut in top of pipe with a lid on it
0.0	49	MWL						10							
1.8	83	IW								3	6		O&M	2	
16.1	147	HSV								2			S	5	
17.0	186	IW								6	9		O&M	2	
17.3	209	B								9			S	3	
22.3	270	IW								8			O&M	2	
22.3	277	DSZ						20		4	8		O&M	3	storm solids and sticks
32.0	335	RPP								12	2				broken pipe covered with metal patch
43.7	416	D						15					S	5	dent in pipe
44.7	446	H								12			S	3	3 small holes in dented area of pipe
62.2	516	IW								8			O&M	2	
71.1	572	ACB													CB-9172

Everson's Econ-Vac
14023 131st St E
Orting, WA 98360
econovac.cctv@gmail.com
253 405-1048

PACP Sewer Report

Surveyed by: Josh Graves 253 405-1048
Certificate No: 03-2109
Owner:
Survey Customer
Drainage Area:
Sheet Number:

Work order:
Pipeline Segment Ref: SP-3773
Start date/time: 2014/05/13 11:47
Street: 19824 25th Ave NE
City: Shoreline

Location details:
Upstream manhole No: CB-2700
Rim to invert:
Grade to invert:
Rim to grade:

Downstream manhole No: CB-2701
Rim to invert:
Grade to invert:
Rim to grade:
Sewer use:
Direction: D
Flow Control:
Height: 24

Width:
Shape: C
Material: CMP
Ln. Method:
Pipe Joint Length:
Total length:
Length surveyed: 58.4
Year Laid:
Year renewed:
Media Label:

Purpose:
Sewer Category:
Pre-Cleaning: N
Date Cleaned:
Weather: 1
Location Code:
Additional info: SP-3773

Starting access point:
Easting:
Northing:
Elevation:
Coordinate system:
GPS accuracy:

	Structural						O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	0	0000	0	0	0	4	2200	2	4	2
2	0	0				2	4					
3	0	0				0	0					
4	0	0				0	0					
5	0	0				0	0					

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Orting, WA 98360
econovac.cctv@gmail.com
253 405-1048

Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	CB-2700	SP-3773	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	11	ACB													CB-2700
0.0	23	MWL						5							
20.3	74	IW								3	6		O&M	2	
40.4	135	IW								4	8		O&M	2	
58.4	215	ACOM													CB-2701 is not a catch basin - it is a hole cut in top of pipe with a lid on it

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Orting, WA 98360
econovac.cctv@gmail.com
253 405-1048

PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage Area:	Sheet Number:
Josh Graves 253 405-1048	03-2109				

Work order:	Pipeline Segment Ref:	Start date/time:		Street:	City:
	SP-3783	2014/05/13	10:18	19824 25th Ave NE	Shoreline

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	CB-3312			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow Control:	Height:
MH-59					D		30

Width:	Shape:	Material:	Ln. Method:	Pipe Joint Length:	Total length:	Length surveyed:	Year Laid:	Year renewed:	Media Label:
	C	CMP				39.3			

Purpose:	Sewer Category:	Pre-Cleaning	Date Cleaned:	Weather:	Location Code:	Additional info:
		N		1		SP-3783

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

	Structural					O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	21	3700	3	0	0	10	2500	2	31	2.583333
2	0	0				5	10					
3	7	21				0	0					
4	0	0				0	0					
5	0	0				0	0					

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253 405-1048

Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	CB-3312	SP-3783	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	12	ACB													CB-3312
0.0	25	MWL						10							
2.0	157	SCP		S02						4	8		S	3	
2.4	67	OBR		S01				10		4	8		O&M	2	
24.9	134	OBR		F01				10		4	8		O&M	2	
39.3	298	SCP		F02						4	8		S	3	
39.3	305	AMH													MH-59

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Field	Value
Surveyed by:	Josh Graves 253 405-1048
Certificate No:	03-2109
Owner:	
Survey Customer	
Drainage Area:	
Sheet Number:	
Work order:	
Pipeline Segment Ref:	SP-4677
Start date/time:	2014/05/13 11:24
Street:	19824 25th Ave NE
City:	Shoreline
Location details:	
Upstream manhole No:	CB-9172
Rim to invert:	
Grade to invert:	
Rim to grade:	
Downstream manhole No:	MH-59
Rim to invert:	
Grade to invert:	
Rim to grade:	
Sewer use:	
Direction:	U
Flow Control:	
Height:	24
Width:	
Shape:	C
Material:	CMP
Ln. Method:	
Pipe Joint Length:	
Total length:	
Length surveyed:	62.2
Year Laid:	
Year renewed:	
Media Label:	
Purpose:	
Sewer Category:	
Pre-Cleaning	N
Date Cleaned:	
Weather:	1
Location Code:	
Additional info:	SP-4677

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

	Structural					O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	96	5A3A	4	0	0	6	3200	3	102	3.923077
2	0	0				0	0					
3	12	36				2	6					
4	0	0				0	0					
5	12	60				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	CB-9172	SP-4677	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	16	AMH													MH-59
0.0	36	MWL						15							
2.0	60	D		S01				15					S	5	Oval
2.0	85	SCP		S02						4	8		S	3	
2.0	134	DAE						15		4	8		O&M	3	
28.6	250	OBM						15		5	7		O&M	3	piece of concrete pipe
62.1	461	D		F01				15					S	5	Oval
62.1	461	SCP		F02						4	8		S	3	
62.2	428	ACB													CB-9172

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Field	Value
Surveyed by:	Josh Graves 253 405-1048
Certificate No:	03-2109
Owner:	
Survey Customer	
Drainage Area:	
Sheet Number:	
Work order:	
Pipeline Segment Ref:	SP-4679
Start date/time:	2014/05/13 12:29
Street:	19824 25th Ave NE
City:	Shoreline
Location details:	
Upstream manhole No:	NC-252
Rim to invert:	
Grade to invert:	
Rim to grade:	
Downstream manhole No:	CB-9171
Rim to invert:	
Grade to invert:	
Rim to grade:	
Sewer use:	
Direction:	U
Flow Control:	
Height:	24
Width:	
Shape:	C
Material:	CMP
Ln. Method:	
Pipe Joint Length:	
Total length:	
Length surveyed:	46.8
Year Laid:	
Year renewed:	
Media Label:	
Purpose:	
Sewer Category:	
Pre-Cleaning	N
Date Cleaned:	
Weather:	1
Location Code:	
Additional info:	SP-4679

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

		Structural				O&M					Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0				0	0					
2	1	2				0	0					
3	0	0	2	2100	2	0	0	0	0000	0	2	2
4	0	0				0	0					
5	0	0				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	NC-252	SP-4679	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	15	ACB													CB-9171
0.0	32	MWL						5							
21.7	83	CL								12			S	2	
46.8	164	AEP													NC-252 open ditch

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage Area:	Sheet Number:
Josh Graves 253 405-1048	03-2109				

Work order:	Pipeline Segment Ref:	Start date/time:		Street:	City:
	SP-7051	2014/05/13	09:27	19824 25th Ave NE	Shoreline

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	CB-9537			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow Control:	Height:
CB-3313					U		24

Width:	Shape:	Material:	Ln. Method:	Pipe Joint Length:	Total length:	Length surveyed:	Year Laid:	Year renewed:	Media Label:
	C	CMP				96.6			

Purpose:	Sewer Category:	Pre-Cleaning	Date Cleaned:	Weather:	Location Code:	Additional info:
		N		1		SP-7051

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

	Structural					O&M					Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	0	0000	0	0	0	8	2400	2	8	2
2	0	0				4	8					
3	0	0				0	0					
4	0	0				0	0					
5	0	0				0	0					

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EVERSON'S ECONO VAC (253) 848-5250

Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	CB-9537	SP-7051	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	%	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	14	ACB													CB-3313
0.0	25	MWL						15							
7.2	83	IS								8					
38.9	195	IW								8			O&M	2	
55.2	248	IW								4	8		O&M	2	
64.0	293	TBA				6				2					
64.1	310	DAE						10		3	6		O&M	2	
81.5	380	OBR						10		5	7		O&M	2	
96.6	459	ACB													CB-9537

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PACP Sewer Report

Surveyed by: Josh Graves 253 405-1048
Certificate No: 03-2109
Owner:
Survey Customer
Drainage Area:
Sheet Number:

Work order:
Pipeline Segment Ref: SP-7062
Start date/time: 2014/05/13 10:50
Street: 19824 25th Ave NE
City: Shoreline

Location details:
Upstream manhole No: MH-59
Rim to invert:
Grade to invert:
Rim to grade:

Downstream manhole No: MH-342
Rim to invert:
Grade to invert:
Rim to grade:
Sewer use:
Direction: D
Flow Control:
Height: 36

Width:
Shape: C
Material: CMP
Ln. Method:
Pipe Joint Length:
Total length:
Length surveyed: 104.6
Year Laid:
Year renewed:
Media Label:

Purpose:
Sewer Category:
Pre-Cleaning: N
Date Cleaned:
Weather: 1
Location Code:
Additional info: SP-7062

Starting access point:
Easting:
Northing:
Elevation:
Coordinate system:
GPS accuracy:

		Structural					O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	100	5C00	5	0	0	0	0000	0	100	5
2	0	0				0	0					
3	0	0				0	0					
4	0	0				0	0					
5	20	100				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	MH-59	SP-7062	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	11	AMH													MH-59
0.0	27	MWL						15							
4.5	81	D		S01				15					S	5	Oval
104.0	439	D		F01				15					S	5	
104.6	396	ACB													MH-342

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage area:	Sheet number:
John Brent 253-405-1592	06021414				

Work order:	Pipeline segment ref:	Start date/time:		Street:	City:
	SP-8485	2014/07/25	08:24	2502 NE 195TH PL	SHORELINE

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	FIELD			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow control:	Height:
CB-3312					U		12

Width:	Shape:	Material:	Ln. method:	Pipe joint length:	Total length:	Length surveyed:	Year laid:	Year renewed:	Media label:
24	O	CMP				9.6			

Purpose:	Sewer category:	Pre-cleaning	Date cleaned:	Weather:	Location code:	Additional info:
		N		1		SP-8485

Starting access point:	Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

		Structural					O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	0	0000	0	0	0	0	0000	0	0	0
2	0	0				0	0					
3	0	0				0	0					
4	0	0				0	0					
5	0	0				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline segment ref:	Sheet number:
John Brent 253-405-1592		2014/07/25	FIELD	SP-8485	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	Value S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	Value %	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	19	ACB													CB-3312
0.0	41	MWL						10							
9.6	57	MMC													CMP TO CP
9.6	57	MSA													UNABLE TO COMPLETE DUE TO MATERIAL CHANGE

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Surveyed by: Josh Graves 253 405-1048
Certificate No: 03-2109
Owner:
Survey Customer
Drainage Area:
Sheet Number:

Work order:
Pipeline Segment Ref: SP-9016
Start date/time: 2014/05/13 11:06
Street: 19824 25th Ave NE
City: Shoreline

Location details:
Upstream manhole No: MH-342
Rim to invert:
Grade to invert:
Rim to grade:

Downstream manhole No: JO5323
Rim to invert:
Grade to invert:
Rim to grade:
Sewer use:
Direction: D
Flow Control:
Height: 36

Width:
Shape: C
Material: CMP
Ln. Method:
Pipe Joint Length:
Total length:
Length surveyed: 62.0
Year Laid:
Year renewed:
Media Label:

Purpose:
Sewer Category:
Pre-Cleaning: N
Date Cleaned:
Weather: 1
Location Code:
Additional info: SP-9016

Starting access point:
Easting:
Northing:
Elevation:
Coordinate system:
GPS accuracy:

	Structural					O&M					Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	84	4A3A	3.5	0	0	0	0000	0	84	3.5
2	0	0				0	0					
3	12	36				0	0					
4	12	48				0	0					
5	0	0				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	MH-342	SP-9016	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	%	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	15	AMH													MH-342
0.0	27	MWL						15							
2.0	47	D		S01				10					S	4	Oval
2.0	93	SCP		S02						4	8		S	3	
61.9	227	ADP													JO5323 - Outfall to open ditch
62.0	289	D		F01				10					S	4	Oval
62.0	289	SCP		F02						4	8		S	3	

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PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage area:	Sheet number:
John Brent 253-405-1592	06021414				

Work order:	Pipeline segment ref:	Start date/time:		Street:	City:
	SP-14463	2014/07/18	12:27	19553 25TH AVE NE	SHORELINE

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	91622			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow control:	Height:
CB-9537					U		24

Width:	Shape:	Material:	Ln. method:	Pipe joint length:	Total length:	Length surveyed:	Year laid:	Year renewed:	Media label:
	C	CMP				61.0			

Purpose:	Sewer category:	Pre-cleaning	Date cleaned:	Weather:	Location code:	Additional info:
		N		1		SP-14463

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

	Structural					O&M				Overall Pipe	
Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	0	0000	0	0	0	8	2400	2	8	2
2	0	0				4	8					
3	0	0				0	0					
4	0	0				0	0					
5	0	0				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline segment ref:	Sheet number:
John Brent 253-405-1592		2014/07/18	91622	SP-14463	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor	Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	2nd	%	Joint	Circumferential Location At/From	to	Image Ref.	Family	Rating	Remarks
0.0	20	ACB													CB-9537
0.0	33	MWL						10							
22.0	82	DAE						5		3	6		O&M	2	
25.1	126	IW								10			O&M	2	
29.1	153	IW								10			O&M	2	
41.9	191	DAE						5		4	5		O&M	2	
61.0	240	AEP													91622

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EVERSON'S ECONO VAC (253) 848-5250

PACP Sewer Report

Surveyed by:	Certificate No:	Owner:	Survey Customer	Drainage Area:	Sheet Number:
Josh Graves 253 405-1048	03-2109				

Work order:	Pipeline Segment Ref:	Start date/time:		Street:	City:
	SP-14463	2014/05/13	06:26	19824 25th Ave NE	Shoreline

Location details:	Upstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:
	Ditch			

Downstream manhole No:	Rim to invert:	Grade to invert:	Rim to grade:	Sewer use:	Direction:	Flow Control:	Height:
CB-9537					U		24

Width:	Shape:	Material:	Ln. Method:	Pipe Joint Length:	Total length:	Length surveyed:	Year Laid:	Year renewed:	Media Label:
	C	CMP				61.4			

Purpose:	Sewer Category:	Pre-Cleaning	Date Cleaned:	Weather:	Location Code:	Additional info:
		N		1		

Starting access point:

Easting:	Northing:	Elevation:	Coordinate system:	GPS accuracy:

Grade	Amount of Structural Defects	Structural Segment Grade	Structural Pipe Rating	Structural Quick Rating	Structural Pipe Rating Index	Amount of O&M Defects	O&M Segment Grade	O&M Pipe Rating	O&M Quick Rating	O&M Pipe Rating Index	Overall Pipe Rating	Overall Pipe Rating Index
1	0	0	0	0000	0	0	0	14	2700	2	14	2
2	0	0				7	14					
3	0	0				0	0					
4	0	0				0	0					
5	0	0				0	0					

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Surveyed by:	Owner:	Start date/time:	Upstream manhole No:	Pipeline Segment Ref:	Sheet Number:
Josh Graves 253 405-1048		2014/05/13	Ditch	SP-14463	

Distance (Feet) (Meters)	Video Ref.	Group/ Descriptor Modifier/ Severity	Continuous Defect	S/M/L	Value Inches (mm) 1st	Value Inches (mm) 2nd	%	Joint	Circumferential Location At/From	Circumferential Location to	Image Ref.	Family	Rating	Remarks
0.0	24	ACB												CB-9537
22.5	95	DAE					5		2	6		O&M	2	
22.5	105	IW	S01						12	12		O&M	2	defect wanders
30.7	201	IW	F01						12	12		O&M	2	Defect wanders
42.5	252	IW							3	9		O&M	2	
46.6	270	IW							7	10		O&M	2	
54.8	310	IW							2	10		O&M	2	
58.9	329	IW							7	10		O&M	2	
61.4	354	AEP												Stop at open ditch - inlet 50% blocked with vegetation

Appendix P
Aldercrest Annex Memo

July 12, 2017

Mr. John Featherstone, P.E.
Project Manager
City of Shoreline
17500 Midvale Avenue North
Shoreline, WA 98133-4905

Subject: **25th Avenue NE Flood Reduction Project, Phase 1 (Pre-Design)**
Feasibility Assessment of Daylighting Ballinger Creek at Aldercrest Annex Site

Dear John:

The City requested that Louis Berger conduct a high level assessment of the additional costs and land area that would be required to daylight Ballinger Creek on the east side of 25th Avenue NE within the Shoreline School District's Aldercrest Annex Site, under the assumption that daylighting improvements constructed under the 25th Avenue NE Flood Reduction Project could also provide stormwater mitigation (detention and treatment) for future redevelopment at the Aldercrest Annex property. Inclusion of a stormwater mitigation facility under the City's project could potentially incentivize the District to allow the City to use a small portion of the western periphery of the property to daylight Ballinger Creek.

Executive Summary

A combined wet pond and detention pond facility is the preferred concept due to minimal footprint size of this facility type compared with other options. Daylighting Ballinger Creek and providing stormwater management facilities for potential intensive future redevelopment of the Aldercrest Annex site would require 2.1 acres (or 13% of the total property), allowing the remaining 14.1 acres (87% of the total property) for other uses.

Providing Aldercrest Annex Stormwater Mitigation facilities are expected to cost approximately $570,000 for design and construction. This amount is in addition to the 25th Avenue NE Flood Reduction Project regular costs, generally for daylighting Ballinger Creek and installing several box culverts.

The additional costs for Aldercrest Annex Stormwater Mitigation facilities may be offset at least partially by cost savings compared to other alternatives. For example, daylighting Ballinger Creek within the City's North Maintenance Facility (NMF) site could encounter contaminated soils and associated cleanup costs. Avoidance of such cleanup costs associated with the NMF site could make the Aldercrest Annex alternative more cost-competitive in spite of the stormwater pond costs.

Scope of Assessment

The scope of work for this assessment was approved by the City on May 12, 2017. The scope of work includes the following:

- Perform a high level analysis to estimate the cost and land area that would be required to provide stormwater mitigation for the potential future redevelopment of the Aldercrest Annex Site. The extent of potential redevelopment shall be estimated based on three comparable school district sites; (1) Shoreline Stadium at 18560 1st Ave NE, (2) Einstein Middle School, and (3) Kellogg Middle School. Shoreline Stadium was included because the District may be interested in relocating that facility due to the existing stadium's proximity to the future 185th Street Light Rail station; the two middle schools were included given that the Aldercrest Annex is a former middle school site and in the long-term future the District may presumably wish to reconstruct a similarly-sized school at this site.
- Based upon assumed future redevelopment of the Aldercrest Annex site, stormwater mitigation facilities (detention and stormwater quality treatment) shall be sized using a continuous simulation hydrologic model such as WWHM or MGSFlood per Department of Ecology requirements. Sizing analysis shall assume forested conditions for the predeveloped model (i.e., assuming that the District must comply with the City's Ecology-based site stormwater management requirements for redevelopment). Louis Berger shall consider providing the detention storage as "floodplain storage" associated with potential Ballinger creek daylighting being considered as part of the 25th Avenue Flood Reduction project if possible. Additionally, Louis Berger shall assess options for providing stormwater quality (basic) treatment of stormwater as part of the site mitigation.
- Based on the analysis results, prepare a schematic plan of the daylighted channel and stormwater mitigation facilities and cost estimate. The cost estimate should include the additional costs (calculated separately) to provide stormwater mitigation for the Aldercrest Annex site. The costs for a daylighted stream approach utilizing the Aldercrest Annex property are assumed to be generally analogous to costs developed under the 25th Avenue NE Flood Reduction Project Draft Pre-Design Report Alternative 3-2 for daylighting Ballinger Creek across the street on the west side of 25th Avenue NE within the NMF site.

Analysis and Results

Potential future redevelopment of the Aldercrest Annex site was estimated by considering a similar level of development for the three developed school district properties listed above. Based on a rough analysis of aerial imagery, the three sites were determined to have an average of approximately 60.5% percent impervious surface coverage:

Site	Total Area (ac)	Impervious Area (ac)	% Impervious
Shoreline Stadium	12.66	5.92	46.8%
Einstein MS	12.4	10.37	83.6%
Kellogg MS	20.92	10.69	51.1%
Average	15.33	8.99	60.5%

The Aldercrest Annex site has a total area of about 16.2 acres. Assuming that the Aldercrest Annex property could undergo future redevelopment at a similar density (i.e., 60.5%), the site would include an estimated 9.8 acres of impervious surfaces, with the remainder assumed to be pervious surfaces such as grass and landscaping. This appeared to be a reasonable – if somewhat conservative – estimate of the potential future redevelopment conditions at the Aldercrest Annex site. The Western Washington Hydrology Model (WWHM) was used to model the pre-developed (forested) and developed conditions in order to initially size stormwater detention volumes for the developed site. The model was also used to assess the water quality treatment requirements. Three options were generally considered as described below:

- Option 1 - Floodplain Storage Approach: Apply the required detention storage volume for the Aldercrest Annex to "floodplain storage" area adjacent to the new daylighted channel. Floodplain storage is a concept of creating new channel storage that is integrated into the creek floodplain above its low flow channel that provides attenuating storage and helps reduce downstream peak flows. Based on the WWHM modeling, approximately 5 acre-feet of detention storage would be necessary. To be effective as floodplain storage this volume would need to be integrated into the future daylighted Ballinger Creek floodplain at a relatively shallow depth (about 2.4 feet) in order to match the projected water surface elevations of the creek (i.e., equivalent storage would be provided within the range of stream elevations between the low flow and 100-year water surface elevation (WSE)). Distributing the required storage volume over this depth requires a bottom area (including the daylighted channel) of about 3 acres and a top area 3.3 acres (approximately 20% of the total property area for Aldercrest Annex). Because site runoff would also require treatment prior to entering the floodplain storage area, a separate stormwater treatment system (such as a wetpond or stormwater wetland) would be needed, requiring additional area. Combining this floodplain storage area plus a separate water quality treatment facility would take up a large percentage of the site which would presumably be undesirable to the District. Due to this apparent infeasibility, further analysis was not performed for this option to determine the additional area that would be required for treatment.
- Option 2 – Constructed Wetland and Detention Pond: Provide stormwater mitigation using a combined constructed wetland and detention pond separated from the future Ballinger Creek daylighted channel with a berm. The advantage of a separated facility (compared with Option 1 - floodplain storage) is that it allows for greater storage depth and accordingly a smaller facility footprint. Per Ecology requirements for a constructed wetland, the facility would be comprised of two cells: a pre-settling cell and a wetland cell. The pre-settling cell could have a depth of 4 to 8 feet and contain 33% of the storage volume. The wetland cell would have an average depth of 1.5 feet and account for the remaining 67% of the storage volume. An initial layout of this option was created and (while having a smaller footprint than the floodplain storage option) at 2.3 acres or 14% of the total property area, it is likely too large to be desirable to the District, assuming more compact options are available.
- Option 3 – Combined Wet Pond and Detention Pond: Provide stormwater mitigation using a combined wet pond and detention pond separated from the daylighted channel with a berm. The

combined detention pond and wet pond approach is similar to using a more conventional detention pond while providing additional “dead storage” for treatment. Dead storage is a volume of “standing water” within the facility which does not drain between storm events. The advantage of this option over the combined constructed wetland and detention pond (Option 2) it that it allows for a deeper facility and thus a more efficient use of space. The detention portion was sized assuming a 6 foot effective depth (including 1 foot of freeboard) contained within a berm. This option would have the smallest stormwater management facility footprint of about 1.8 acres (11% of the total property) and thus is the preferred option to maximize usable area of the Aldercrest Annex site.

Based upon the Option 3 combined wet pond and detention pond concept, a preliminary sketch was developed and is attached as Figure 1. Due to the high-level nature of this assessment a number of assumptions were made in the analysis:

- Stormwater pond sizing is based on a maximum 9.8 acres of impervious future redevelopment at the Aldercrest Annex site. For any redevelopment concept with significantly less impervious surface, a significantly smaller stormwater pond could be used.
- It is assumed that the Aldercrest Annex would still need to comply with Ecology’s Minimum Requirement #5 (On-site Stormwater Management) and that the District would bear this cost separately. The analysis does not account for some potential minor reductions in stormwater pond size resulting from use dispersed on-site stormwater management facilities such as LID features to satisfy MR #5.
- The analysis assumes rooftop drainage will not be separated from pollution generating impervious surfaces and water quality treatment is required for the combined flows.
- The analysis assumes an available area for daylighting the Ballinger Creek channel approximately 50 feet wide and 300 feet long between the east side of 25th Avenue NE right-of-way and the western toe of stormwater pond berm. This space would allow for some meandering and habitat features for the daylighted Ballinger Creek; however a much smaller floodplain storage area is available compared to the Alternative 3-2 concept for the NMF site.

Overall it is estimated that approximately 2.1 acres (13% of the total property) could provide sufficient space for both daylighting Ballinger Creek and providing stormwater management facilities for intensive redevelopment of the Aldercrest Annex site.

Based on the analysis and schematic of Option 3 – Combined Wet Pond and Detention Pond, a cost estimate (see attached) was developed to determine the additional cost of providing stormwater mitigation for future redevelopment of the Aldercrest Annex site as compared to daylighting and constructing floodplain storage within the NMF site (Alternative 3-2 from the 25th Avenue NE Flood Reduction Project Draft Pre-Design Report). Costs for Alternative 3-2 were updated for daylighting along east side of 25th Avenue NE within District property, and an added cost schedule was developed for the Aldercrest Annex stormwater mitigation facilities.

The costs for the Aldercrest Annex stormwater mitigation facilities include construction of the detention/wet pond, control structure, some planting, access road, and a trail amenity which would connect the upper portions of school property to 25th Avenue NE (by going around the pond), as well as all associated costs such as design, permitting, and construction management. The cost estimate does not include land cost, assuming that the 50 foot wide daylighting area east of 25th Avenue NE would be made available to the City for creek daylighting usage in exchange for the stormwater mitigation pond.

A comparison of costs between Alternative 3-2 and the alternative of daylighting the creek within the Aldercrest Annex was then performed and is shown below:

Project Element (Schedule)	Alternative 3-2 (adjusted from Draft Pre-Design Report, see discussion below)	Alternative to daylight Ballinger Creek within Aldercrest Annex and provide stormwater mitigation for property redevelopment
Schedule A (NE 195th Street and Downstream Improvements) – [NO CHANGE]	$2.24 Million	$2.24 Million
Schedule B (25th Avenue NE Improvements)	$4.04 Million	$3.79 Million
[NEW] Schedule C (Aldercrest Annex Stormwater Mitigation)	$0 [Not Applicable]	$0.57 Million
Total	$6.3 Million	$6.6 Million

Thus, a high-level cost estimate for the net increase above Alternative 3-2 for locating the daylighted Ballinger Creek channel on the east side of 25th Avenue NE if costs are added to provide stormwater mitigation for the Aldercrest Annex site would be about $300,000.

One note about the cost comparison is that the cost estimate for Alternative 3-2 was updated from the draft Pre-design Report based upon subsequent geotechnical investigations within the NMF site. The draft Pre-design report included a cost contingency for special handling and disposal of contaminated soil because prior investigations had found some areas of contamination. The subsequent geotechnical investigations included a series of shallow borings and testing for contaminated materials. While some contaminated soils were found, it was less extensive than assumed for the cost contingency in the draft Pre-Design report. The cost estimate for Alternative 3-2 was therefore reduced to reflect an assumption that less contaminated materials would be found during excavation. The updated cost for Alternative 3-2 with this assumption is included as an attachment.

Please call if you have any questions at (206) 453-1549.

Sincerely,

Mike Giseburt, P.E.
Senior Project Manager

MSG/atoEnclosure

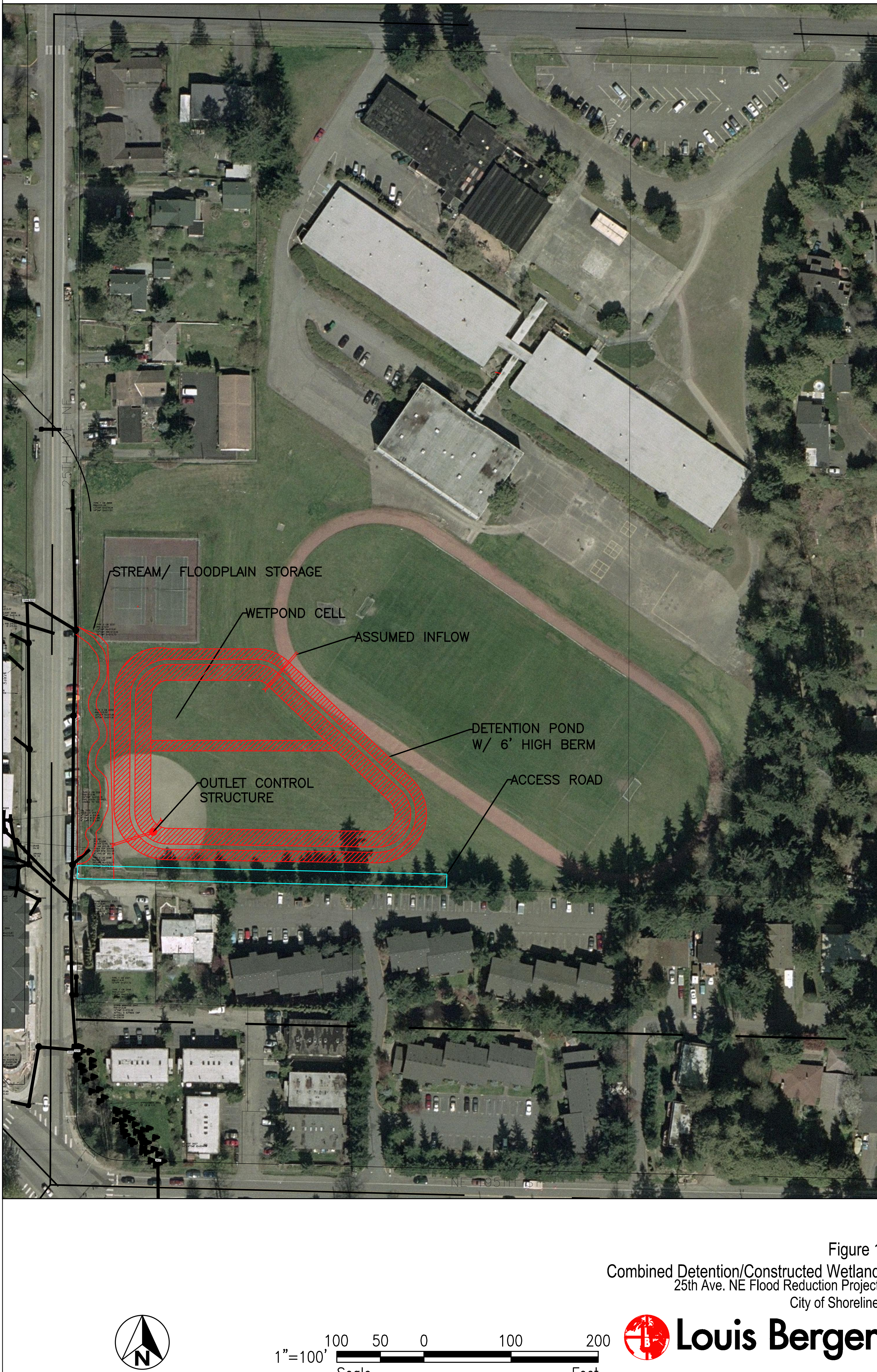

Figure 1
Combined Detention/Constructed Wetland
25th Ave. NE Flood Reduction Project
City of Shoreline

Louis Berger

Table 1. Planning Level Design, Permitting, and Construction Cost Estimate for Aldercrest Annex Detention Facility

SCHEDULE A: NE 195TH STREET						
1	MOBILIZATION (10%)	1	LS	$107,000	$107,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (5%)	1	LS	$40,000	$40,000	Assume access to residences maintained during construction
3	SURVEYING	1	LS	$20,000	$20,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVE ASPHALT CONC. PAVEMENT	164	SY	$18	$2,952	
7	REMOVE CURB AND GUTTER	45	LF	$12	$540	
8	REMOVE SIDEWALK	35	SY	$20	$700	
9	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$20,000	$20,000	
10	EMBANKMENT COMPACTION	908	CY	$4	$3,631	
11	GRAVEL BORROW INCL HAUL	908	CY	$30	$27,233	
12	CHANNEL EXCAVATION	464	CY	$25	$11,595	
13	STRUCTURE EXCAVATION CLASS B INCL. HAUL	1221	CY	$30	$36,630	
14	SHORING OR EXTRA EXCAVATION CLASS B	854	SF	$10	$8,540	
15	9' W x 3.6' H x61'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$132,000	$132,000	
16	WING WALLS	1050	SF	$50	$52,500	
17	CRUSHED SURFACING TOP COURSE	120	TN	$35	$4,199	2" FOR PAVEMENT RESTORATION
18	HMA CL. 1/2 IN. PG	24	TN	$200	$4,726	2"
19	ASPHALT TREATED BASE	18	TN	$190	$3,455	4"
20	PLANING BITUMINOUS PAVEMENT	71	SY	$15	$1,067	
21	CEMENT CONC. TRAFFIC CURB AND GUTTER	45	LF	$25	$1,125	
22	CEMENT CONC. SIDEWALK	35	SY	$100	$3,500	
23	CEMENT CONC DRIVEYWAY ENTRANCE TYPE_	0	SY	$110	$0	
24	STREAMBED SEDIMENT	458	TN	$40	$18,315	
25	WATER SERVICE RELOCATION	0	EA	$2,000	$0	
26	SEWER CASING	100	LF	$300	$30,000	PADDEN BID PRICE
27	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	1,236	EA	$10.00	$12,360	4' spacing on center, includes establishment,17133 SF TRIANGLE PATTERN
28	TREE	28	EA	$1,000.00	$28,000	
29	SOD INSTALLATION	0	SY			
30	TOPSOIL	635	CY	$50.00	$31,728	
31	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$50,000	$50,000	
32	LARGE WOODY DEBRIS	13	EA	$1,200	$15,655	FOX AND BOLTON 11 KEY PIECES PER 100M
33	EARTH ANCHORS	26	EA	$800	$20,873	
34	HANDRAIL	80	LF	$180	$14,400	
35	BEAM GUARDRAIL	80	LF	$60	$4,800	FACTORED UP FOR WALL INTEGRATION
36	ABANDON/PLUG EXISTING PIPE	0	EA	$2,000	$0	
37	HABITAT BOULDERS	25	TN	$85	$2,125	
38	EROSION/WATER POLLUTION CONTROL	1	LS	$45,000	$45,000	
39	SPECIAL HANDLING 66" DIA PIPE	1	LS	$20,000	$20,000	
40	PROTECT EXISTING UTILITIES	1	LS	$10,000	$10,000	
41	ROCK PROTECTION	617	TN	$70	$43,167	
42	EARTH FILLED GEOCELLS	500	SY	$50	$25,000	
43	GABION OUTLET PROTECTION	1	LS	$15,000	$15,000	
44	STREAM ACCESS ROAD	185	TN	$35	$6,475	
45	DEWATERING	1	LS	$40,000	$40,000	
46	RECORD DRAWINGS	1	LS	$5,000	$5,000	
SUBTOTAL SCHEDULE A CONSTRUCTION COST					$929,291	
CONSTUCTION CONTINGENCY				30.0%	$278,787	
SUBTOTAL SCHEDULE A CONSTRUCTION COST WITH CONTINGENCY					$1,209,000	
SALES TAX				9.5%	$114,860	
TOTAL SCHEDULE A CONSTRUCTION COST WITH TAX AND CONTINGENCY					**$1,323,900**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$133,000	
DESIGN					$384,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$199,000	
EASEMENT		4500	SF	$ 30.00	$135,000	
SPECIAL TESTING AND INSPECTIONS				5%	$67,000	
TOTAL SCHEDULE A PROJECT COST					$2,242,000	
SCHEDULE B: 25TH AVENUE NE						
1	MOBILIZATION (10%)	1	LS	$175,000	$175,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (8%)	1	LS	$100,000	$100,000	Assume access to residences maintained during construction
3	SURVEYING	1	LS	$20,000	$20,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVE ASPHALT CONC. PAVEMENT	392	SY	$18	$7,056	
7	REMOVE CURB AND GUTTER		LF	$12	$0	
8	REMOVE SIDEWALK		SY	$20	$0	
9	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$20,000	$20,000	
10	EMBANKMENT COMPACTION	2187	CY	$4	$8,747	
11	GRAVEL BORROW INCL HAUL	2187	CY	$30	$65,605	
12	CHANNEL EXCAVATION	3193	CY	$25	$79,816	
13	STRUCTURE EXCAVATION CLASS B INCL. HAUL	2086	CY	$30	$62,568	
14	SHORING OR EXTRA EXCAVATION CLASS B	311	SY	$5	$1,555	
15	9' W x 4.6' H x75'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$135,000	$135,000	
16	9' W x 4.6' H x30'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$54,000	$54,000	
17	9' W x 4.6' H x52'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$93,600	$93,600	
18	WALL	2530	SF	$50	$126,500	
19	CATCHBASIN TYPE 1	5	EA	$1,500	$7,500	
20	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DI	100	LF	$45	$4,500	
21	CRUSHED SURFACING TOP COURSE	257	TN	$35	$8,985	2" FOR PAVEMENT RESTORATION
22	HMA CL. 1/2 IN. PG	137	TN	$110	$15,083	2"
23	ASPHALT TREATED BASE	91	TN	$100	$9,139	4"
24	PLANING BITUMINOUS PAVEMENT	1567	SY	$15	$23,508	
25	CEMENT CONC. TRAFFIC CURB AND GUTTER	471	LF	$25	$11,775	
26	CEMENT CONC. SIDEWALK	419	SY	$100	$41,867	
27	CEMENT CONC DRIVEYWAY ENTRANCE TYPE_	0	SY	$110	$0	
28	STREAMBED SEDIMENT	712	TN	$40	$28,490	
29	WATER SERVICE RELOCATION	7	EA	$2,000	$14,000	
30	WATER RELOCATION 6" DIA	170	LF	$120	$20,400	Assume need to replace adjacent to culverts and wall

31	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	1,070	EA	$10.00	$10,695	4' spacing on center, includes establishment,(6384-9*150)+(530-70-75-30-52)*6 SF TRIANGLE PATTERN
32	TREE MITIGATION	20	EA	$1,000.00	$20,000	
33	SOD INSTALLATION	95	SY	$30.00	$2,863	
34	TOPSOIL	250	CY	$50.00	$12,500	
35	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$15,000	$15,000	
36	LARGE WOODY DEBRIS	10	EA	$1,200	$12,000	FOX AND BOLTON 11 KEY PIECES PER 100M
37	EARTH ANCHORS	32	EA	$800	$25,600	
38	HANDRAIL	594	LF	$180	$106,920	
39	BEAM GUARDRAIL	562	LF	$60	$33,720	FACTORED UP FOR WALL INTEGRATION
40	ABANDON/PLUG EXISTING PIPE	2	EA	$2,000	$4,000	
41	HABITAT BOULDERS	25	TN	$85	$2,125	
42	EROSION/WATER POLLUTION CONTROL	1	LS	$20,000	$20,000	
43	DEWATERING	1	LS	$100,000	$100,000	
44	RECORD DRAWINGS	1	LS	$5,000	$5,000	
SUBTOTAL SCHEDULE B CONSTRUCTION COST					$1,515,116	
CONSTRUCTION CONTINGENCY				30.0%	$454,535	
TOTAL SCHEDULE B CONSTRUCTION COST WITH CONTINGENCY					$1,970,000	
SALES TAX				9.5%	$187,150	
TOTAL SCHEDULE B CONSTRUCTION COST WITH TAX AND CONTINGENCY					**$2,158,000**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$216,000	
DESIGN AND PERMITTING					$874,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$324,000	
TEMPORARY AND PERMANENT EASEMENT NEGOTIATION				5%	$108,000	
SPECIAL TESTING AND INSPECTIONS				5%	$108,000	
TOTAL SCHEDULE B PROJECT COST					$3,788,000	
SCHEDULE C: ALDERCREST ANNEX DETENTION POND						
1	MOBILIZATION (10%)	1	LS	$30,000	$30,000	
2	SURVEYING	1	LS	$2,000	$2,000	
3	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
4	EMBANKMENT COMPACTION	2260	CY	$4	$9,040	
5	COMMON BORROW INCL HAUL	6780	CY	$8	$54,240	
6	EXCAVATION	2260	CY	$25	$56,500	
7	OUTLET CONTROL STRUCTURE	1	EA	$4,000	$4,000	
8	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DI	110	LF	$45	$4,950	
9	HMA CL. 1/2 IN. PG	55	TN	$110	$6,050	
10	SEEDING, FERTILIZING, AND MULCHING	2	AC	$5,500.00	$9,185	
11	EROSION/WATER POLLUTION CONTROL	1	LS	$20,000	$20,000	
12	STREAM ACCESS ROAD	185	TN	$35	$6,475	
13	QUARRY SPALLS	666	TON	$27	$17,982	
14	CRUSHED SURFACING TOP COURSE	250	TON	$35	$8,753	
15	DEWATERING	1	LS	$20,000	$20,000	
16	RECORD DRAWINGS	1	LS	$1,000	$1,000	
SUBTOTAL SCHEDULE A CONSTRUCTION COST					$255,175	
CONSTRUCTION CONTINGENCY				30%	$76,553	
TOTAL SCHEDULE A CONSTRUCTION COST WITH CONTINGENCY					$332,000	
SALES TAX				9.5%	$31,540	
TOTAL SCHEDULE A CONSTRUCTION COST WITH TAX					**$363,500**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$37,000	
DESIGN AND PERMITTING				20%	$73,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$55,000	
TEMPORARY AND PERMANENT EASEMENT NEGOTIATION				5%	$19,000	
SPECIAL TESTING AND INSPECTIONS				5%	$19,000	
TOTAL SCHEDULE C PROJECT COST					$567,000	
TOTAL ESTIMATED PROJECT COST SCHEDULES A, B, AND C:					**$6,597,000**	Estimate based on 2017 dollars, rounded to nearest $1000; costs will need to be adjusted for Time Value of Money (TMV) when programming funds.

Table 1. Planning Level Design, Permitting, and Construction Cost Estimate for Alternative 3 - Alternative 2 Alignment (UPDATED 7/10/17)						
Spec Section	**Bid Item Description**	**Quantity**	**Unit**	**Unit Cost**	**Amount**	**Assumptions/Notes**
SCHEDULE A: NE 195TH STREET						
1	MOBILIZATION (10%)	1	LS	$107,000	$107,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (5%)	1	LS	$40,000	$40,000	Assume access to residences maintained during construction
3	SURVEYING	1	LS	$20,000	$20,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVE ASPHALT CONC. PAVEMENT	164	SY	$18	$2,952	
7	REMOVE CURB AND GUTTER	45	LF	$12	$540	
8	REMOVE SIDEWALK	35	SY	$20	$700	
9	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$20,000	$20,000	
10	EMBANKMENT COMPACTION	908	CY	$4	$3,631	
11	GRAVEL BORROW INCL HAUL	908	CY	$30	$27,233	
12	CHANNEL EXCAVATION	464	CY	$25	$11,595	
13	STRUCTURE EXCAVATION CLASS B INCL. HAUL	1221	CY	$30	$36,630	
14	SHORING OR EXTRA EXCAVATION CLASS B	854	SY	$10	$8,540	
15	9' W x 3.6' H x61'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$132,000	$132,000	
16	WING WALLS	1050	SF	$50	$52,500	
17	CRUSHED SURFACING TOP COURSE	120	TN	$35	$4,199	2" FOR PAVEMENT RESTORATION
18	HMA CL. 1/2 IN. PG	24	TN	$200	$4,726	2"
19	ASPHALT TREATED BASE	18	TN	$190	$3,455	4"
20	PLANING BITUMINOUS PAVEMENT	71	SY	$15	$1,067	
21	CEMENT CONC. TRAFFIC CURB AND GUTTER	45	LF	$25	$1,125	
22	CEMENT CONC. SIDEWALK	35	SY	$100	$3,500	
23	CEMENT CONC DRIVEYWAY ENTRANCE TYPE_	0	SY	$110	$0	
24	STREAMBED SEDIMENT	458	TN	$40	$18,315	
25	WATER SERVICE RELOCATION	0	EA	$2,000	$0	
26	SEWER CASING	100	LF	$300	$30,000	PADDEN BID PRICE
27	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	1,236	EA	$10.00	$12,360	4' spacing on center, includes establishment,17133 SF TRIANGLE PATTERN
28	TREES	28	EA	$1,000.00	$28,000	
29	SOD INSTALLATION	0	SY			
30	TOPSOIL	635	CY	$50.00	$31,728	
31	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$50,000	$50,000	
32	LARGE WOODY DEBRIS	13	EA	$1,200	$15,655	FOX AND BOLTON 11 KEY PIECES PER 100M
33	EARTH ANCHORS	26	EA	$800	$20,873	
34	HANDRAIL	80	LF	$180	$14,400	
35	BEAM GUARDRAIL	80	LF	$60	$4,800	FACTORED UP FOR WALL
36	ABANDON/PLUG EXISTING PIPE	0	EA	$2,000	$0	
37	HABITAT BOULDERS	25	TN	$85	$2,125	
38	EROSION/WATER POLLUTION CONTROL	1	LS	$45,000	$45,000	
39	SPECIAL HANDLING 66" DIA PIP	1	LS	$20,000	$20,000	
40	PROTECT EXISTING UTILITIES	1	LS	$10,000	$10,000	
41	ROCK PROTECTION	617	TN	$70	$43,167	
42	EARTH FILLED GEOCELLS	500	SY	$50	$25,000	
43	GABION PROTECTION	1	LS	$15,000	$15,000	
44	STREAM ACCESS ROAD	185	TN	$35	$6,475	
45	DEWATERING	1	LS	$40,000	$40,000	
46	RECORD DRAWINGS	1	LS	$5,000	$5,000	
SUBTOTAL SCHEDULE A CONSTRUCTION COST					$929,291	
CONSTRUCTION CONTINGENCY				30%	$278,787	
TOTAL SCHEDULE A CONSTRUCTION COST WITH CONTINGENCY					$1,209,000	
SALES TAX				9.5%	$114,860	
TOTAL SCHEDULE A CONSTRUCTION COST WITH TAX					**$1,323,900**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$133,000	
DESIGN AND PERMITTING					$384,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$199,000	
EASEMENT		4500	SF	$30	$135,000	
SPECIAL TESTING AND INSPECTIONS				5%	$67,000	
TOTAL SCHEDULE A CONSTRUCTION COST					$2,242,000	
SCHEDULE B: 25TH AVENUE NE						
1	MOBILIZATION (10%)	1	LS	$190,000	$190,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (5%)	1	LS	$70,000	$70,000	Assume access to residences maintained during construction
3	SURVEYING	1	LS	$20,000	$20,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVE ASPHALT CONC. PAVEMENT	309	SY	$18	$5,562	
7	REMOVE CURB AND GUTTER		LF	$12	$0	
8	REMOVE SIDEWALK		SY	$20	$0	
9	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$20,000	$20,000	
10	EMBANKMENT COMPACTION	2056	CY	$4	$8,225	
11	GRAVEL BORROW INCL HAUL	2056	CY	$30	$61,686	
12	CHANNEL EXCAVATION	5887	CY	$25	$147,173	
13	CHANNEL EXCAVATION WITH SPECIAL DISPOSAL[1]	388	CY	$100	$68,849.68	See Note [1]
14	STRUCTURE EXCAVATION CLASS B INCL. HAUL	2820	CY	$30	$84,600	
15	SHORING OR EXTRA EXCAVATION CLASS B	350	SY	$5	$1,750	
16	9' W x 4.6' H x70'L CONCRETE BOX CULVERT STRUCTURE	0	EA	$126,000	$0	
17	9' W x 4.6' H x75'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$135,000	$135,000	
18	9' W x 4.6' H x30'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$54,000	$54,000	
19	9' W x 4.6' H x52'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$93,600	$93,600	
20	WALL	2,530	SF	$50	$126,500	
21	CATCH BASIN TYPE 1	3	EA	$1,500	$4,500	
22	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DI	60	LF	$45	$2,700	
23	CRUSHED SURFACING TOP COURSE	419	TN	$35	$14,678	2" FOR PAVEMENT RESTORATION
24	HMA CL. 1/2 IN. PG	84	TN	$110	$9,197	2"
25	ASPHALT TREATED BASE	72	TN	$100	$7,202	4"
26	PLANING BITUMINOUS PAVEMENT	816	SY	$15	$12,240	
27	CEMENT CONC. TRAFFIC CURB AND GUTTER	471	LF	$25	$11,775	
28	CEMENT CONC. SIDEWALK	419	SY	$100	$41,867	
29	CEMENT CONC DRIVEYWAY ENTRANCE TYPE_	0	SY	$110	$0	

30	STREAMBED SEDIMENT	712	TN	$40	$28,490	
31	WATER SERVICE RELOCATION	6	EA	$2,000	$12,000	
32	WATER RELOCATION 6" DIA	170	LF	$120	$20,400	Assume need to replace adjacent to culverts and wall
33	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	1,236	EA	$10.00	$12,360	4' spacing on center, includes establishment,17133 SF TRIANGLE PATTERN
34	TREES	20	EA	$1,000.00	$20,000	
35	SOD INSTALLATION	0	SY	$30.00	$0	
36	TOPSOIL	250	CY	$50.00	$12,500	
37	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$15,000	$15,000	
38	LARGE WOODY DEBRIS	16	EA	$1,200	$19,035	FOX AND BOLTON 11 KEY PIECES PER 100M
39	EARTH ANCHORS	32	EA	$800	$25,380	
40	HANDRAIL	594	LF	$180	$106,920	
41	BEAM GUARDRAIL	562	LF	$60	$33,720	FACTORED FOR WALL INTEGRATION
42	ABANDON/PLUG EXISTING PIPE	2	EA	$2,000	$4,000	
43	HABITAT BOULDERS	25	TN	$85	$2,125	
44	EROSION/WATER POLLUTION CONTROL	1	LS	$20,000	$20,000	
45	STREAM ACCESS ROAD	185	TN	$35	$6,475	
46	DEWATERING	1	LS	$100,000	$100,000	
47	RECORD DRAWINGS	1	LS	$5,000	$5,000	
	SUBTOTAL SCHEDULE B CONSTRUCTION COST				$1,644,511	
	CONSTRUCTION CONTINGENCY			30%	$493,353	
	TOTAL SCHEDULE A CONSTRUCTION COST WITH CONTINGENCY				$2,138,000	
	SALES TAX			9.5%	$203,110	
	TOTAL SCHEDULE A CONSTRUCTION COST WITH TAX				**$2,341,100**	
	OTHER APPROXIMATED PROJECT COSTS					
	ADMINISTRATIVE COSTS			10%	$235,000	
	DESIGN AND PERMITTING				$874,000	
	CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION			15%	$352,000	
	TEMPORARY AND PERMANENT EASEMENT NEGOTIATION			5%	$118,000	
	SPECIAL TESTING AND INSPECTIONS			5%	$118,000	
	TOTAL SCHEDULE B CONSTRUCTION COST				$4,039,000	
	TOTAL ESTIMATED PROJECT COST SCHEDULES A AND B:				**$6,281,000**	Estimate based on 2016 dollars, rounded to nearest $1000; costs will need to be adjusted for Time Value of Money (TMV) when programming funds.

[1]Assumes approximately 7% material exceeds MOTCA standards and requires special disposal, plus additional $30k for sediment sampling and monitoring. This allowance does not cover full site clean up if required.

Table 1. Planning Level Design, Permitting, and Construction Cost Estimate for Aldercrest Annex Detention Facility

SCHEDULE A: NE 195TH STREET						
1	MOBILIZATION (10%)	1	LS	$107,000	$107,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (5%)	1	LS	$40,000	$40,000	Assume access to residences maintained during construction
3	SURVEYING	1	LS	$20,000	$20,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVE ASPHALT CONC. PAVEMENT	164	SY	$18	$2,952	
7	REMOVE CURB AND GUTTER	45	LF	$12	$540	
8	REMOVE SIDEWALK	35	SY	$20	$700	
9	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$20,000	$20,000	
10	EMBANKMENT COMPACTION	908	CY	$4	$3,631	
11	GRAVEL BORROW INCL HAUL	908	CY	$30	$27,233	
12	CHANNEL EXCAVATION	464	CY	$25	$11,595	
13	STRUCTURE EXCAVATION CLASS B INCL. HAUL	1221	CY	$30	$36,630	
14	SHORING OR EXTRA EXCAVATION CLASS B	854	SF	$10	$8,540	
15	9' W x 3.6' H x61'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$132,000	$132,000	
16	WING WALLS	1050	SF	$50	$52,500	
17	CRUSHED SURFACING TOP COURSE	120	TN	$35	$4,199	2" FOR PAVEMENT RESTORATION
18	HMA CL. 1/2 IN. PG	24	TN	$200	$4,726	2"
19	ASPHALT TREATED BASE	18	TN	$190	$3,455	4"
20	PLANING BITUMINOUS PAVEMENT	71	SY	$15	$1,067	
21	CEMENT CONC. TRAFFIC CURB AND GUTTER	45	LF	$25	$1,125	
22	CEMENT CONC. SIDEWALK	35	SY	$100	$3,500	
23	CEMENT CONC DRIVEYWAY ENTRANCE TYPE_	0	SY	$110	$0	
24	STREAMBED SEDIMENT	458	TN	$40	$18,315	
25	WATER SERVICE RELOCATION	0	EA	$2,000	$0	
26	SEWER CASING	100	LF	$300	$30,000	PADDEN BID PRICE
27	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	1,236	EA	$10.00	$12,360	4' spacing on center, includes establishment,17133 SF TRIANGLE PATTERN
28	TREE	28	EA	$1,000.00	$28,000	
29	SOD INSTALLATION	0	SY			
30	TOPSOIL	635	CY	$50.00	$31,728	
31	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$50,000	$50,000	
32	LARGE WOODY DEBRIS	13	EA	$1,200	$15,655	FOX AND BOLTON 11 KEY PIECES PER 100M
33	EARTH ANCHORS	26	EA	$800	$20,873	
34	HANDRAIL	80	LF	$180	$14,400	
35	BEAM GUARDRAIL	80	LF	$60	$4,800	FACTORED UP FOR WALL INTEGRATION
36	ABANDON/PLUG EXISTING PIPE	0	EA	$2,000	$0	
37	HABITAT BOULDERS	25	TN	$85	$2,125	
38	EROSION/WATER POLLUTION CONTROL	1	LS	$45,000	$45,000	
39	SPECIAL HANDLING 66" DIA PIPE	1	LS	$20,000	$20,000	
40	PROTECT EXISTING UTILITIES	1	LS	$10,000	$10,000	
41	ROCK PROTECTION	617	TN	$70	$43,167	
42	EARTH FILLED GEOCELLS	500	SY	$50	$25,000	
43	GABION OUTLET PROTECTION	1	LS	$15,000	$15,000	
44	STREAM ACCESS ROAD	185	TN	$35	$6,475	
45	DEWATERING	1	LS	$40,000	$40,000	
46	RECORD DRAWINGS	1	LS	$5,000	$5,000	
SUBTOTAL SCHEDULE A CONSTRUCTION COST					$929,291	
CONSTUCTION CONTINGENCY				30.0%	$278,787	
SUBTOTAL SCHEDULE A CONSTRUCTION COST WITH CONTINGENCY					$1,209,000	
SALES TAX				9.5%	$114,860	
TOTAL SCHEDULE A CONSTRUCTION COST WITH TAX AND CONTINGENCY					**$1,323,900**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$133,000	
DESIGN					$384,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$199,000	
EASEMENT		4500	SF	$ 30.00	$135,000	
SPECIAL TESTING AND INSPECTIONS				5%	$67,000	
TOTAL SCHEDULE A PROJECT COST					$2,242,000	
SCHEDULE B: 25TH AVENUE NE						
1	MOBILIZATION (10%)	1	LS	$175,000	$175,000	
2	PROJECT TEMPORARY TRAFFIC CONTROL (8%)	1	LS	$100,000	$100,000	Assume access to residences maintained during construction
3	SURVEYING	1	LS	$20,000	$20,000	
4	SPCC PLAN	1	LS	$5,000	$5,000	
5	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
6	REMOVE ASPHALT CONC. PAVEMENT	392	SY	$18	$7,056	
7	REMOVE CURB AND GUTTER		LF	$12	$0	
8	REMOVE SIDEWALK		SY	$20	$0	
9	REMOVAL OF STRUCTURE AND OBSTRUCTION	1	LS	$20,000	$20,000	
10	EMBANKMENT COMPACTION	2187	CY	$4	$8,747	
11	GRAVEL BORROW INCL HAUL	2187	CY	$30	$65,605	
12	CHANNEL EXCAVATION	3193	CY	$25	$79,816	
13	STRUCTURE EXCAVATION CLASS B INCL. HAUL	2086	CY	$30	$62,568	
14	SHORING OR EXTRA EXCAVATION CLASS B	311	SY	$5	$1,555	
15	9' W x 4.6' H x75'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$135,000	$135,000	
16	9' W x 4.6' H x30'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$54,000	$54,000	
17	9' W x 4.6' H x52'L CONCRETE BOX CULVERT STRUCTURE	1	EA	$93,600	$93,600	
18	WALL	2530	SF	$50	$126,500	
19	CATCHBASIN TYPE 1	5	EA	$1,500	$7,500	
20	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DI	100	LF	$45	$4,500	
21	CRUSHED SURFACING TOP COURSE	257	TN	$35	$8,985	2" FOR PAVEMENT RESTORATION
22	HMA CL. 1/2 IN. PG	137	TN	$110	$15,083	2"
23	ASPHALT TREATED BASE	91	TN	$100	$9,139	4"
24	PLANING BITUMINOUS PAVEMENT	1567	SY	$15	$23,508	
25	CEMENT CONC. TRAFFIC CURB AND GUTTER	471	LF	$25	$11,775	
26	CEMENT CONC. SIDEWALK	419	SY	$100	$41,867	
27	CEMENT CONC DRIVEYWAY ENTRANCE TYPE_	0	SY	$110	$0	
28	STREAMBED SEDIMENT	712	TN	$40	$28,490	
29	WATER SERVICE RELOCATION	7	EA	$2,000	$14,000	
30	WATER RELOCATION 6" DIA	170	LF	$120	$20,400	Assume need to replace adjacent to culverts and wall

31	PSIPE - 1 GAL PLANTS - RIPARIAN PLANTINGS	1,070	EA	$10.00	$10,695	4' spacing on center, includes establishment,(6384-9*150)+(530-70-75-30-52)*6 SF TRIANGLE PATTERN
32	TREE MITIGATION	20	EA	$1,000.00	$20,000	
33	SOD INSTALLATION	95	SY	$30.00	$2,863	
34	TOPSOIL	250	CY	$50.00	$12,500	
35	STREAMFLOW DIVERSION / FLOW BYPASS	1	LS	$15,000	$15,000	
36	LARGE WOODY DEBRIS	10	EA	$1,200	$12,000	FOX AND BOLTON 11 KEY PIECES PER 100M
37	EARTH ANCHORS	32	EA	$800	$25,600	
38	HANDRAIL	594	LF	$180	$106,920	
39	BEAM GUARDRAIL	562	LF	$60	$33,720	FACTORED UP FOR WALL INTEGRATION
40	ABANDON/PLUG EXISTING PIPE	2	EA	$2,000	$4,000	
41	HABITAT BOULDERS	25	TN	$85	$2,125	
42	EROSION/WATER POLLUTION CONTROL	1	LS	$20,000	$20,000	
43	DEWATERING	1	LS	$100,000	$100,000	
44	RECORD DRAWINGS	1	LS	$5,000	$5,000	
SUBTOTAL SCHEDULE B CONSTRUCTION COST					$1,515,116	
CONSTRUCTION CONTINGENCY				30.0%	$454,535	
TOTAL SCHEDULE B CONSTRUCTION COST WITH CONTINGENCY					$1,970,000	
SALES TAX				9.5%	$187,150	
TOTAL SCHEDULE B CONSTRUCTION COST WITH TAX AND CONTINGENCY					**$2,158,000**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$216,000	
DESIGN AND PERMITTING					$874,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$324,000	
TEMPORARY AND PERMANENT EASEMENT NEGOTIATION				5%	$108,000	
SPECIAL TESTING AND INSPECTIONS				5%	$108,000	
TOTAL SCHEDULE B PROJECT COST					$3,788,000	
SCHEDULE C: ALDERCREST ANNEX DETENTION POND						
1	MOBILIZATION (10%)	1	LS	$30,000	$30,000	
2	SURVEYING	1	LS	$2,000	$2,000	
3	CLEARING AND GRUBBING	1	LS	$5,000	$5,000	
4	EMBANKMENT COMPACTION	2260	CY	$4	$9,040	
5	COMMON BORROW INCL HAUL	6780	CY	$8	$54,240	
6	EXCAVATION	2260	CY	$25	$56,500	
7	OUTLET CONTROL STRUCTURE	1	EA	$4,000	$4,000	
8	CORRUGATED POLYETHYLENE STORM SEWER PIPE 12 IN. DI	110	LF	$45	$4,950	
9	HMA CL. 1/2 IN. PG	55	TN	$110	$6,050	
10	SEEDING, FERTILIZING, AND MULCHING	2	AC	$5,500.00	$9,185	
11	EROSION/WATER POLLUTION CONTROL	1	LS	$20,000	$20,000	
12	STREAM ACCESS ROAD	185	TN	$35	$6,475	
13	QUARRY SPALLS	666	TON	$27	$17,982	
14	CRUSHED SURFACING TOP COURSE	250	TON	$35	$8,753	
15	DEWATERING	1	LS	$20,000	$20,000	
16	RECORD DRAWINGS	1	LS	$1,000	$1,000	
SUBTOTAL SCHEDULE A CONSTRUCTION COST					$255,175	
CONSTRUCTION CONTINGENCY				30%	$76,553	
TOTAL SCHEDULE A CONSTRUCTION COST WITH CONTINGENCY					$332,000	
SALES TAX				9.5%	$31,540	
TOTAL SCHEDULE A CONSTRUCTION COST WITH TAX					**$363,500**	
OTHER APPROXIMATED PROJECT COSTS						
ADMINISTRATIVE COSTS				10%	$37,000	
DESIGN AND PERMITTING				20%	$73,000	
CONSTRUCTION MANAGEMENT/CONSTRUCTION ADMINISTRATION				15%	$55,000	
TEMPORARY AND PERMANENT EASEMENT NEGOTIATION				5%	$19,000	
SPECIAL TESTING AND INSPECTIONS				5%	$19,000	
TOTAL SCHEDULE C PROJECT COST					$567,000	
TOTAL ESTIMATED PROJECT COST SCHEDULES A, B, AND C:					**$6,597,000**	Estimate based on 2017 dollars, rounded to nearest $1000; costs will need to be adjusted for Time Value of Money (TMV) when programming funds.

Appendix Q
Ballinger Creek Flow Monitoring Data

HERRERA

TECHNICAL MEMORANDUM

Date: February 23, 2018

To: Mike Giseburt, Louis Berger

Copy to: John Featherstone, City of Shoreline and Shelby Petro, Herrera

From: Alex Svendsen and Dylan Ahearn

Subject: 25th Avenue NE Flood Reduction Project: Ballinger Creek Hydrologic Monitoring

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CONTENTS

APPENDICES

TABLES

FIGURES

2200 Sixth Avenue | Suite 1100 | Seattle, Washington | 98121 | p 206 441 9080 | f 206 441 9108

PORTLAND, OR | MISSOULA, MT | OLYMPIA, WA | BELLINGHAM, WA

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INTRODUCTION

In October 2016, Louis Berger authorized Herrera Environmental Consultants (Herrera) to gage flow rates at four locations in Ballinger Creek to support design information (i.e., to calibrate stormwater runoff models) and alternative selection for Ballinger Creek fish passage and stream restoration for the City of Shoreline (City). In coordination with the City and Louis Berger, the use of four gages was deemed necessary to provide sufficient information for this project. A technical memorandum summarizing data collected from December 2016 through August 2017 was prepared by Herrera in September 2017; this technical memorandum includes additional data collected from September 2017 through January 2018.

METHODS

Herrera installed four stream gages in Ballinger Creek in December 2016. The gages were installed in the following locations (see Figure 1):

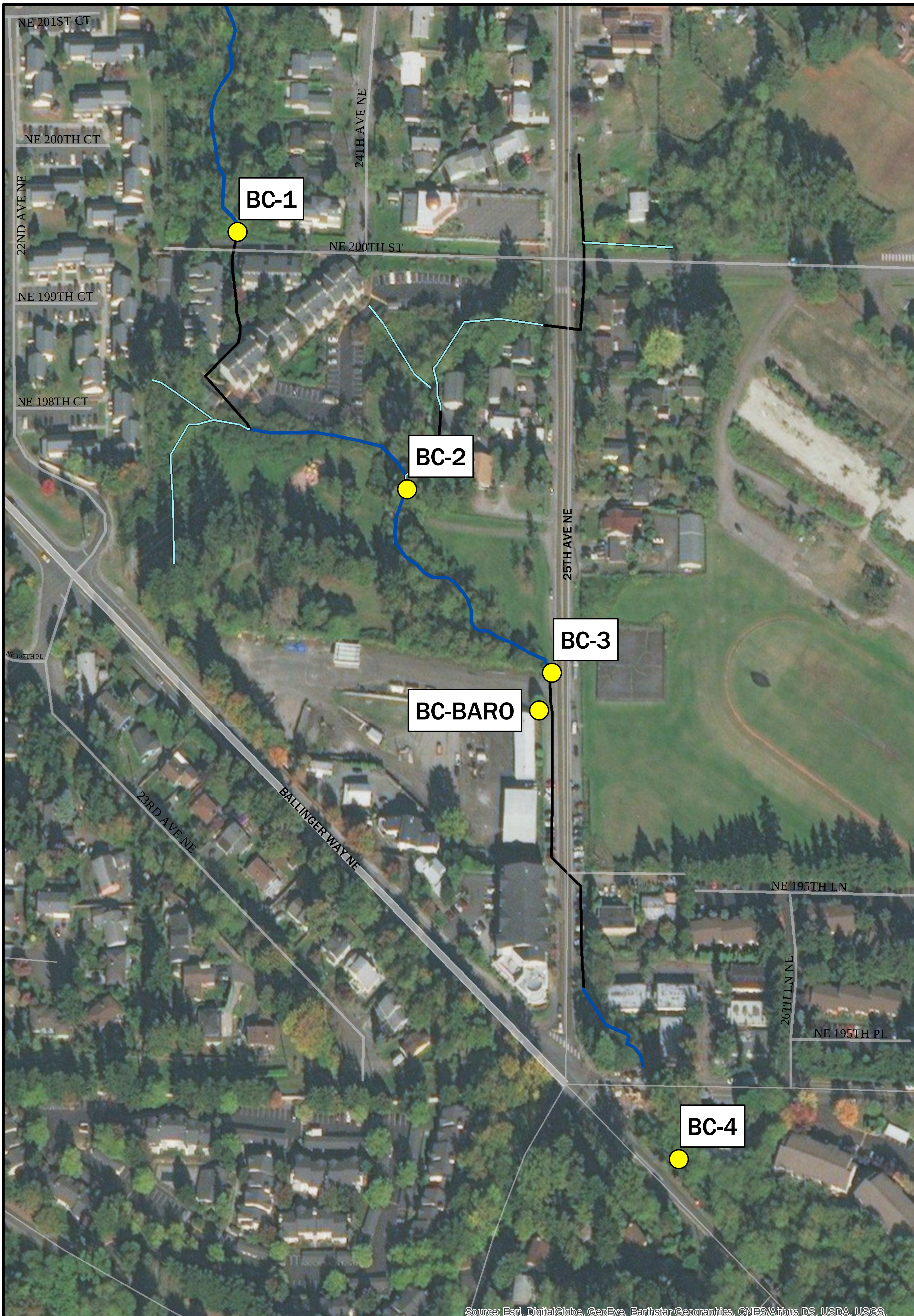
1. Gage BC-1 was installed in a "bird cage" along the north side of NE 200th Street (Figure 2).

2. Gage BC-2 was installed in the northeast corner of Brugger's Bog Park downstream of an unnamed tributary that enters Ballinger Creek from the northeast (Figure 3).

3. Gage BC-3 was installed in the southeast corner of Brugger's Bog Park immediately upstream of the culverts that convey Ballinger Creek beneath 25th Avenue NE (Figure 4).

4. Gage BC-4 was installed approximately 100 feet downstream of the Ballinger Creek culvert outlet under NE 195th Street (Figure 5).

Each gage was installed using 2-inch-diameter PVC pipes with a perforated stilling well tee to maintain a hydraulic connection to Ballinger Creek. In-Situ Rugged TROLL® 100 non-vented pressure transducers were housed inside the PVC piping to record water depths (see Appendix A). Each gage was anchored to the stream using an angle iron and hose clamps. Staff gages were also attached to the gages to enable manual water level measurements to ensure the automated logging equipment is functioning correctly and to develop a rating curve for each gaged location to convert water depth to discharge. Finally, an In-Situ Rugged BaroTROLL® Data Logger (BC-Baro) was installed amid a rhododendron for visual obscurity to the public along the east side of the City's maintenance facility next to Brugger's Bog Park (Figure 6 and Appendix A). The barometric pressure recorded by this data logger is used to compensate for atmospheric pressure in the non-vented water level measurements.



Legend

Ballinger Creek Gage Locations

Stream

F: Contains Fish Habitat

Np: Perenial Non-fish Habitiat

Ns: Seasonal Non-fish Habitat

Piped

Not Typed

Figure 1. Ballinger Creek Gage Locations for the 25th Avenue NE Flood Reduction Project.

N

0 150 300 Feet

HERRERA

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Figure 2. Ballinger Creek Gage Station BC-1.

Figure 3. Ballinger Creek Gage Station BC-2.

Figure 4. Ballinger Creek Gage Station BC-3.

Figure 5. Ballinger Creek Gage Station BC-4.

Figure 6. Ballinger Creek Gage Station BC-Baro.

Field Measurement Procedures

A rating curve was developed at each gaged location to convert the automated water level measurements (i.e., stage) in Ballinger Creek to a corresponding volumetric rate of flow. Discharge measurements were collected over a range of creek stages to sufficiently develop the rating curve. The stage at each gage location was measured using the staff gage attached to the gage piping, and was manually recorded when the discharge in the creek was manually measured. In the case of gages BC-1 and BC-3, discharge measurements were collected in pipes using a HACH FH950 Portable Velocity Meter and wading rod; Manning's roughness ("n") values for pipes were used to convert water depth and velocity measurements in each pipe to discharge. At gages BC-2 and BC-4, the discharge was recorded using the USGS midpoint velocity-area method in which the creek was subdivided into cross sections and the depth and velocity were measured using a HACH FH950 Portable Velocity Meter and wading rod. All data were recorded using standardized field forms (Appendix B).

Data Management

Stage data collected using the pressure transducers and barometric pressure data logger were uploaded approximately every 2 months using a laptop computer in the field. Uploaded data were transferred to a spreadsheet and reviewed for quality assurance purposes. The manual discharge measurements were also calculated in the office and transferred to a spreadsheet.

The difference between the staff gage reading and automatically logged water level data (at coincident points in time) was calculated after every data download field visit. These offset values were then used to correct raw water level data obtained from the data logger to ensure that they conformed to the measured staff gage readings. These offset values were also used for quality control purposes.

All water level data were compiled and imported into the Aquarius Time-Series data management system software (produced by Aquatic Informatics, Inc.) to develop the rating curves at each of the four gaging stations.

The data were screened for gaps and anomalies prior to converting the stage values to flows. Subsequently, the flow data were imported in a proprietary storm delineation tool (Storm 3.0) to segregate the data into individual storm events. The flow characteristics of each of these storm events were then automatically summarized.

Precipitation Data Referencing

Raw precipitation data (15-minute intervals) were compiled from the King County Hydrologic Information Center using data collected at the Boeing Creek Rain Gauge 04u near Shoreline

Community College. Continuous precipitation data from the rain gage were compiled for the period of December 2016 through January 2018.

RESULTS AND DISCUSSION

The quality assessment of the water level data in Aquarius indicated that there were no gaps or spikes in the data (the exceptions were 10-minute gaps when the data were being downloaded in the field). Consequently, the water level signal did not require correction prior to being converted to flow.

Developing rating curves in small streams is a difficult task. Due to the shifting nature of the stream bed, the rating is frequently associated with errors of between 10 and 25 percent. In addition, since it is exceedingly difficult to be present during the few minutes when each gage experiences its highest flow during the measurement period of record, there is inevitably error associated with extrapolating the rating curve to that highest stage reading. The general rule is that a rating curve should not be extended more than 20 percent beyond the recorded data; however, conditions frequently necessitate extrapolation well beyond that.

Table 1 presents the stage-discharge rating measurements collected at each of the gage locations. As with all rating curves, the best-fit curve was not a perfect fit to the measured points presented in the table. The root mean square error of each curve, as calculated by Aquarius, was 12.7, 10.1, 28.1, and 29.3 percent for gages BC-1, BC-2, BC-3, and BC-4, respectively. This degree of error is typical for rating curves developed in small streams.

Extrapolation error must also be considered when interpreting stage-discharge relationships. At gage BC-1 the highest measured flow was 9.3 cubic feet per second (cfs), but the highest calculated flow was 31.9 cfs, more than a three-fold difference. Similar extrapolations were necessary at the other gage locations. At gage BC-2 the maximum measured flow was 13.3 cfs and the maximum calculated flow was 54.4 cfs; at gage BC-3 the maximum measured flow was 14.6 cfs while the maximum calculated flow was 58.4 cfs; finally, at gage BC-4 the maximum measured flow was 11.4 cfs and the maximum calculated flow was 20.0 cfs. These extrapolations represent the largest uncertainty in the datasets. If more accuracy is desired above the 15 cfs threshold, then additional rating measurements would need to be collected during high flow events. If the data are to be used for model calibration, then Herrera suggests only calibrating for events below the 15 cfs threshold until additional high flow data can be collected.

During the monitoring period of December 2016 through January 2018, a total of 78 individual storm events were identified from the nearby precipitation gage record. The storm event delineation criteria were at least 0.2 inches of rain and an inter-event dry period of 6 hours or more with no rain; 93 storm events did not meet the aforementioned criteria. The general pattern observed in the gage data was an increase in flow in the downstream direction with the exception that the reach between gages BC-3 and BC-4 seems to be a “losing reach” (i.e., flow infiltrating into the stream bed and/or banks). The riparian area along this reach may be attenuating flows and promoting infiltration. For the 78 delineated storm events, the average storm flow was 0.8, 1.6, 1.8, and 1.6 cfs at gages BC-1, BC-2, BC-3, and BC-4, respectively. The average peak storm discharge was 8.2, 12.7, 14.9, and 8.3 cfs at gages BC-1, BC-2, BC-3, and BC-4, respectively. Finally, the average storm volume was 104,000; 200,000; 228,000; and 192,000 cubic feet (cf) at gages BC-1, BC-2, BC-3, and BC-4, respectively.

Appendix C (an electronic appendix) provides the 5-minute real-time flow data and the summary results for the 78 delineated storm events including event hydrographs. These results can be used to compare with modeled results and to help with alternatives analysis for the proposed project.

Table 1. Ballinger Creek Manual Discharge and Offset Values.

BC-1 Date/Time	BC-1 Manual Discharge (cfs)	BC-1 Gage Height (feet)	BC-1 Data Logger Stage (feet)	BC-1 Gage – Logger Stage (feet)	BC-2 Date/Time	BC-2 Manual Discharge (cfs)	BC-2 Gage Height (feet)	BC-2 Data Logger Stage (feet)	BC-2 Gage – Logger Stage (feet)	BC-3 Date/Time	BC-3 Manual Discharge (cfs)	BC-3 Gage Height (feet)	BC-3 Data Logger Stage (feet)	BC-3 Gage – Logger Stage (feet)	BC-4 Date/Time	BC-4 Manual Discharge (cfs)	BC-4 Gage Height (feet)	BC-4 Data Logger Stage (feet)	BC-4 Gage – Logger Stage (feet)
12/16/2016 10:00	0.11	1.93	0.468	1.46	12/16/2016 10:40	0.32	4.92	1.231	3.69	12/16/2016 11:10	0.45	4.55	1.006	3.54	12/16/2016 13:05	0.68	0.80	0.418	0.38
12/19/2016 21:40	4.16	2.40	0.941	1.46	12/19/2016 22:10	4.97	5.40	1.696	3.70	12/19/2016 22:20	4.63	5.28	1.794	3.49	12/19/2016 22:40	4.43	1.30	0.903	0.40
1/18/2017 10:15	3.12	2.35	0.920	1.43	1/18/2017 10:45	6.22	5.41	1.733	3.68	1/18/2017 10:45	5.10	5.31	1.846	3.46	1/18/2017 11:45	3.96	1.23	0.822	0.41
2/8/2017 19:55	2.72	2.31	0.889	1.42	2/15/2017 13:27	6.26	5.42	1.771	3.65	2/15/2017 13:45	9.65	5.52	2.058	3.46	2/15/2017 14:19	8.84	1.52	1.174	0.35
2/15/2017 13:01	4.07	2.34	0.912	1.43	2/15/2017 17:42	8.69	5.53	1.835	3.70	2/15/2017 17:58	8.80	5.52	2.031	3.49	3/17/2017 13:34	0.95	0.70	0.309	0.39
2/15/2017 14:57	6.73	2.58	1.222	1.36	3/17/2017 12:13	0.84	5.02	1.302	3.71	3/17/2017 12:58	0.96	4.70	1.166	3.53	6/15/2017 15:40	0.39	0.63	0.293	0.34
3/17/2017 11:40	0.40	2.05	0.606	1.44	6/15/2017 14:00	1.73	5.13	1.409	3.72	6/15/2017 14:42	1.40	4.86	1.334	3.53	6/15/2017 17:10	1.42	0.77	0.278	0.49
6/15/2017 13:35	0.47	2.09	0.666	1.42	6/15/2017 16:05	0.50	4.95	1.277	3.67	6/15/2017 17:00	0.61	4.63	1.148	3.48	8/31/2017 14:40	0.11	0.52	0.117	0.40
6/16/2017 15:35	0.24	2.05	0.586	1.46	8/31/2017 13:30	0.09	4.86	1.151	3.71	8/31/2017 14:05	0.05	4.41	0.899	3.51	11/21/2017 12:45	10.0	1.65	1.238	0.41
8/31/2017 12:35	0.02	1.83	0.380	1.45	11/21/2017 11:40	8.84	5.55	1.827	3.72	11/21/2017 12:15	7.45	5.77	2.173	3.60	12/19/2017 9:50	11.4	1.73	1.326	0.40
11/21/2017 11:15	6.21	2.62	1.167	1.45	12/19/2017 8:45	12.2	5.70	2.008	3.69	12/19/2017 9:15	13.3	5.99	2.384	3.61	12/19/2017 12:05	7.15	1.44	1.065	0.38
12/19/2017 8:20	8.16	2.69	1.307	1.38	12/19/2017 11:15	10.1	5.57	1.858	3.71	12/19/2017 11:45	11.9	5.43	1.968	3.46	1/11/2018 10:50	11.0	1.63	1.207	0.42
12/19/2017 10:40	5.45	2.51	1.055	1.46	1/11/2018 9:28	11.0	5.63	1.918	3.71	1/11/2018 10:10	9.81	5.51	2.032	3.48	1/23/2018 11:00	3.29	1.02	0.628	0.39
1/11/2018 9:01	8.78	2.74	1.216	1.52	1/11/2018 12:18	13.3	5.74	2.041	3.69	1/11/2018 12:44	14.6	5.90	2.418	3.48					
1/11/2018 11:53	9.34	2.81	1.386	1.42	1/23/2018 10:10	3.83	5.30	1.579	3.72	1/23/2018 10:35	4.23	5.17	1.708	3.46					
1/23/2018 9:40	0.33	2.05	0.605	1.45															
OFFSETS:				**1.44**					**3.70**					**3.51**					**0.40**

APPENDIX A

Equipment Specifications

HACH FH950 HANDHELD FLOW METER

Applications

- Wastewater
- Collection Systems
- Environmental

The perfect handheld solution for wastewater and environmental flow monitoring.

Knowledge gained through years of in-the-field flow measurement experience has come together in the Hach FH950 Handheld Flow Meter. Designed for use in both environmental and sewer/wastewater flow measurement scenarios—whether you're profiling streams and rivers or providing redundant verification of wastewater flow data—even the smallest hassles have been addressed. And the result for you? Massive time savings. From the field to the office, the Hach FH950 increases your efficiency at every turn.

Designed for Accuracy and Efficiency

The lightweight, battery-powered Hach FH950 was designed to provide accurate velocity and level measurements while simplifying the entire measurement process in rugged field environments. Multiple user-friendly features designed into the FH950 allow you to quickly and easily determine stream velocities for required discharge measurements, calibrate area velocity flow meters, or verify primary devices such as weirs and flumes.

Easy Programming and Data Transfer

The FH950's rugged, lightweight and user-friendly design allows for easy set-up, operation and data management. With an easy-to-use, menu-driven user interface that is readable even in bright sunlight, the FH950 has the ability to store both velocity and level information right within the meter, minimizing field time by up to 50%. Once the data is collected, simply download to a PC via the USB connection, eliminating the need for labor intensive manual data transfer.

Maintenance-Free Electromagnetic Sensor

Available with either Velocity or Velocity and Level capabilities, the FH950's electromagnetic sensor has no moving parts and never requires mechanical maintenance, making it one of the lowest maintenance solutions on the market.

Smart Sensor Capabilities

With an innovative and compact sensor shape with intelligently-designed flow characteristics, the FH950 delivers reliable measurements at low velocities, in very shallow water, and in turbulent flow conditions. It even takes accurate readings in sediment, weed or organic debris-choked water. Plus, with an optional pressure cell for automatic level measurement and sensor positioning, the Hach FH950 is known for having as much brain as it has brawn.

Quickly profile streams and rivers. Easily verify other metering tools or use to select optimal monitoring sites.

MARSH McBIRNEY SIGMA

HACH® Be Right™

Specifications*

Sensor

VELOCITY MEASUREMENT

Method	Electromagnetic
Accuracy	±2% of reading ±0.05 ft/s (±0.015 m/s) through the range 0 to 10 ft/s (0 to 3.04 m/s); ±4% of reading from 10 to 16 ft/s. (3.04 to 4.87 m/s)
Zero Stability	±0.05 ft/s (± 0.015 m/s)
Resolution	0.01 value <100; 0.1 value <1000; 1.0 value ≥1000
Range	0 to +20 ft/s (0 to +6.09 m/s)

LEVEL MEASUREMENT

Method	Diaphragm type: Absolute pressure with single point calibration
Accuracy (static)	The larger of ±2% of reading or ±0.504 in (0.015 m). Steady state temperature and static non-flowing water.
Range	0 to 10 ft (0 to 3.05 m)
Resolution	0.01 value <100; 0.1 value <1000; 1.0 value ≥1000
Minimum Water Level	1.25 in (3.18 cm)

GENERAL ATTRIBUTES

Material	ABS, glass-filled
Environmental Rating	IP68
Dimensions of Sensor	4.7" L x 1.7" W x 2.5" H (11.9 cm L x 4.3 cm W x 6.3 H cm)
Cable Material	Polyurethane jacketed
Cable Lengths	6.5, 20, 40, and 100 ft. (2, 6.1,12.2, and 30.5 m)

Portable Meter

GENERAL ATTRIBUTES

Material	Polycarbonate with a thermoplastic elastomer (TPE) overmold
Environmental Rating	IP67
Dimensions of Portable Meter	8.6" L x 3.7" W x 2.1" H (21.8 L x 9.3 W x 5.3 H cm)
Storage Temperature Range	-4 to 140°F (-20 to 60°C)
Operating Temperature Range	-4 to 131°F (-20 to 55ºC)
Battery Charge Temperature Range	32 to 104°F (0 to 40°C)
Battery Type	Lithium-Ion, rechargeable
Battery Life Gauge	5 segment bar graph
Battery Life	18 hours heavy typical day use†; 68°F (20°C)

†Defined as 30 minutes of set up, 6 one-hour periods of continuous use with sensor active and display at maximum brightness, 30 minutes of sleep mode between use periods, data download and power off.

Battery Charger	AC wall outlet charger
USB Connector	Type Mini-B, 5-pin, rated to IP67 when capped

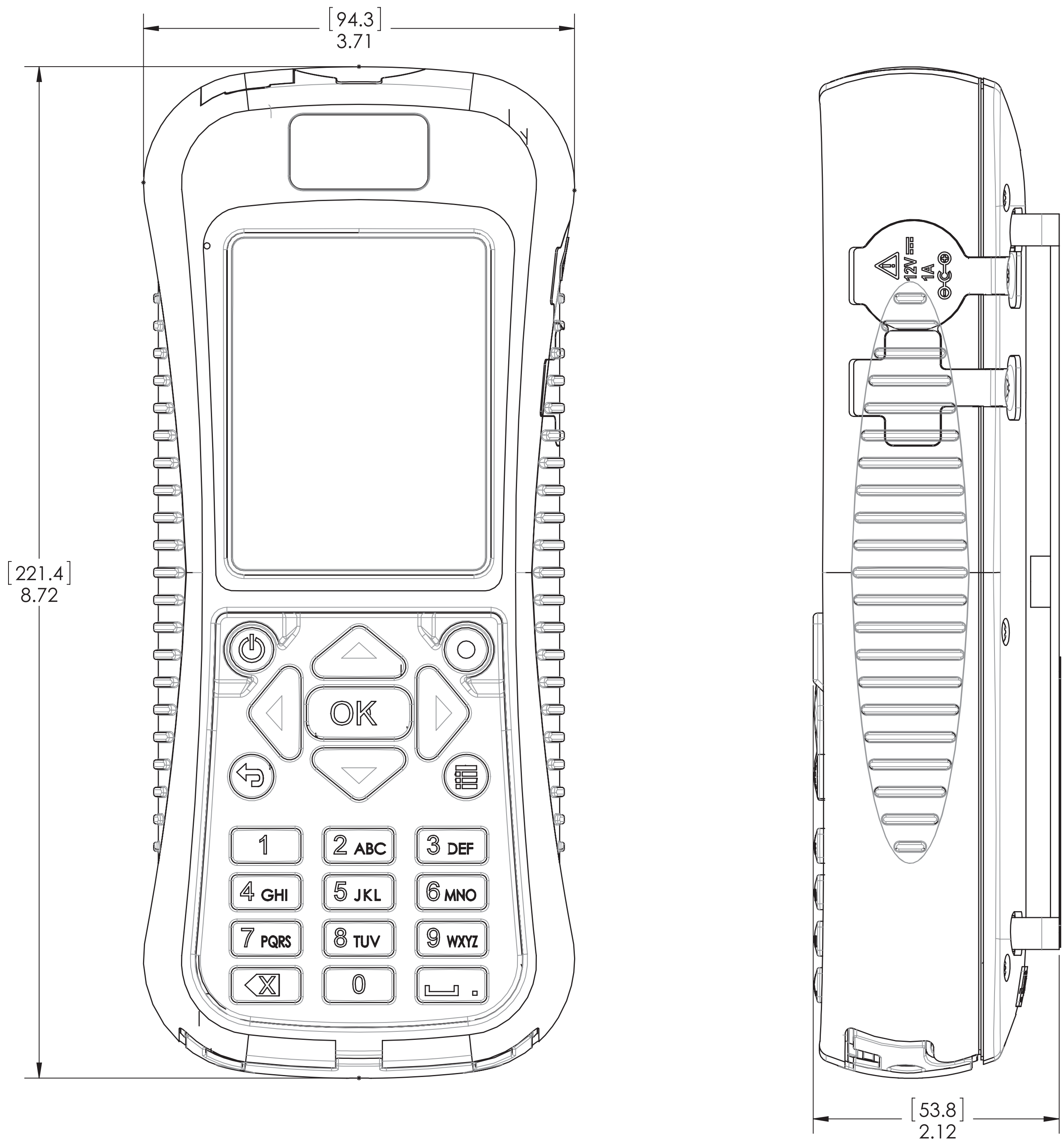
USER INTERFACE AND PROGRAMMING

Graphics Display	Color, LCD; 3.5" QVGA, transflective (readable in direct sunlight)
Measurement Resolution	0.01 value <100; 0.1 value <1000; 1.0 value ≥1000
Keypad	Alpha-numeric
Operating Modes	Real-time, Profiling
Profiling Types	Stream, Conduit
Conduit Shapes	Circular, Rectangular, Trapezoidal, 2/3 Egg, Inverted 2/3 Egg
Stream Entries	Fixed, Non-Fixed Stations
Firmware	Sensor and portable meter firmware are field upgradeable via USB
Noise Rejection	User selectable 50Hz, 60Hz
Units of Measure	Velocity: ft/s, m/s, cm/s, mm/s Flow: ft^3/sec, million gal/day, gal/day, gal/min, m^3/sec, m^3/min, m^3/hour, m^3/day, liters/s, liters/min Level: in, ft, m, cm, mm
Stream Flow Calculation	Mean-section, Mid-section
Diagnostics	Self test, keypad, display, event log
Conduit Profile Methods	0.9 x Vmax, 0.2/0.4/0.8, velocity and level integrator, 2D
Stream Profile Methods	1, 2, 3, 5 and 6 point (Velocity method - USGS and ISO)
File Types	Real-time, Profiling, Event Log
Profiles	Data storage for up to 10 profiles with 32 stations per profile.
Maximum Number of Real-Time Files	Three each with up to 75 readings captured by the user.
Language Support	English, Bulgarian, Chinese, Czech, Danish, Dutch, Finnish, French, German, Greek, Hungarian, Italian, Japanese, Korean, Polish, Portuguese, Romanian, Russian, Slovenian, Spanish, Swedish, Turkish

**Subject to change without notice.*

Dimensions

In inches and [millimeters}.



Ordering Information

FH950 Portable Flow Meter System

System includes portable flow meter, electromagnetic sensor with specified cable length, universal sensor mount, USB cable, wading rod mount, power supply/charger, neck strap, thumb screw kit, soft case, and disposable cloth for cleaning.

FH950 Meter and Sensor System FH950.	1	X	X	X	X
Portable Meter (Hach FH950, with User Manual)	1				
Electromagnetic Sensor (Velocity)		0			
Electromagnetic Sensor (Velocity and Level)		1			
Cable Length					
6.5 foot (2m)			0	0	5
20 foot (6.1m)			0	2	0
40 foot (12.2m)			0	4	0
100 foot (30.5m)			1	0	0

Replacement Parts & Accessories

FH950 Portable Meter

FH950.1 FH950 Handheld Flow Meter (includes battery, battery charger and meter), English

Electromagnetic Sensors

EM950.0005 Velocity Sensor w/6.5 ft (2 m) cable
EM950.0020 Velocity Sensor w/20 ft (6.1 m) cable
EM950.0040 Velocity Sensor w/40 ft (12.2 m) cable
EM950.0100 Velocity Sensor w/100 ft (30.5 m) cable
EM950.1005 Velocity and Level Sensor w/6.5 ft (2 m) cable
EM950.1020 Velocity and Level Sensor w/20 ft (6.1 m) cable
EM950.1040 Velocity and Level Sensor w/40 ft (12.2 m) cable
EM950.1100 Velocity and Level Sensor w/100 ft (30.5 m) cable

Accessories

9073400 Fabric Carrying Case
9073600 Lithium Ion Battery
9072600 Battery Charger
9070800 USB Cable, 3 ft (1 m)
75015 Universal Sensor Mount
9071700 Adjustable Meter Mount
9073500 Wipe Cloth, used for cleaning
9073200 Sensor Thumb Screw Kit
9072700 Lanyard

Contact factory for information on Standard and Top Setting Wading Rod Kits or Suspension Cable Kits.

NOTE: Additional cable cannot be added after order is entered.

HACH COMPANY World Headquarters: Loveland, Colorado USA

United States: 800-368-2723 tel 970-619-5150 fax hachflowsales@hach.com
Outside United States: 970-622-7120 tel
hachflow.com

LIT2568 Rev 6
Printed in U.S.A.

Be Right™

Innovations in **Water Monitoring** | Spec Sheet

Rugged TROLL® 100 and 200 Data Loggers

Rugged TROLL 100 and 200 Data Loggers are designed for long- and short-term groundwater and surface water monitoring. These non-vented (absolute) water level data loggers measure and record changes in water level, pressure, and temperature. Ensure accurate results by using a Rugged BaroTROLL® Data Logger. All loggers are compatible with the user-friendly VuSitu™ Mobile App and Win-Situ® PC Software.

Affordable Titanium Data Loggers

- Get reliable data at a budget-friendly price.
- Use in harsh environments. Solid titanium construction offers chemical- and corrosion-resistance and outlasts specially-coated data loggers.
- Select the appropriate logging mode for your project: Linear, Fast Linear, or Event.

Flexible Deployment Options

- Deploy zero-maintenance loggers in flood-prone areas, high-humidity environments, and remote locations.
- Choose the cable length and termination type that works best for your project.
- Use suspension wire and backshell hanger for applications requiring minimal instrument access.

World Class Support

- Receive 24/7 technical support and online resources.
- Order data loggers and accessories directly from our website.
- Get guaranteed 7-day service for maintenance (U.S.A. only).

Simplified Setup and Data Retrieval

- Use the VuSitu Mobile App to consolidate all site information on your smartphone and tag data with site photos and GPS coordinates. Simply connect the instrument to a Wireless Rugged TROLL Com, launch the mobile app, and start reading results.
- Save time and reduce errors with the intuitive Win-Situ Software platform. Quickly program loggers, download data, graph results, and more.
- Connect a cabled logger to a telemetry system, radio, controller, or a SCADA/PLC system via Modbus/RS485 or SDI-12 (with the Rugged TROLL 200 and Rugged BaroTROLL).
- Integrate with In-Situ Tube and Cube Telemetry Systems and HydroVu™ Data Services for real-time feedback on your remote monitoring sites.

Applications

- **Coastal wetland and estuary research**
- **Crest stage gaging and stream gaging**
- **Drilling and well development**
- **Flood and storm surge monitoring**
- **Landfill leachate monitoring**

Rugged TROLL® 100 and 200 Data Loggers

Spec Sheet

General	Rugged TROLL 100 & 200	Rugged BaroTROLL
Temperature ranges[1]	Operational: 0-50° C (32-122° F) Storage: -40-80° C (-40-176° F) Calibrated: 0-50° C (32-122° F)	Operational: 0-50° C (32-122° F) Storage: -40-80° C (-40-176° F) Calibrated: 0-50° C (32-122° F)
Diameter	2.62 cm (1.03 in.)	2.62 cm (1.03 in.)
Length	14.43 cm (5.68 in.)	14.43 cm (5.68 in.)
Weight	137 g (0.30 lb)	137 g (0.30 lb)
Materials	Titanium body; Delrin® nose cone, hanger, backend	Titanium body; Delrin nose cone, hanger, backend
Output options	Rugged TROLL 100: USB via docking station; Wireless Rugged TROLL Com Rugged TROLL 200: USB via docking station; Wireless Rugged TROLL Com; Modbus/RS485 or SDI-12 via Rugged TROLL 200 Cable	USB or RS232 via docking station; Modbus/RS485 or SDI-12 via Rugged TROLL 200 Cable; Wireless Rugged TROLL Com Device
Battery type & life[2]	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings
External power	Rugged TROLL 100: NA Rugged TROLL 200: 8-36 VDC	8-36 VDC
Memory Data records[3] Data logs	2.0 MB 120,000 Rugged TROLL 100: 1 log Rugged TROLL 200: 2 logs	2.0 MB 120,000 2 logs
Fastest logging rate	1 per second	1 per minute
Fastest output rate	Rugged TROLL 200 only Modbus & SDI-12: 1 per second	Modbus & SDI-12: 1 per second
Log types	Linear, Fast Linear, and Event	Linear
Sensor Type/Material	Piezoresistive; Ceramic	Piezoresistive; Ceramic
Range	9 m (30 ft) (Burst: 18 m; 60 ft) 30 m (100 ft) (Burst: 40 m; 134 ft) 76 m (250 ft) (Burst: 112 m; 368 ft)	7 to 30 psi; 0.5 to 2 bar
Accuracy[4]	±0.1% full scale (FS) typical ±0.3% FS max.	±0.1% FS typical ±0.3% FS max.
Resolution	±0.01% FS or better	±0.01% FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg
Temperature Sensor	Silicon	Silicon
Accuracy	±0.3° C	±0.3° C
Resolution	0.01° C or better	0.01° C or better
Units of measure	Celsius or Fahrenheit	Celsius or Fahrenheit
Warranty	2 years	2 years

Notes: [1]Temperature range for non-freezing liquids. [2]Typical battery life when used within the factory-calibrated temperature range. [3]1 data record = date/time plus 2 parameters logged for a total of 360,000 data points, no wrapping. [4]Across factory-calibrated pressure and temperature ranges. Delrin is a registered trademark of E.I. du Pont de Nemours & Co. Specifications are subject to change without notice. Android is a trademark of Google Inc.

VuSitu Mobile App for Wireless Connection

Use the VuSitu Mobile App to view results instantly from your Android™ smartphone or tablet when connected to the Wireless Rugged TROLL Com. Consolidate all site information and tag data with site photos and GPS coordinates. Log data to your smartphone and download results in a standard .csv file format.

Rugged TROLL® 200 Cable

Access real-time data by using Rugged TROLL 200 Cable with a Rugged TROLL 200 or a Rugged BaroTROLL. Use a Cable Suspension Kit to anchor the cable in place. Available configurations:

- Modbus/RS485 stripped-and-tinned cable or SDI-12 stripped-and-tinned cable—Use with PLC, telemetry system, or logger.
- Modbus/RS485 top-of-well cable—Use with Rugged TROLL Com Device and a RuggedReader® Handheld PC or a PC.

Jacket options	TPU (thermoplastic polyurethane)
Conductors	4 conductors, 24 AWG, polypropylene insulation
Diameter	Cable: 5.1 mm (0.200 in.) Connector: 26.1 mm (1.03 in.)
Cable lengths	Modbus/RS485: Customizable up to 300 m (1,000 ft) SDI-12: Standard lengths up to 60 m (200 ft)
Minimum bend radius	5X cable diameter
Break strength	68 kg (150 lbs)

Wireless Rugged TROLL® Com Communication Device

Use the Wireless Rugged TROLL Com Device for communication between a cabled Rugged TROLL 100/200 or a cabled Rugged BaroTROLL and a RuggedReader Handheld PC or a laptop/PC.

Operating temp. range	-5-50° C (23-122° F), 95% relative humidity, non-condensing
Storage temp. range	-20-50° C (-4-122° F), 95% relative humidity, non-condensing*
Materials	PC/ABS blend, Silicon, Urethane, Stainless Steel, Brass, Santoprene, Poron, Polyethylene, Versapor, Titanium, PEEK, Viton
Environmental rating	IP67
Dimensions (LxWxH) Weight (with batteries)	6.3 x 1.710 x 1.210 in. 165 g
Communication Protocol	Android: SPP; Windows: SPP or USB
Output connection	Bluetooth and USB communication
Battery type	1 3.7V 8600mWHr Lithium Rechargable cell (UBBL19-FL)
Charging requirements	5VDC USB charger (1A or 500 mA)
Certifications	CE, FCC (SSSBC127-X), WEEE
Warranty	1 year

APPENDIX B

Ballinger Creek Manual Discharge Field Sheets

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 1.93	Stream: Ballinger Creek
Date: 12/16/16	Start Time: 1000	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.93	Method: **Wading** / Culvert
	End Time: 1005	

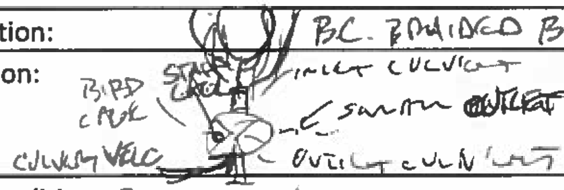
Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
BASE FLOW CONDITIONS; LOW + VERY CLEAR FLOW

Cross Section Location: BC. BRAIDED BEFORE ENTERING CULVERT

Sketch of XS Location:



Control Feature/Condition: BIRD CAGE / GOOD

Weather: SUNNY + COLD, ~ 34°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
[CULVERT H_2O DEPTH: 0.18 FT / VELC. 0.75 FPS] MANUAL DISCH.
INLET CULVERT: 2.5 FT DIAMETER CMP
SIDE CULVERT - 1.0 FT DIA CMP / OUTLET: 2.5 DIA CONCRETE PIPE

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5		NA	23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.11	Entered into Ballinger Creek Database? Y Date: 12/19/16 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 4.92 ft	Stream: Ballinger Creek
Date: 2016-12-16	Start Time: 10:36	Client: City of Shoreline
Observer Initials: JB/AS	Gauge End Height: 4.92 ft	Method: Wading / Culvert
	End Time: 10:56	

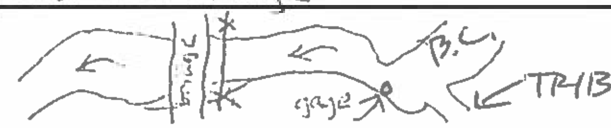
Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): BASE FLOW CONDITIONS; LOW, VERY CLEAR FLOW

Cross Section Location: 0.5 ft upstream of pedestrian bridge

Sketch of XS Location:



Control Feature/Condition:

Weather: COLD & CLEAR

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 1.0		LB Distance (ft): 8.0	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.0	0	0	19 8.0	0	0
2 1.4	0.05	0	20		
3 1.8	0.1	0	21		
4 2.2	0.4	0.17	22		
5 2.6	0.55	0.16	23		
6 3.0	0.55	0.18	24		
7 3.4	0.55	0.20	25		
8 3.8	0.52	0.22	26		
9 4.2	0.51	0.17	27		
Time / SG: 4.92 (1044)			Time / SG:		
10 4.6	0.50	0.15	28		
11 5.0	0.44	0.15	29		
12 5.4	0.50	0.08	30		
13 5.8	0.47	0.05	31		
14 6.2	0.33	0.05	32		
15 6.6	0.22	0.04	33		
16 7.0	0.15	0.01	34		
17 7.4	0.05	0	35		
18 7.8	0.05	0	36		
Time / SG: 4.92 (1052)			Time / SG:		
Flow (cfs): 0.32			Entered into Ballinger Creek Database? Y Date: 12/19/16 Initials: AS		

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 4.55	Stream: Ballinger Creek
Date: 12/16/16	Start Time: 1105	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 4.55	Method: **Wading** / Culvert
	End Time: 1110	

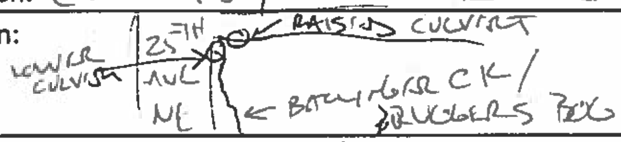
Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
BASE FLOW CONDITIONS; LOW + VERY CLEAR FLOW

Cross Section Location: BC CULVERTS / 25TH AVE NE

Sketch of XS Location:



Control Feature/Condition: 2 CULVERTS / GOOD

Weather: SUNNY + COLD (~36°F)

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
LOWER CULVERT: 2FT DIA CMP / 0.25FT DEPTH, VELC 0.35 FPS
UPPER CULVERT: 2FT DIA / 0FT/0FPS – NO FLOW

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3		NA	21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.45	Entered into Ballinger Creek Database? Y Date: 12/19/16 Initials: AS

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 0.80 ft	Stream: Ballinger Creek
Date: 2016-12-16	Start Time: 13:00	Client: City of Shoreline
Observer Initials: AS, JB	Gauge End Height: ~~13:08~~ 0.80	Method: Wading / Culvert
	End Time: 13:08	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
BASE FLOW CONDITIONS; LOW + VERY CLEAR

Cross Section Location: DS of BC-4 30' US of 20" DBH Alder in RB Gabions

Sketch of XS Location:

Control Feature/Condition:

Weather: COLD & CLEAR

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
RB SMALL DEBRIS JAM 5' UPSTREAM PUSHING FLOW TO LB, FORMING SMALL RB EDDY

Measurement Data — RB Distance (ft): 0.4 ft — LB Distance (ft): 5.6 ft

#	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	#	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.4	0	0	19	5.6	0	0
2	0.7	0.05	0	20			
3	1.0	0.22	-0.18	21			
4	1.3	0.28	-0.17	22			
5	1.6	0.25	-0.14	23			
6	1.9	0.25	-0.13	24			
7	2.2	0.25	-0.17	25			
8	2.5	0.30	-0.05	26			
9	2.8	0.45	-0.07	27			
Time / SG:				Time / SG:			
10	3.1	0.55	0.15	28			
11	3.4	0.62	0.25	29			
12	3.7	0.62	0.40	30			
13	4.0	0.69	0.61	31			
14	4.3	0.75	0.71	32			
15	4.6	0.75	0.65	33			
16	4.9	0.71	0.56	34			
17	5.2	0.70	0.25	35			
18	5.5	0.60	0	36			
Time / SG:				Time / SG:			

Flow (cfs): 0.677

Entered into Ballinger Creek Database? Y
Date: 12/19/16 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.40 FT	Stream: Ballinger Creek
Date: 12/19/16	Start Time: 2138	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.40 FT	Method: **Wading** / Culvert
	End Time: 2140	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): MINIMAL TURBULANCE AROUND GAGE, CAN HEAR COBBLE MOVING THROUGH CULVERTS

Cross Section Location: CULVERT INLET IN BIRDCAGE

Sketch of XS Location:

Control Feature/Condition: CULVERTS / OK

Weather: STEADY RAIN, ~42°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT DEPTH: 0.65 FT
CULVERT VELOCITY: 4.10 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 4.16	Entered into Ballinger Creek Database? Y Date: 12/20/16 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.41	Stream: Ballinger Creek
Date: 2016-12-19	Start Time: 22:00	Client: City of Shoreline
Observer Initials: JB, AS	Gauge End Height: 5.38	Method: Wading / Culvert
	End Time: 22:15	

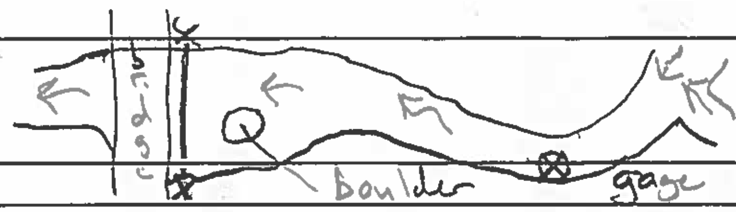
Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
SMOOTH FLOW, TURBID

Cross Section Location:

Sketch of XS Location:



Control Feature/Condition:

Weather: RAINY

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data — RB Distance (ft): — LB Distance (ft):

	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)		Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.6	Ø	Ø	19	13.2	0.05	Ø
2	~~0.7~~ 1.3	0.35	0.47	20	13.9	Ø	Ø
3	~~1.4~~ 2.0	~~1.0~~ 0.5	0.98	21	14.6	Ø	Ø
4	~~2.1~~ 2.7	0.95 ~~1.15~~	1.07	22			
5	~~2.8~~ 3.4	0.95	1.15	23			
6	~~3.5~~ 4.1	0.9	1.11	24			
7	4.8	0.8	1.28	25			
8	5.5	0.85	1.27	26			
9	6.2	0.75	0.86	27			
Time / SG:				Time / SG:			
10	6.9	0.6	0.56	28			
11	7.6	0.5	0.36	29			
12	8.3	0.35	0.17	30			
13	9.0	0.1	0.02	31			
14	9.7	0.1	0.03	32			
15	10.4	0.15	0.05	33			
16	11.1	0.15	0.02	34			
17	11.8	0.1	0.04	35			
18	12.5	0.05	0	36			
Time / SG:				Time / SG:			

Flow (cfs): 4.16

Entered into Ballinger Creek Database? Y
Date: 12/20/16 Initials: AP

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC - 3	Gauge Start Height: 5.29	Stream: Ballinger Creek
Date: 2016-12-19	Start Time: 22:19	Client: City of Shoreline
Observer Initials: JB, AS	Gauge End Height: 5.26	Method: **Wading** / **Culvert**
	End Time: 22:24	

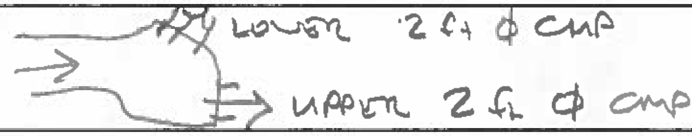
Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
STREAM FLOW UPWELLING AROUND GAGE, CAUSING MODERATE TURBULANCE, FLOW ALSO APPEARS TURBID

Cross Section Location:

Sketch of XS Location:



Control Feature/Condition:

Weather: RAINY

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
COBBLE/GRAVEL IN ENTRANCE TO LOWER CULVERT

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 LOWER	1.55	1.45	19		
2			20		
3 UPPER	0.5	1.34	21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 3.81 + 0.82 = 4.63	Entered into Ballinger Creek Database? Y Date: 12/20/16 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.30	Stream: Ballinger Creek
Date: 2016-12-16	Start Time: 22:35	Client: City of Shoreline
Observer Initials: JB, AS	Gauge End Height: 1.29	Method: Wading / Culvert
	End Time: 22:46	

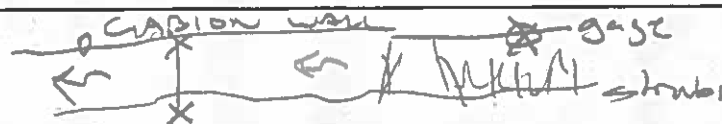
Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
MINIMAL TURBULANCE AROUND GAGE, FLOW TURBID

Cross Section Location:

Sketch of XS Location:



Control Feature/Condition: GABYON WALL / OK

Weather: RAINY

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
NONE PROBLEMS OBSERVED

Measurement Data		RB Distance (ft): 0.3		LB Distance (ft): 7.9	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.3	Ø	Ø	19 7.5	Ø	Ø
2 0.7	0.87	0.1	20 7.9		
3 1.1	1.0	0.5	21		
4 1.5	1.05	0.9	22		
5 1.9	1.05	0.55	23		
6 2.3	1.1	0.25	24		
7 2.7	1.2	0.4	25		
8 3.1	1.32	0.5	26		
9 3.5	1.4	0.8	27		
Time / SG:			Time / SG:		
10 3.9	1.4	1.0	28		
11 4.3	1.47	1.14	29		
12 4.7	1.5	1.07	30		
13 5.1	1.45	0.83	31		
14 5.5	1.4	0.19	32		
15 5.9	0.4	0.55	33		
16 6.3	0.28	0.18	34		
17 6.7	0.16	Ø	35		
18 7.1	0.05	Ø	36		
Time / SG:			Time / SG:		

Flow (cfs): 4.426	Entered into Ballinger Creek Database? Y Date: 12/20/16 Initials: AJ

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC - 1	Gauge Start Height: 2.35	Stream: Ballinger Creek
Date: JAN 18, 2017	Start Time: 10:15	Client: City of Shoreline
Observer Initials: JB, AS	Gauge End Height: 10:17	Method: **Wading** / Culvert
	End Time: 2:35	

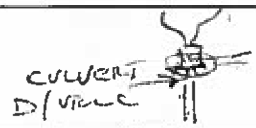
Gauging Assessment: ~~Circle One~~ *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
FLOWS ELEVATED, MODERATELY TURBID, MINIMAL TURBULANCE OBS. AROUND CAGE

Cross Section Location: CULVERT IN BIRD CAGE

Sketch of XS Location:



Control Feature/Condition: CULVERT / FREE FLOWING

Weather: RAIN, HIGH CLOUDS, MODERATE TEMP

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT DEPTH: 0.65
CULVERT VELOCITY 3.08

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 3.12	Entered into Ballinger Creek Database? Y Date: 1/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC - 2	Gauge Start Height: 5.42	Stream: Ballinger Creek
Date: 2016-01-18	Start Time: 10:39	Client: City of Shoreline
Observer Initials: JB, AS	Gauge End Height: 5.40	Method: Wading / Culvert
	End Time: 10:58	

Gauging Assessment: ~~Circle One~~ *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. ~~turbulence~~ around gauge, lots of material in water, etc.):

N/C, No turbulence (upstream) around gage

Cross Section Location: 0.5 ft US of FOOT BRIDGE

Sketch of XS Location:

NO CHANGE FROM 12/19/2016

Control Feature/Condition:

Weather: RAIN, MODERATE TEMP.

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

No unusual stream conditions observed

Measurement Data — RB Distance (ft): 0.8 — LB Distance (ft): 13.7

	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)		Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.8	Ø	Ø	19	13.4	0.1	0.05
2	1.5	0.35	0.66	20	13.7	Ø	Ø
3	2.2	0.55	0.79	21			
4	2.9	0.9	1.09	22			
5	3.6	0.9	1.30	23			
6	4.3	0.95	1.56	24			
7	5.0	1.0	1.64	25			
8	5.7	1.0	1.28	26			
9	6.4	0.8	0.98	27			
Time / SG:				Time / SG:			
10	7.1	0.6	0.66	28			
11	7.8	0.4	0.45	29			
12	8.5	0.3	0.47	30			
13	9.2	0.2	0.40	31			
14	9.9	0.15	0.20	32			
15	10.6	0.15	0.10	33			
16	11.3	0.2	0.10	34			
17	12.0	0.15	0.09	35			
18	12.7	0.1	0.05	36			
Time / SG:				Time / SG:			

Flow (cfs): 6.221	Entered into Ballinger Creek Database? Y Date: 1/19/16 Initials: AC

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.32	Stream: Ballinger Creek
Date: 2017-01-18	Start Time: 11:13	Client: City of Shoreline
Observer Initials: JB, AS	Gauge End Height: 5.29	Method: **Wading** / Culvert
	End Time: 11:15	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): UPWELLING @ GAGE ; VEG OVER WATER, UPSTREAM

Cross Section Location:

Sketch of XS Location: 2' CMP: UPPER 2' CMP: LWR

VEG, DEBRIS BRIDGE

Control Feature/Condition:

Weather: LOW CLOUD, NO RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2 ~~LOWER~~	~~2.05~~		20		
3 LOWER	1.55	1.52	21		
4			22		
5 UPPER	0.55	1.53	23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 4.00 + 1.10 = 5.10	Entered into Ballinger Creek Database? Y Date: 1/19/17 Initials: AS

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #:	BC-4	Gauge Start Height:	1.27	Stream: Ballinger Creek
Date:	2017-01-18	Start Time:	11:36	Client: City of Shoreline
Observer Initials:	JB, AS	Gauge End Height:	1.18	Method: Wading / Culvert
		End Time:	11:53	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): 4 cm ϕ stick racked against staff gage, ADDITIONAL WOODY DEBRIS MOVED @ DISCHARGE (MANUAL) SITE

Cross Section Location: @ POINT OF COMPLIANCE MARKER

Sketch of XS Location: NO CHANGE FROM 2016-12-16

Control Feature/Condition:

Weather: CLEARING, NO RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 0.5		LB Distance (ft): 7.3	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.5	~~Ø~~ 0.8	Ø	19 6.8	0.1	Ø
2 0.85	0.8	0.3	20 7.15	Ø	Ø
3 1.2	0.95	0.3	21		
4 1.55	1.0	0.41	22		
5 1.9	1.0	0.63	23		
6 2.25	1.1	0.66	24		
7 2.6	1.1	0.84	25		
8 2.95	1.0	1.03	26		
9 3.3	1.0	1.0	27		
Time / SG:			Time / SG:		
10 3.65	1.1	0.85	28		
11 4.0	1.15	1.0	29		
12 4.35	1.2	1.1	30		
13 4.7	1.3	0.88	31		
14 5.05	1.3	0.68	32		
15 5.4	1.3	0.40	33		
16 5.75	1.1	0.10	34		
17 6.1	0.3	0.03	35		
18 6.45	0.2	-0.01	36		
Time / SG:			Time / SG:		

Flow (cfs): 3.96	Entered into Ballinger Creek Database? Y Date: 1/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.31	Stream: Ballinger Creek
Date: 2/8/17	Start Time: 1952	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.31	Method: Wading / Culvert
	End Time: 2000	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): MODERATE TURB. AROUND GAGE, CREEK FLOW MODERATELY TURBID

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition:

Weather: LIGHT RAIN, COOL ~ 39°C

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
DEPTH: 0.65
VELOCITY: 2.68 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 2.72	Entered into Ballinger Creek Database? Y Date: 2/10/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

...#: BC-1	Gauge Start Height: 2.34	Stream: Ballinger Creek
2/15/17	Start Time: 1300	Client: City of Shoreline
...ver Initials: AS	Gauge End Height: 2.34	Method: **Wading** / Culvert
	End Time: 1302	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
ELEVATED FLOW, LOW-MODERATE TURBIDITY

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: CULVERTS / OK

Weather: STEADY RAIN, MODERATE INTENSITY

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
DEPTH 0.65 FT
VELOCITY 4.01 FPS

Measurement Data N/A		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 4.07	Entered into Ballinger Creek Database? Y Date: 2/16/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.57	Stream: Ballinger Creek
Date: 2.15.17	Start Time: 1456	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.58	Method: **Wading** / Culvert
	End Time: 1457 1458	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
RISING, TURBID

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: CULVERTS / OK

Weather: STEADY RAIN; MED-HEAVY PRECIP

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT (OUTLET) DEPTH: 0.90 FT
VELOCITY: 4.23 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 6.73	Entered into Ballinger Creek Database? Y Date: 2/16/17 Initials: AC

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.37	Stream: Ballinger Creek
Date: 2-15-17	Start Time: ~~8~~ 1317	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.48	Method: Wading Culvert
	End Time: 1337	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): MINIMAL TURBULENCE AROUND GAGE, MODERATE TURBIDITY

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: BRIDGE/LARGE ROCK/UNCHANGED

Weather: STEADY RAIN, MODERATE TO HEAVY AT TIMES

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.): CREEK FLOWING NORMALLY

Measurement Data		RB Distance (ft): 0.6		LB Distance (ft): 11.6	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.6	0	0	19 9.6	0.45	0.32
2 1.1	0.45	0.40	20 10.1	0.30	0.05
3 1.6	0.70	0.73	21 10.6	0.25	0.05
4 2.1	0.70	0.83	22 11.1	0.20	0
5 2.6	0.95	0.88	23 11.8	0	0
6 3.1	0.95	1.01	24 ~~4~~		
7 3.6	0.95	1.35	25		
8 4.1	1.05	1.55	26		
9 4.6	1.15	1.65	27		
Time / SG: 1327 / 5.40			Time / SG:		
10 5.1	0.90	1.20	28		
11 5.6	1.05	1.07	29		
12 6.1	1.0	0.72	30		
13 6.6	0.8	0.42	31		
14 7.1	0.65	0.12	32		
15 7.6	0.50	0.27	33		
16 8.1	0.40	0.50	34		
17 8.6	0.40	0.77	35		
18 9.1	0.45	0.57	36		
Time / SG:			Time / SG:		

Flow (cfs): 6.26	Entered into Ballinger Creek Database? Y Date: 2/16/17 Initials: AS

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.55	Stream: Ballinger Creek
Date: 2.15.17	Start Time: 17:35	Client: City of Shoreline
Observer Initials: AJ/SB	Gauge End Height: 5.50	Method: Wading / Culvert
	End Time: 17:48	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

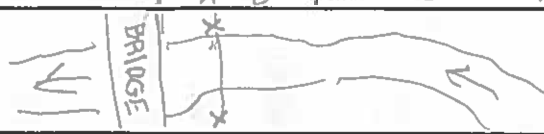
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

LESS TURBID THAN OTHER DAYS

Cross Section Location: 2' N. OF PED. BRIDGE

Sketch of XS Location:



Control Feature/Condition:

Weather: RAIN, MODERATE → LIGHT

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.5	∅	∅	19 9.5	0.5	0.92
2 1.0	0.5	0.71	20 10.0	0.3	0.20
3 1.5	0.8	0.88	21 10.5	0.2	0.0
4 2.0	1.0	0.77	22 11.0	0.25	0.0
5 2.5	1.0	1.09	23 11.5	∅	∅
6 3.0	1.05	1.43	24		
7 3.5	1.05	1.79	25		
8 4.0	1.25	1.88	26		
9 4.5	1.2	2.02	27		
Time / SG: 17:40 / 5.55			Time / SG:		
10 5.0	1.25	1.69	28		
11 5.5	1.2	1.17	29		
12 6.0	1.0	0.73	30		
13 6.5	0.9	0.55	31		
14 7.0	0.8	0.12	32		
15 7.5	0.6	0.10	33		
16 8.0	0.45	0.36	34		
17 8.5	0.5	0.63	35		
18 9.0	0.55	0.86	36		
Time / SG: 17:45 / 5.53			Time / SG:		
Flow (cfs): 8.69			Entered into Ballinger Creek Database? Date: Initials:		

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet		
Flow Station #: BC-3	Gauge Start Height: 5.49	Stream: Ballinger Creek
Date: 2.15.17	Start Time: 1342	Client: City of Shoreline
Observer Initials: AK	Gauge End Height: 5.54	Method: **Wading** / Culverts
	End Time: 1348	

Gauging Assessment: Circle One *(within ~~_%~~ deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
CONSIDERABLE UPWELLING AROUND GAGE, LOTS OF BLACKBERRY PLANTS + OTHER VEG

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: CULVERTS / LOTS OF VEG HUNG UP IN LOWER CULVERT

Weather: STEADY RAIN, MODERATE TO HEAVY

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
LOWER CULVERT DEPTH 1.85 FT VELC 2.38 FPS | UPPER CULVERT DEPTH: 0.75 FT VELC: 2.18 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 17.25 + 2.4 = 19.65	Entered into Ballinger Creek Database? Y Date: 2/16/17 Initials: AK

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.54	Stream: Ballinger Creek
Date: 2017-02-15	Start Time: 17:58	Client: City of Shoreline
Observer Initials: AS, JB	Gauge End Height: 5.50	Method: Wading / Culvert
	End Time: 18:00	

Gauging Assessment: Circle One *(within % deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition:

Weather: STOPPED RAINING - MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

VEG. IMPEDING FLOW @ CULVERT ENTRANCES, VINES PULLED INTO UPPER CULVERT ENTRANCE

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2 LWR CULV.	1.85	2.26	20		
3			21		
4 ~~UPPER CULV~~			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG: 17:58 / 5.50			Time / SG:		
10			28		
11 UPPER			29		
12 CULV.	0.75	1.73	30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		
Flow (cfs): 6.9 + 1.9 = 8.8			Entered into Ballinger Creek Database? Y Date: 2/16/17 Initials: AS		

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.53	Stream: Ballinger Creek
Date: 2-15-17	Start Time: 1407	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.52	Method: Wading / Culvert
	End Time: 1431	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: GABION WALL + WETLAND VEG / OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

#16 BELOW LEDGE

Measurement Data			RB Distance (ft): 0.30		LB Distance (ft): 7.0	
	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.3	0	0	19: 5.7	0.80	0.84
2	0.6	0.9	0.34	20: 6.0	0.60	0.94
3	0.9	1.2	0.69	21: 6.3	0.4	0.65
4	1.2	1.4	1.04	22: 6.6	0.3	0.87
5	1.5	1.3	1.12	23: 7.0	0.2	0
6	1.8	1.35	1.16	24		
7	2.1	1.35	1.20	25		
8	2.4	1.40	1.43	26		
9	2.7	1.50	1.83	27		
Time / SG:	1.55 / 1416			Time / SG:		
10	3.0	1.55	1.76	28		
11	3.3	1.55	1.53	29		
12	3.6	1.55	1.51	30		
13	3.9	1.6	1.67	31		
14	4.2	1.55	1.84	32		
15	4.5	1.5	1.3	33		
16	4.8	1.5	0.05	34		
17	5.1	1.3	0.5	35		
18	5.4	1.3	0.10	36		
Time / SG:				Time / SG:		

Flow (cfs): 8.84	Entered into Ballinger Creek Database? Y Date: 2/15/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.04 FT	Stream: Ballinger Creek
Date: 3/17/17	Start Time: 1139	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.06 FT	Method: Wading / Culvert
	End Time: 1143	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): LOW, CLEAR BASE FLOW CONDITIONS

Cross Section Location: CULVERTS / OK

Sketch of XS Location: SAME AS PREVIOUS RATING CURVE / MANUAL DISCH. MEASUREMENTS

Control Feature/Condition: CULVERTS / GOOD

Weather: OVERCAST + MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
DEPTH: 0.30 FT
VELC: 1.21 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.40	Entered into Ballinger Creek Database? Y Date: 3/22/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.03	Stream: Ballinger Creek
Date: 3/17/17	Start Time: 1210	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.00	Method: Wading / Culvert
	End Time: 1225	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
LOW, CLEAR BASE FLOW CONDITIONS

Cross Section Location: —

Sketch of XS Location: SAME AS PREVIOUS MONITORING EVENTS

Control Feature/Condition:

Weather: OVERCAST W/ MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
—

Measurement Data		RB Distance (ft): 1.1		LB Distance (ft): 10.3	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.1	0	0	19 8.3	0.2	0
2 1.5	0.25	0.08	20 8.7	0.25	0
3 1.9	0.55	0.25	21 9.1	0.25	0
4 2.3	0.65	0.25	22 9.5	0.15	0
5 2.7	0.75	0.18	23 9.9	0.05	0
6 3.1	0.75	0.23	24 10.3	0	0
7 3.5	0.75	0.31	25		
8 3.9	0.75	0.26	26		
9 4.3	0.80	0.26	27		
Time / SG:			Time / SG:		
10 4.7	0.75	0.24	28		
11 5.1	0.80	0.27	29		
12 5.5	0.80	0.33	30		
13 5.9	0.75	0.16	31		
14 6.3	0.65	0.08	32		
15 6.7	0.6	0.07	33		
16 7.1	0.5	0	34		
17 7.5	0.35	-0.07	35		
18 7.9	0.3	0	36		
Time / SG:			Time / SG:		

Flow (cfs): 0.843	Entered into Ballinger Creek Database? Y Date: 3/22/17 Initials: AS

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 4.70	Stream: Ballinger Creek
Date: 3/17/17	Start Time: 1255	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 4.70	Method: Wading Culvert
	End Time: 1300	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): - MINIMAL TURBULANCE AROUND GAGE, LOW/CLEAR BASE FLOW
* REMOVED SUBMERGED VEGETATION AROUND CULVERTS

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: CULVERTS (MUCH IMPROVED AFTER REMOVING VEGETATION IN CULVERT)

Weather: MILD TEMPS (~50 °F), LIGHT RAIN BEGINNING

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
LOWER CULVERT DEPTH: 1.10 FT
VELC: 0.54 FPS
(LOWER CULVERT)
UPPER CULVERT DRY/NO FLOW

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.96	Entered into Ballinger Creek Database? Y Date: 3/22/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 0.70	Stream: Ballinger Creek
Date: 3/17/17	Start Time: 1327	Client: City of Shoreline
Observer Initials: AR	Gauge End Height: 0.70	Method: Wading / Culvert
	End Time: 1340	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): MINIMAL TURBULANCE AROUND GAGE, CREEK FLOW LOW + CLEAR

Cross Section Location: SAME AS PREVIOUS EVENTS

Sketch of XS Location:

Control Feature/Condition:

Weather: LIGHT RAIN W/MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.): REMOVED MINOR AMOUNT OF STICKS/DEBRIS AROUND GAGE

Measurement Data		RB Distance (ft): 0.3		LB Distance (ft): 5.4	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.3	Ø	Ø	19		
2 0.6	0.20	0.28	20		
3 0.9	0.30	0.45	21		
4 1.2	0.30	0.45	22		
5 1.5	0.35	0.65	23		
6 1.8	0.45	0.35	24		
7 2.1	0.45	0.08	25		
8 2.4	0.45	-0.05	26		
9 2.7	0.45	0	27		
Time / SG:			Time / SG:		
10 3.0	0.45	-0.10	28		
11 3.3	0.50	-0.14	29		
12 3.6	0.55	0	30		
13 3.9	0.60	0.44	31		
14 4.2	0.60	0.50	32		
15 4.5	0.60	0.85	33		
16 4.8	0.65	1.20	34		
17 5.1	0.60	1.17	35		
18 5.4	Ø	Ø	36		
Time / SG:			Time / SG:		

Flow (cfs): 0.95	Entered into Ballinger Creek Database? Y Date: 3/22/17 Initials: AR

Herrera - Ballinger Creek - Stream Flow Data Sheet		
Flow Station #: BC-1	Gauge Start Height: 2.09	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1335	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.09	Method: Wading & Culvert
	End Time: 1340	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- RELATIVELY LOW, CLEAR FLOW CONDITIONS

Cross Section Location: —

Sketch of XS Location: —

Control Feature/Condition: CULVERTS / OK

Weather: LIGHT RAIN W/ MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
MANUAL DISCHARGE IN CULVERT: DEPTH: 0.33 FT
VELOCITY: 1.26 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.47

Entered into Ballinger Creek Database? Y
Date: 6/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.05	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1534	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.05	Method: Wading / Culvert
	End Time: 1535	

Gauging Assessment: ~~Circle One~~ *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- FLOWS LOWER, CLEAR
- STILLING WELL BURRIED IN SAND, REMOVED SAND WHEN ACCESSING DATA LOGGER

Cross Section Location: —

Sketch of XS Location: —

Control Feature/Condition: CULVERTS / OK

Weather: SPOTTY LIGHT RAIN, OVERCAST

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

DEPTH : 0.27 FT
VELC : 0.83 FPS
DATA DOWNLOAD COMPLETE

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.24	Entered into Ballinger Creek Database? Y Date: 6/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.13	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1358	Client: City of Shoreline
Observer Initials: AT	Gauge End Height: 5.15	Method: Wading Culvert
	End Time: 1425	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- FLOWS SLIGHTLY ELEVATED, TURBID, LOTS OF VEGETATION OVERGROWN + SUBMERGED IN CREEK ALONG BOTH BANKS

Cross Section Location: UPSTREAM OF PEDESTRIAN BRIDGE

Sketch of XS Location: NA

Control Feature/Condition: LB + RB'S / OVERGROWN VEG MAY IMPACT GAGE LEVELS DURING HIGH FLOW EVENTS

Weather: OSTEADY RAIN + MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- SEE FLOW COMMENTS ABOVE

Measurement Data		RB Distance (ft): 0.8		LB Distance (ft): 8.8	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.8	0	0	19 8.0	0.10	0.06
2 1.2	0.12	0.26	20 8.4	0.05	0
3 1.6	0.20	0.31	21 8.8	0.05	0
4 2.0	0.40	0.58	22 9.1	0	0
5 2.4	0.55	0.54	23		
6 2.8	0.55	0.55	24		
7 3.2	0.55	0.59	25		
8 3.6	0.65	0.54	26		
9 4.0	0.70	0.45	27		
Time / SG: 1411	/ 5.13		Time / SG:		
10 4.4	0.70	0.56	28		
11 4.8	0.65	0.59	29		
12 5.2	0.70	0.61	30		
13 5.6	0.70	0.57	31		
14 6.0	0.65	0.39	32		
15 6.4	0.55	0.47	33		
16 6.8	0.45	0.34	34		
17 7.2	0.30	0.25	35		
18 7.6	0.25	0.22	36		
Time / SG: 1425 / 5.15			Time / SG:		

Flow (cfs): 1.73	Entered into Ballinger Creek Database? Y Date: 6/19/17 Initials: AT

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 4.95	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1605	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 4.94	Method: Wading / Culvert
	End Time: 1617	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
CLEAR, APPROACHING BASEFLOW CONDITIONS

Cross Section Location: —

Sketch of XS Location: —

Control Feature/Condition: LB+RB's / OK

Weather: PERIODIC LIGHT RAIN SHOWERS, MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
DATA DOWNLOAD PERFORMED

Measurement Data		RB Distance (ft): 1.0		LB Distance (ft): 8.3	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.0	0	0	19 8.25	0	0
2 1.4	0.10	0	20		
3 1.8	0.40	0.13	21		
4 2.2	0.45	0.22	22		
5 2.6	0.50	0.20	23		
6 3.0	0.60	0.24	24		
7 3.4	0.60	0.24	25		
8 3.8	0.60	0.23	26		
9 4.2	0.60	0.18	27		
Time / SG: —			Time / SG:		
10 4.6	0.55	0.17	28		
11 5.0	0.60	0.16	29		
12 5.4	0.60	0.14	30		
13 5.8	0.55	0.15	31		
14 6.2	0.45	0.12	32		
15 6.6	0.35	0.10	33		
16 7.0	0.25	0.05	34		
17 7.4	0.15	0.05	35		
18 7.8	0.05	0	36		
Time / SG: —			Time / SG:		

Flow (cfs): 0.500	Entered into Ballinger Creek Database? Y Date: 6/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 4.86	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1442	Client: City of Shoreline
Observer Initials: AC	Gauge End Height: 4.86	Method: **Wading** / Culvert
	End Time: 1445	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- FLOWS ARE ELEVATED + TURBID, MINIMAL TURBULENCE AROUND GAGE, MINIMAL AMT'S OF VEG. CAUGHT IN LOWER CULVERT

Cross Section Location: SAME AS PREVIOUS MEASUREMENTS

Sketch of XS Location: " "

Control Feature/Condition: CULVERTS / OK

Weather: OVERCAST, RAIN STOPPED

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
LOWER CULVERT DEPTH: 1.20 VELOCITY: 0.69
UPPER CULVERT DEPTH: 0.20 VELOCITY: 0.25

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 1.36 + 0.04 = 1.40	Entered into Ballinger Creek Database? Y Date: 6/19/17 Initials: AC

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 4.63	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1658	Client: City of Shoreline
Observer Initials: KS	Gauge End Height: 4.63	Method: **Wading** / **Culvert**
	End Time: 1702	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
LOW FLOW / BASE FLOW CONDITIONS

Cross Section Location: NA

Sketch of XS Location: NA

Control Feature/Condition:

Weather: OVERCAST W/ VERY LIGHT RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- DOWNLOADED DATA F/ BAROTROLL + BC-3 DATA LOGGER
LOWER CULVERT: DEPTH: 1.0 FT
VELOCITY 0.39 FPS
UPPER CULVERT: NO FLOW

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.61	Entered into Ballinger Creek Database? Y Date: 6/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 0.63	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1540	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 0.63	Method: Wading / Culvert
	End Time: 1552	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- MINIMAL TURBULENCE AROUND GAGE

Cross Section Location: SAME AS PREVIOUS MEASUREMENTS

Sketch of XS Location:

Control Feature/Condition: GABION WALL / OK

Weather: LIGHT RAIN, MILD TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- REMOVED SAND BUILT UP AROUND GAGE, BUT DID NOT APPEAR TO EFFECT WATER LEVELS

Measurement Data		RB Distance (ft): 0.8		LB Distance (ft): 5.6	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.8	0	0	19		
2 1.1	0.15	0.21	20		
3 1.4	0.15	0.20	21		
4 1.7	0	0	22		
5			23		
6 2.8	0	0	24		
7 3.1	0.1	0.41	25		
8 3.4	0.15	1.02	26		
9 3.7	0.25	1.66	27		
Time / SG:			Time / SG:		
10 4.0	0.25	1.25	28		
11 4.3	0.25	1.15	29		
12 4.6	0.20	0.05	30		
13 4.9	0.10	0.06	31		
14 5.2	0.10	0.05	32		
15 5.5	0.10	0.10	33		
16 5.6	0	0	34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.39	Entered into Ballinger Creek Database? Y Date: 6/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 0.78	Stream: Ballinger Creek
Date: 6/15/17	Start Time: 1700	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 0.76	Method: ~~Wading~~ / Culvert
	End Time: 1719	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- FLOWS SLIGHTLY ELEVATED, SLIGHTLY TURBID

Cross Section Location: ~ 10 FEET UPSTREAM OF NORMAL LOCATION / [illegible]

Sketch of XS Location:

Control Feature/Condition: GABION WALL / OK

Weather: OVERCAST, RAIN STILL VERY LIGHT / NO RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
DOWNLOADED DATA FROM DATA LOGGER
BATTERY: 4% (USED)
MEMORY: 31% (USED)

Measurement Data — RB Distance (ft): 0.4 — LB Distance (ft): 5.4

	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)		Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.4	0	0	19			
2	0.7	0.25	0	20			
3	1.0	0.35	0.04	21			
4	1.3	0.35	0.06	22			
5	1.6	0.40	0.33	23			
6	1.9	0.45	0.39	24			
7	2.2	0.45	0.40	25			
8	2.5	0.40	0.96	26			
9	2.8	0.30	1.38	27			
Time / SG: —				Time / SG:			
10	3.1	0.30	1.51	28			
11	3.4	0.25	1.70	29			
12	3.7	0.25	1.79	30			
13	4.0	0.25	1.77	31			
14	4.3	0.20	2.16	32			
15	4.6	0.20	2.09	33			
16	4.9	0.30	1.90	34			
17	5.2	0.35	0.82	35			
18	5.4	0	0	36			
Time / SG: 1719 / 0.76				Time / SG:			

Flow (cfs): 1.424

Entered into Ballinger Creek Database? Y
Date: 6/19/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 1.83	Stream: Ballinger Creek
Date: 8/31/17	Start Time: 1235	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.83	Method: Wading / Culvert
	End Time: 1240	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
LOW, CLEAR BASEFLOW CONDITIONS

Cross Section Location: CULVERT (OUTLET)

Sketch of XS Location:
DEPTH: 0.06 FT / VELOCITY. 0.74 FPS

Control Feature/Condition: CULVERT / OIL

Weather: MOSTLY SUNNY + WARM

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- REMOVED BLACKBERRIES GROWING INTO BIRD GAGE, CLEANED GAUGE
- DOWNLOADED DATA; LOOKS COMPLETE

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.02

Entered into Ballinger Creek Database? Y
Date: 9/6/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 4.86	Stream: Ballinger Creek
Date: 8/31/17	Start Time: 1322	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 4.86	Method: Wading / Culvert
	End Time: 1338	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): VERY LOW, CLEAR BASEFLOW CONDITIONS

Cross Section Location: JUST UPSTREAM OF BRIDGE

Sketch of XS Location: SAME AS PREVIOUS MEASUREMENTS

Control Feature/Condition: STREAMBANKS / OK

Weather: MOSTLY SUNNY + WARM

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
– DOWNLOADED DATA – LOOKS OK, COMPLETE

Measurement Data		RB Distance (ft): 1.0		LB Distance (ft): 7.0	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.0	0	0	19 6.4	0.2	0
2 1.3	0.2	0	20 6.7	0.1	0
3 1.6	0.15	0.10	21 7.0	0	0
4 1.9	0.40	0.06	22		
5 2.2	0.40	0.06	23		
6 2.5	0.50	0.06	24		
7 2.8	0.45	0.06	25		
8 3.1	0.50	0.06	26		
9 3.4	0.50	0.06	27		
Time / SG: 1326 / 4.86			Time / SG:		
10 3.7	0.45	0.06	28		
11 4.0	0.50	0.04	29		
12 4.3	0.40	0.04	30		
13 4.6	0.45	0.04	31		
14 4.9	0.50	0.02	32		
15 5.2	0.45	0.03	33		
16 5.5	0.40	0.02	34		
17 5.8	0.30	0	35		
18 6.1	0.20	0.02	36		
Time / SG: 1332 / 4.86			Time / SG:		
Flow (cfs): 0.09			Entered into Ballinger Creek Database? Y Date: 9/6/17 Initials: AS		

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 4.41	Stream: Ballinger Creek
Date: 8/31/17	Start Time: 1403	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 4.41	Method: Wading / Culvert
	End Time: 1405	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
LOW, CLEAR BASEFLOW CONDITIONS

Cross Section Location: CULVERT

Sketch of XS Location: LOWER CULVERT = DEPTH: 0.75 FT / VEL: 0.05 FPS
UPPER CULVERT: DRY

Control Feature/Condition: CULVERTS / OK

Weather: SUNNY + WARM

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
DATA DOWNLOAD OK - DATA SET COMPLETE
- CLEANED GAUGE
- LOCK MISSING! NEEDS REPLACEMENT

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.05	Entered into Ballinger Creek Database? Y Date: 9/6/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 0.52	Stream: Ballinger Creek
Date: 8/31/17	Start Time: 1438	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 0.52	Method: Wading / Culvert
	End Time: 1447	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
VERY LOW, CLEAR BASEFLOW CONDITIONS

Cross Section Location: ~ 10 FEET UPSTREAM OF USUAL LOCATION

Sketch of XS Location:

Control Feature/Condition: STREAM BANKS / OK

Weather: SUNNY + WARM

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- DATA DOWNLOAD COMPLETE -
- CLEANED GAUGE, REMOVED SAND AROUND CAGE
- STILLING WELL BARELY ENGAGED DUE TO LOW FLOWS

Measurement Data		RB Distance (ft): 0.1		LB Distance (ft): 1.1	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.1	0	0	19		
2 0.4	0.1	0.22	20		
3 0.7	0.2	1.18	21		
4 1.0	0.25	0.71	22		
5 1.1	0	0	23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.11

Entered into Ballinger Creek Database? Y
Date: 9/6/17 Initials: AC

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.62	Stream: Ballinger Creek
Date: 11/21/17	Start Time: 1112	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.62	Method: Wading / Culvert
	End Time: 1118	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- HIGH FLOW, TURBULENCE, + TURBIDITY

Cross Section Location: SAME AS PREVIOUS MEASUREMENTS

Sketch of XS Location:

Control Feature/Condition: CULVERTS / BIRD CAGE - OK

Weather: STEADY RAIN, 45°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- CULVERT OUTLET: DEPTH: 0.95 FT
VELC: 3.63 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 6.21	Entered into Ballinger Creek Database? ✓ Date: 11/22/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.53	Stream: Ballinger Creek
Date: 11/21/17	Start Time: 1130	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.57	Method: Wading / Culvert
	End Time: 1152	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
– MINIMAL TURBULENCE AROUND GAGE

Cross Section Location: SAME AS PREVIOUS

Sketch of XS Location:

Control Feature/Condition: STREAMBANKS/BRIDGE – 9C

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 1.3		LB Distance (ft): 14.5	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.3	0	0	19 13.9	0.15	0
2 2.0	0.50	0.89	20 14.5	0	0
3 2.7	0.70	1.06	21		
4 3.4	0.80	1.31	22		
5 4.1	0.90	1.51	23		
6 4.8	0.95	1.64	24		
7 5.5	0.95	1.92	25		
8 6.2	0.95	2.13	26		
9 6.9	0.80	1.71	27		
Time / SG: 1142/5.56			Time / SG:		
10 7.6	0.70	1.14	28		
11 8.3	0.50	0.80	29		
12 9.0	0.40	0.81	30		
13 9.7	0.30	0.78	31		
14 10.4	0.25	0.65	32		
15 11.1	0.30	0.58	33		
16 11.8	0.30	0.28	34		
17 12.5	0.30	0.24	35		
18 13.2	0.20	0.05	36		
Time / SG: 1152/5.57			Time / SG:		
Flow (cfs): 8.84			Entered into Ballinger Creek Database? ✓ Date: 11/22/17 Initials: AS		

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.75	Stream: Ballinger Creek
Date: 11/21/17	Start Time: 1210	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.78	Method: Wading / Culvert
	End Time: 1218	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- LOTS OF TURBULENCE AROUND GAGE

Cross Section Location:

Sketch of XS Location:
VEGETATION PARTIALLY BLOCKING BOTH CULVERTS

Control Feature/Condition:

Weather:

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
LOWER CULVERT: DEPTH 2.00 FT VELC 1.58 FPS UPPER CULVERT DEPTH 0.70 VELC 2.54
*

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 4.96 + 2.49 = 7.45

Entered into Ballinger Creek Database? ✓
Date: 11/28/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.66	Stream: Ballinger Creek
Date: 11/21/17	Start Time: 1230	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.64	Method: Wading / Culvert
	End Time: 1256	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- MINOR TURBULENCE AROUND CAGE

Cross Section Location: SAME AS PREVIOUS MEASUREMENTS

Sketch of XS Location: " "

Control Feature/Condition: STREAM BANK/GABION WALL OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data			RB Distance (ft): 0.4			LB Distance (ft): 18.3		
	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)		Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.4	0	0	19	10	0.20	0
2	0.9	1.46	0.35	20	12	0.20	0
3	1.4	1.40	0.77	21	13	0.30	0.03
4	1.9	1.50	1.08	22	14	0.25	0.07
5	2.4	1.40	1.30	23	15	0.30	0.06
6	2.9	1.35	1.42	24	16	0.25	0.01
7	3.4	1.35	1.13	25	17	0.10	0
8	3.9	1.30	1.45	26	18	0.05	0
9	4.4	1.38	1.80	27	18.3	0	0
Time / SG:				Time / SG:			
10	4.9	1.46	2.18	28			
11	5.4	1.45	1.36	29			
12	5.9	1.50	0.25	30			
13	6.4	0.70	0.06	31			
14	6.9	0.65	1.30	32			
15	7.4	0.55	0.83	33			
16	7.9	0.45	0.37	34			
17	8.4	0.40	0.55	35			
18	8.9	0.35	0.04	36			
Time / SG: 1249/1.64				Time / SG:			

Flow (cfs): 10.01

Entered into Ballinger Creek Database? ✓
Date: 11/28/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.68	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 0820	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.70	Method: Wading / Culvert
	End Time: 0823	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- LOTS OF TURBULENCE AROUND GAGE W/SAND DEPOSITED AROUND GAGE, TURBID FLOW

Cross Section Location: BIRD CAGE/ CULVERT OUTLET

Sketch of XS Location:

Control Feature/Condition: BIRDCAGE / OK

Weather: STEADY RAIN, COOL TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT DEPTH: 1.05 FT
VELOCITY: 4.17 FPS

Measurement Data | RB Distance (ft): | LB Distance (ft):

Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 8.16

Entered into Ballinger Creek Database? ✓
Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.70	Stream: Ballinger Creek
Date: 12/12/17	Start Time: 0833	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.69	Method: Wading / Culvert
	End Time: 0900	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- MODERATE TURBULENCE AROUND GAGE, TURBID FLOW

Cross Section Location: ~6" UPSTREAM OF BRIDGE

Sketch of XS Location:

Control Feature/Condition: STREAM BANKS /OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 1.0		LB Distance (ft): 14.0	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.0	0	0	19 10	0.30	1.25
2 1.5	0.4	0.37	20 10.5	0.25	1.21
3 2	0.55	1.24	21 11	0.35	1.05
4 2.5	0.75	1.50	22 11.5	0.35	0.80
5 3	0.75	1.26	23 12	0.35	0.62
6 3.5	1.00	1.74	24 12.5	0.30	0.41
7 4	1.00	1.68	25 13	0.30	0.38
8 4.5	1.05	1.80	26 13.5	0.15	0.34
9 5	1.05	1.95	27 14	0	0
Time / SG: 0841/5.70			Time / SG:		
10 5.5	1.05	2.34	28		
11 6	1.05	2.52	29		
12 6.5	1.00	2.47	30		
13 7	0.85	1.95	31		
14 7.5	0.75	1.54	32		
15 8	0.60	1.07	33		
16 8.5	0.55	0.84	34		
17 9	0.50	0.78	35		
18 9.5	0.40	1.01	36		
Time / SG: 0852/5.69			Time / SG:		

Flow (cfs): 12.16	Entered into Ballinger Creek Database? ✓ Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.98	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 0912	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.99	Method: Wading / Culvert
	End Time: 0930	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- LOTS OF TURBULENCE AROUND GAGE, TURBID FLOW, OBSERVED SURFACE FLOW THROUGH BREGGER'S BOG (SMALL CREEK), ENTERING BALL CK BETWEEN BC-2 / BC-3, REMOVED MINIMAL VEG. FROM CULVERTS

Cross Section Location:

Sketch of XS Location:
*CHECKED CB NEARBY; BETTER FLOW DYNAMICS FOR DISCHARGE MEASUREMENTS COMPARED TO MEASURING FLOW AT INLET OF UPPER CULVERT — USED NEW LOCATION IN DISCH. CALCULATION

Control Feature/Condition: CULVERTS

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

LOWER CULVERT DEPTH: 2.0 FT
VELC: 2.42 FPS

UPPER CULVERT — AT GAGE: D: 1.0, V: 1.88 — CB NEARBY: 0.70 FT, 5.60 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 7.79 + 5.49 = 13.28

Entered into Ballinger Creek Database? ✓
Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.80	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 0940	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.67	Method: Wading / Culvert
	End Time: 1005	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
– MODERATE TURBULENCE AROUND GAGE; REMOVED LEAVES BUILT UP ON GAGE, TURBID FLOWS,

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: STREAMBANKS / OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data — RB Distance (ft): 0.5 — LB Distance (ft): 18.0

	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)		Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.5	0	0	19	9.5	0.45	0
2	1.0	1.50	1.09	20	10	0.40	0
3	1.5	1.55	1.23	21	11	0.35	0
4	2.0	1.65	1.27	22	12	0.30	0
5	2.5	1.55	1.55	23	13	0.40	0.01
6	3.0	1.50	1.50	24	14	0.40	0.06
7	3.5	1.45	1.36	25	15	0.40	0
8	4.0	1.45	1.20	26	16	0.40	0.03
9	4.5	1.50	1.22	27	17	0.25	0
Time / SG:				Time / SG:			
10	5	1.50	1.30	28	18	0	0
11	5.5	1.50	1.10	29			
12	6	0.95	1.14	30			
13	6.5	0.80	0.78	31			
14	7	0.65	0.92	32			
15	7.5	0.55	0.83	33			
16	8	0.50	0.56	34			
17	8.5	0.55	0.41	35			
18	9	0.50	0.04	36			
Time / SG:	0955/1.70			Time / SG:			

Flow (cfs): 11.4

Entered into Ballinger Creek Database? ✓
Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.50	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 1040	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.52	Method: Wading / Culvert
	End Time: 1042	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: BIRDCAGE / OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

CULVERT DEPTH: 0.85 FT
VELC: 3.70 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 5.45	Entered into Ballinger Creek Database? ✓ Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.64	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 1102	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.50	Method: Wading Culvert
	End Time: 1125	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

Cross Section Location: ~6" UPSTREAM OF BRIDGE

Sketch of XS Location:

Control Feature/Condition: STREAMBANKS / OK

Weather: STILL RAINING, BUT RAINFALL INTENSITY DROPPING OFF

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data — RB Distance (ft): 1.0 — LB Distance (ft): 14.0

Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.0	0	0	19 10	0.30	0.79
2 1.5	0.40	0.10	20 10.5	0.25	0.75
3 2	0.60	1.21	21 11	0.30	0.61
4 2.5	0.70	1.35	22 11.5	0.30	0.56
5 3	0.70	1.48	23 12	0.30	0.44
6 3.5	0.90	1.69	24 12.5	0.25	0.21
7 4	0.95	1.70	25 13	0.20	0.18
8 4.5	0.90	1.72	26 13.5	0.10	0.11
9 5	0.90	1.71	27 14	0	0
Time / SG: 1111 / 5.59			Time / SG:		
10 5.5	0.95	1.91	28		
11 6	0.95	2.17	29		
12 6.5	0.90	2.22	30		
13 7	0.80	1.91	31		
14 7.5	0.70	1.61	32		
15 8	0.60	1.17	33		
16 8.5	0.50	0.74	34		
17 9	0.40	0.85	35		
18 9.5	0.35	0.90	36		
Time / SG: 1118 / 5.55			Time / SG:		

Flow (cfs): 10.15	Entered into Ballinger Creek Database? ✓ Date: 12/21/17 Initials: AS

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.44	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 1142	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.42	Method: Wading / Culvert
	End Time: 1147	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

Cross Section Location: CULVERTS

Sketch of XS Location:

Control Feature/Condition: CULVERTS / OK

Weather: LIGHT RAIN, GUSTY

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

LOWER CULVERT D: 1.70 FT V: 3.19 FPS | UPPER CULVERT D: 0.40 FT V: 4.62 FPS] MEASURED @ NEARBY CB

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 9.83 + 2.07 = 11.9	Entered into Ballinger Creek Database? ✓ Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.47	Stream: Ballinger Creek
Date: 12/19/17	Start Time: 1158	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.40	Method: **Wading** / Culvert
	End Time: 1216	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition:

Weather: RAIN STOPPED, GUSTY, COOL TEMP'S

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 0.5		LB Distance (ft): 10.0	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.5	0	0	19 9.5	0.10	0
2 1	0.75	0.38	20 10	0	0
3 1.5	1.30	0.92	21		
4 2	1.25	1.13	22		
5 2.5	1.20	1.41	23		
6 3	1.15	1.56	24		
7 3.5	1.10	1.55	25		
8 4	1.15	1.32	26		
9 4.5	1.15	1.11	27		
Time / SG: 1208 / 1.44			Time / SG:		
10 5	1.25	1.10 ~~54~~	28		
11 5.5	1.70	0.80	29		
12 6	0.80	0.80	30		
13 6.5	0.55	0.06	31		
14 7	0.45	0.52	32		
15 7.5	0.40	0.33	33		
16 8	0.30	0.24	34		
17 8.5	0.30	0.01	35		
18 9	0.20	0	36		
Time / SG:			Time / SG:		

Flow (cfs): 7.15	Entered into Ballinger Creek Database? ✓ Date: 12/21/17 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.74	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 0900	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.74	Method: Wading / Culvert
	End Time: 0902	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- LOTS OF TURBULENCE AROUND GAUGE, FLOWS VERY HIGH, TURBID

Cross Section Location: BIRDCAGE CULVERT OUTLET

Sketch of XS Location:

Control Feature/Condition: BIRDCAGE/OK

Weather: STEADY RAIN, ~43°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

CULVERT DEPTH: 1.05
VELC: 4.49

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 8.78

Entered into Ballinger Creek Database? Y
Date: 1/11/18 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.67	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 0915	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.58	Method: Wading / Culvert
	End Time: 0940	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
LOTS OF TURBULENCE AROUND GAGE, TURBID + ELEVATED FLOW

Cross Section Location: IMMEDIATELY UPSTREAM OF PEDESTRIAN BRIDGE

Sketch of XS Location:

Control Feature/Condition: STREAMBANKS / OK

Weather: STEADY RAIN, ~42°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 1.3		LB Distance (ft): 14.2	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.3	0	0	19 10.3	0.3	0.44
2 1.8	0.35	0	20 10.8	0.3	0.86
3 2.3	0.6	1.25	21 11.3	0.3	0.81
4 2.8	0.8	1.10	22 11.8	0.3	0.72
5 3.3	0.9	1.20	23 12.3	0.3	0.55
6 3.8	1.0	1.51	24 12.8	0.3	0.30
7 4.3	0.95	1.63	25 13.3	0.2	0
8 4.8	1.0	1.69	26 13.8	0.1	0
9 5.3	1.0	1.99	27 14.2	0	0
Time / SG: 0925 / 5.65			Time / SG:		
10 5.8	1.05	2.24	28		
11 6.3	1.0	2.57	29		
12 6.8	0.95	2.39	30		
13 7.3	0.8	1.84	31		
14 7.8	0.7	1.50	32		
15 8.3	0.55	1.10	33		
16 8.8	0.5	0.71	34		
17 9.3	0.4	0.86	35		
18 9.8	0.35	0.95	36		
Time / SG: 0934 / 5.60			Time / SG:		

Flow (cfs): 10.95	Entered into Ballinger Creek Database? Y Date: 1/11/18 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC - 3	Gauge Start Height: 5.50	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 1007	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.52	Method: **Wading** / Culvert
	End Time: 1012	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.): LOTS OF TURBULENCE AROUND GAGE, TURBID FLOW

Cross Section Location: CULVERTS @ 25TH AVE NE

Sketch of XS Location:

Control Feature/Condition: CULVERTS / CK

Weather: HEAVY RAIN, 42°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
(2) UPPER CULVERT DEPTH: 0.45 VELC: 4.60 (1) LOWER CULVERT DEPTH: 2.0 VELC: 2.35

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): (1) 7.30 + (2) 2.51 = 9.81	Entered into Ballinger Creek Database? Y Date: 1/11/18 Initials: AC

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: NA	Gauge Start Height: ~~NA~~	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 1026	Client: City of Shoreline
Observer Initials: AC	Gauge End Height: NA	Method: Wading Culvert
	End Time: 1030	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- FLOW ELEVATED, TURBID

Cross Section Location: CULVERT OUTLET ON

Sketch of XS Location:

Control Feature/Condition: CULVERT / CULVERT OUTLET APPEARS MODIFIED (IE, WIDTH > HEIGHT)

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT OUTLET (3.0 FT DIAMETER) NO LONGER CIRCULAR)
DEPTH: 1.65
VELC: 2.70

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 10.8	Entered into Ballinger Creek Database? Y Date: 1/11/18 Initials: AC

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.64	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 1040	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 1.62	Method: Wading / Culvert
	End Time: 1102	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- MINOR AMOUNTS OF TURBULENCE AROUND GAGE

Cross Section Location: DOWNSTREAM OF GAGE @ PREVIOUSLY USED LOCATION

Sketch of XS Location:

Control Feature/Condition: STREAM BANKS / OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- SOME LEAVES CAUGHT ON GAGE; REMOVED

Measurement Data — RB Distance (ft): 0.4 — LB Distance (ft): 17.8

	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)		Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1	0.4	0	0	19	7.6	0.46	0.60
2	0.8	1.3	0.4	20	8.0	0.40	0.36
3	1.2	1.5	0.98	21	9.0	0.40	-0.10
4	1.6	1.5	1.49	22	10.	0.3	0
5	2.0	1.55	1.49	23	11	0.3	0.02
6	2.4	1.5	1.67	24	12	0.2	0
7	2.8	1.45	1.71	25	13	0.25	0
8	3.2	1.35	1.56	26	14	0.3	0
9	3.6	1.35	1.52	27	15	0.4	0
Time / SG:				Time / SG:			
10	4.0	1.3	1.44	28	16	0.3	0
11	4.4	1.35	1.56	29	17	0.1	0
12	4.8	1.40	1.53	30	17.8	0	0
13	5.2	1.48	1.1	31			
14	5.6	1.40	0.95	32			
15	6.0	0.75	0.95	33			
16	6.4	0.65	0.96	34			
17	6.8	0.65	0.96	35			
18	7.2	0.40	0.93	36			
Time / SG: 1054/1.65				Time / SG:			

Flow (cfs): 10.96

Entered into Ballinger Creek Database? Y

Date: 1/11/18 Initials: AT

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.80	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 1152	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.81	Method: Wading / Culvert
	End Time: 1154	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
-HIGH FLOW, TURBID, LOTS OF TURBULENCE AROUND GAUGE

Cross Section Location: CULVERT OUTLET

Sketch of XS Location:

Control Feature/Condition: BIRDCAGE/OK

Weather: STEADY RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT [VELC: 4.25
DEPTH: 1.15
* USED STAINLESS STEEL WELL BAILER TO REMOVE SAND/SEDIMENT IN STILLING WELL - WORKED WELL!

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 9.37	Entered into Ballinger Creek Database? Y Date: 1/11/18 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.75	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 1208	Client: City of Shoreline
Observer Initials: AC	Gauge End Height: 5.72	Method: Wading / Culvert
	End Time: 1228	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
FLOWS HIGH, TURBID

Cross Section Location: IMMEDIATELY UPSTREAM OF PED. BRIDGE

Sketch of XS Location:

Control Feature/Condition: STREAMBANKS + BRIDGE / OK

Weather: STEADY RAIN, HEAVY AT TIMES

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):

Measurement Data		RB Distance (ft): 1.0		LB Distance (ft): 14.3	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.0	0	0	19 10	0.35	1.25
2 1.5	0.4	0.15	20 10.5	0.35	1.24
3 2.0	0.55	1.26	21 11	0.40	1.07
4 2.5	0.80	1.15	22 11.5	0.50	0.95
5 3.0	0.95	1.42	23 12	0.40	0.69
6 3.5	1.05	1.70	24 12.5	0.40	0.23
7 4.	1	1.72	25 13	0.30	0.39
8 4.5	1.05	2.05	26 13.5	0.20	0.10
9 5	1.1	2.45	27 14	0.1	0
Time / SG: 1214 / 5.74			Time / SG:		
10 5.5	1.1	2.53	28 14.3	0	0
11 6	1.05	2.70	29		
12 6.5	1	2.57	30		
13 7	0.8	1.95	31		
14 7.5	0.75	1.58	32		
15 8	0.65	1.22	33		
16 8.5	0.55	0.76	34		
17 9	0.50	0.78	35		
18 9.5	0.40	1.08	36		
Time / SG: 1222 / 5.73			Time / SG:		

Flow (cfs): 13.3	Entered into Ballinger Creek Database? Y Date: 1/11/18 Initials: AC

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.90	Stream: Ballinger Creek
Date: 1/11/18	Start Time: 1242	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.89	Method: Wading / Culvert
	End Time: 1246	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- LOTS OF TURBULENCE AROUND GAUGE, FLOWS HIGH + TURBID

Cross Section Location:

Sketch of XS Location:

Control Feature/Condition: CULVERTS / OK

Weather: HEAVY RAIN, TRANSITIONING TO STEADY RAIN, THEN STOPPING

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
1 LOWER CULVERT DEPTH 2 VELC 3.42
2 UPPER CULVERT DEPTH 0.55 VELC 5.45
CULVERT OUTLET (EAST OF 25TH AVE NE) @ 1252 DEPTH 1.80 VELC 3.00 [13.3 CFS]

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 1 10.7 + 2 3.9 = 14.6	Entered into Ballinger Creek Database? Y Date: 1/11/18 Initials: AS

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-1	Gauge Start Height: 2.04	Stream: Ballinger Creek
Date: 1/23/18	Start Time: 0938	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 2.05	Method: Wading / Culvert
	End Time: 0940	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
- MINIMAL TURBULENCE, CHECKED STILLING WELL - HAS NOT FILLED IN WITH SAND, DOWNLOADED DATA F/DATA LOGGER - OK

Cross Section Location: CULVERT OUTLET

Sketch of XS Location:

Control Feature/Condition: BIRDCAGE / OK

Weather: LIGHT RAIN, 43°F, RAIN INTENSITY PICKING UP @ 0940

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
CULVERT DEPTH: 0.30 FT
OUTLET VELC: 1.00 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 0.33	Entered into Ballinger Creek Database? Y Date: 1/23/18 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-2	Gauge Start Height: 5.25	Stream: Ballinger Creek
Date: 1/23/18	Start Time: 1000	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.34	Method: Wading Culvert
	End Time: 1018	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
-MINOR TURBULENCE AROUND GAUGE CREEK FAIRLY CLEAR @ START WITH INCREASING FLOW / TURBIDITY DURING MANUAL FLOW MEAS.

Cross Section Location: IMMEDIATELY UPSTREAM OF PEDESTRIAN BRIDGE

Sketch of XS Location:

Control Feature/Condition: STREAMBANKS / OK

Weather: LIGHT TO MODERATE RAIN, 44°F

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
- DOWNLOAD DATA F/D.L. AFTER COLLECTING R.C.D. POINTS AT EACH STATION - DATA SET COMPLETE

Measurement Data		RB Distance (ft): 1.5		LB Distance (ft): 13	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 1.5	0	0	19 10.5	0.15	0.08
2 2	0.25	0.42	20 11	0.15	0.35
3 2.5	0.45	0.81	21 11.5	0.2	0.11
4 3	0.55	0.90	22 12	0.2	0.08
5 3.5	0.70	0.81	23 12.5	0.15	0.04
6 4	0.70	0.88	24 13.2	0	0
7 4.5	0.70	0.99	25		
8 5	0.75	0.96	26		
9 5.5	0.75	1.07	27		
Time / SG: 1009 / 5.29			Time / SG:		
10 6	0.7	1.15	28		
11 6.5	0.6	1.03	29		
12 7	0.6	0.98	30		
13 7.5	0.5	0.94	31		
14 8	0.4	0.73	32		
15 8.5	0.3	0.54	33		
16 9	0.25	0.58	34		
17 9.5	0.2	0.44	35		
18 10	0.1	0.15	36		
Time / SG: 1015 / 5.30			Time / SG:		
Flow (cfs): 3.83			Entered into Ballinger Creek Database? Y Date: 1/23/18 Initials: AS		

BallingerCkStreamFlowDataSheet.xlsx

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-3	Gauge Start Height: 5.19	Stream: Ballinger Creek
Date: 1/23/18	Start Time: 1035	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 5.15	Method: Wading / Culvert
	End Time: 1041	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)

Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
-MINIMAL TURB. AROUND GAUGE / DOWNLOADED DATA F/ D.L. + BAROTROLL - DATA SET COMPLETE

Cross Section Location: SAME AS PREVIOUS MEASUREMENTS

Sketch of XS Location:

Control Feature/Condition: CULVERTS / O/C

Weather: LIGHT RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
-LOWER CULVERT: DEPTH 1.55 FT VELC 1.11 FPS UPPER CULVERT D: 0.25 FT V: 3.48 FPS

Measurement Data		RB Distance (ft):		LB Distance (ft):	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1			19		
2			20		
3			21		
4			22		
5			23		
6			24		
7			25		
8			26		
9			27		
Time / SG:			Time / SG:		
10			28		
11			29		
12			30		
13			31		
14			32		
15			33		
16			34		
17			35		
18			36		
Time / SG:			Time / SG:		

Flow (cfs): 2.92 + 1.31 = 4.23	Entered into Ballinger Creek Database? Y Date: 1/23/18 Initials: AS

Herrera - Ballinger Creek - Stream Flow Data Sheet

Flow Station #: BC-4	Gauge Start Height: 1.05	Stream: Ballinger Creek
Date: 1/23/18	Start Time: 1046	Client: City of Shoreline
Observer Initials: AS	Gauge End Height: 0.98	Method: Wading / Culvert
	End Time: 1103	

Gauging Assessment: Circle One *(within _% deviation from actual discharge)
Excellent (2%*) Good (5%*) Fair (8%*) Poor (10%*)

Flow Comments (e.g. turbulence around gauge, lots of material in water, etc.):
-MINIMAL TURBULENCE AROUND GAGE, REMOVED A FEW LEAVES CAUGHT ON STAFF GAGE

Cross Section Location: SAME AS PREVIOUS MEASUREMENTS

Sketch of XS Location:

Control Feature/Condition:

Weather: LIGHT TO MODERATE RAIN

Notes (e.g. equipment problems, flow blockages, unusual stream conditions, etc.):
-NOTHING UNUSUAL OBSERVED, DOWNLOADED DATA F/ DATA LOGGER - DATASET COMPLETE

Measurement Data		RB Distance (ft): 0.4		LB Distance (ft): 6.5	
Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)	Horizon. Dist. (ft)	Water Depth (ft)	Velocity (ft/sec)
1 0.4	0	0	19 5.8	0.25	0.11
2 0.7	0.8	0.35	20 6.1	0.05	0
3 1	0.8	0.63	21 6.5	0	0
4 1.3	0.9	0.76	22		
5 1.6	0.9	0.82	23		
6 1.9	0.9	0.83	24		
7 2.2	0.85	0.81	25		
8 2.5	0.8	0.86	26		
9 2.8	0.75	0.87	27		
Time / SG:			Time / SG:		
10 3.1	0.7	0.62	28		
11 3.4	0.7	0.86	29		
12 3.7	0.65	1.03	30		
13 4	0.65	1.25	31		
14 4.3	0.65	1.48	32		
15 4.6	0.65	1.45	33		
16 4.9	0.7	1.25	34		
17 5.2	0.65	0.91	35		
18 5.5	0.7	0.11	36		
Time / SG:			Time / SG:		

Flow (cfs): 3.29	Entered into Ballinger Creek Database? Y Date: 1/23/18 Initials: AS

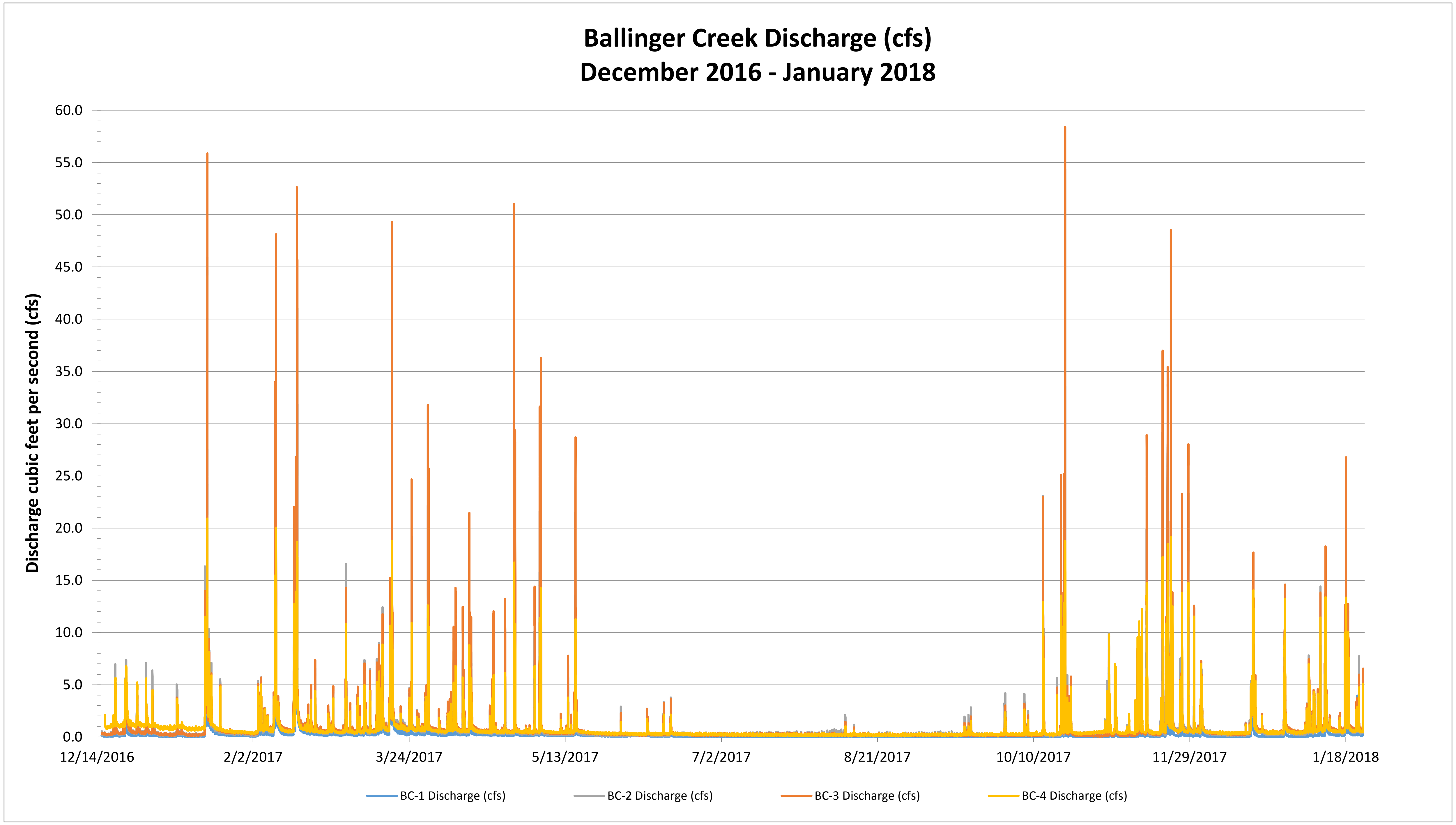
BallingerCkStreamFlowDataSheet.xlsx

APPENDIX C

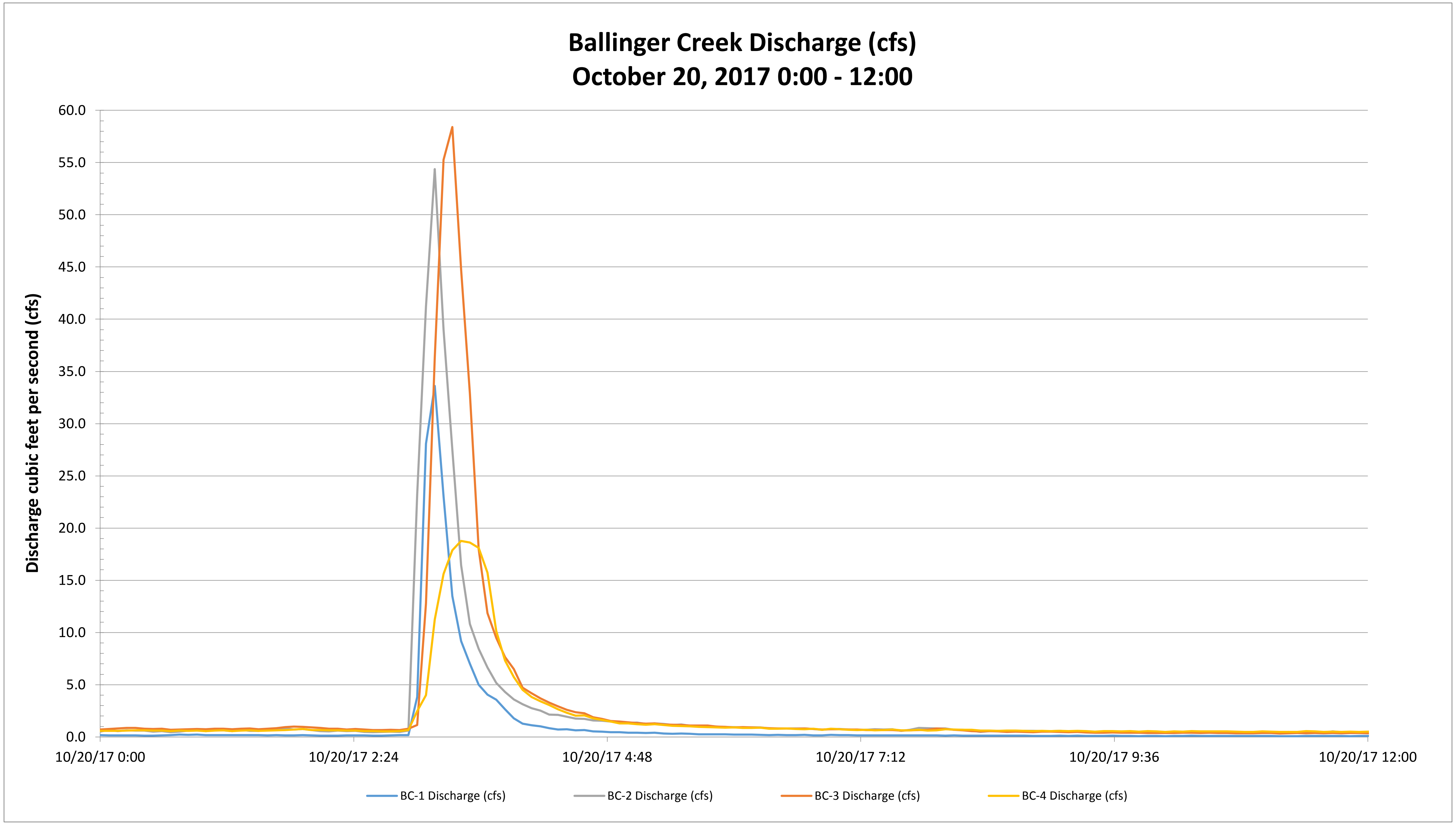
Rating Curve Results and Individual Storm Event Analysis

The contents of this appendix are provided in electronic format transmitted to the City of Shoreline under separate cover. A sample of the gaging results is provided on the following pages and includes the full record of discharge results as well as the results for the two most significant events. These include:

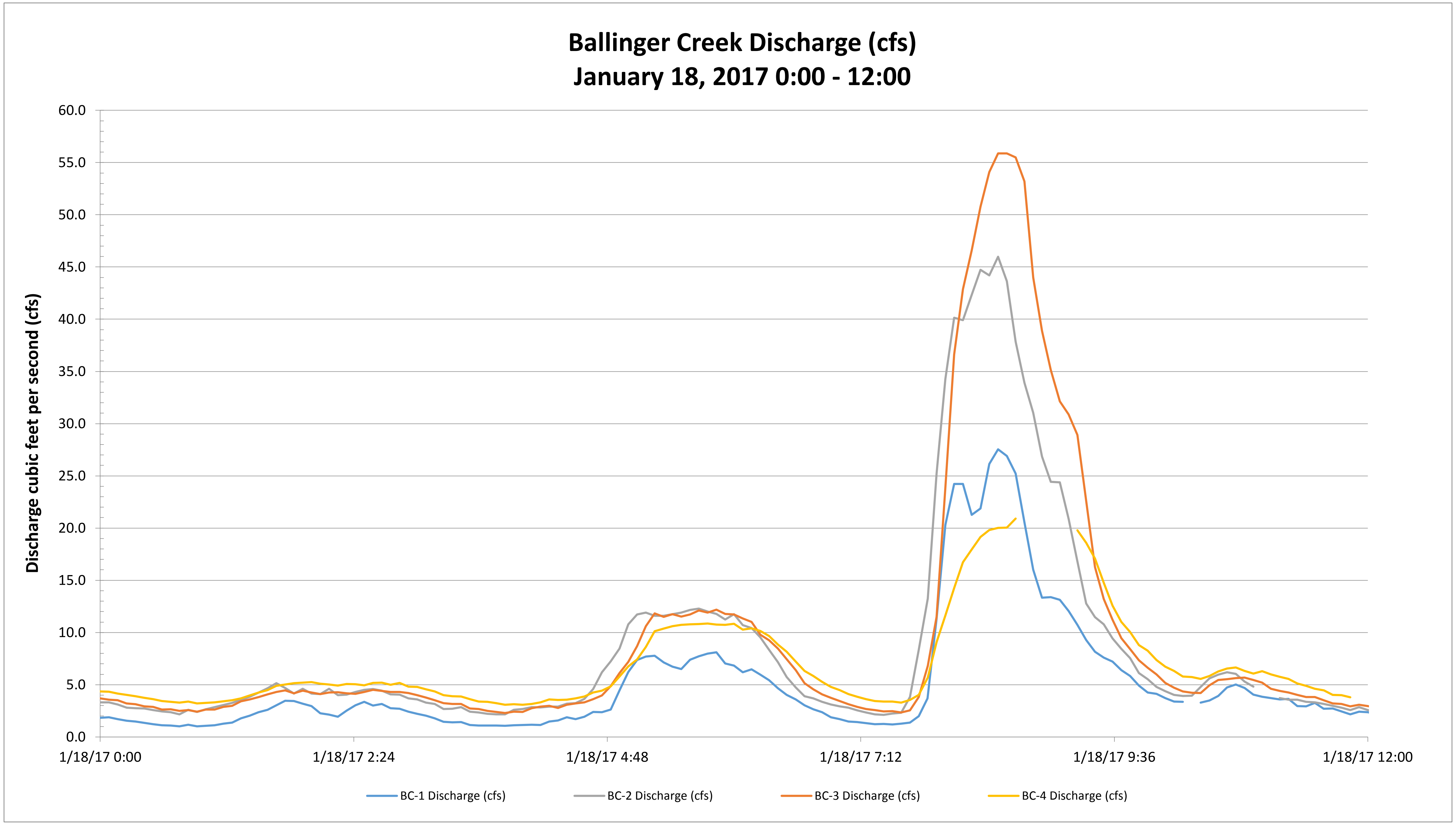
- **Discharge (cfs) at the four stations (December 2016 – January 2018)**
- **Discharge (cfs) summary for the October 20, 2017 storm event**
- **Discharge (cfs) summary for the January 18, 2017 storm event**



Ballinger Creek Discharge (cfs)
December 2016 - January 2018
Discharge cubic feet per second (cfs)
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
12/14/2016
2/2/2017
3/24/2017
5/13/2017
7/2/2017
8/21/2017
10/10/2017
11/29/2017
1/18/2018
BC-1 Discharge (cfs)
BC-2 Discharge (cfs)
BC-3 Discharge (cfs)
BC-4 Discharge (cfs)



Ballinger Creek Discharge (cfs)
October 20, 2017 0:00 - 12:00
Discharge cubic feet per second (cfs)
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
10/20/17 0:00
10/20/17 2:24
10/20/17 4:48
10/20/17 7:12
10/20/17 9:36
10/20/17 12:00
BC-1 Discharge (cfs)
BC-2 Discharge (cfs)
BC-3 Discharge (cfs)
BC-4 Discharge (cfs)



Ballinger Creek Discharge (cfs)
January 18, 2017 0:00 - 12:00
Discharge cubic feet per second (cfs)
60.0
55.0
50.0
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
1/18/17 0:00
1/18/17 2:24
1/18/17 4:48
1/18/17 7:12
1/18/17 9:36
1/18/17 12:00
BC-1 Discharge (cfs)
BC-2 Discharge (cfs)
BC-3 Discharge (cfs)
BC-4 Discharge (cfs)