Subbasin 46.3 Watercourse Stabilization

Design Report

Prepared by:

Northwest Hydraulic Consultants Inc.
12787 Gateway Drive S.
Seattle, WA 98168
Tel: 206.241.6000
www.nhcwater.com

Prepared for:

City of Mercer Island
9601 SE 36th St
Mercer Island, WA 98040

August 27, 2025
Draft Report, Rev. 0

NHC Reference No. 2008561

Report prepared under the direct supervision of:

Unsigned draft by

Dan Heckendorf, PE
Sr. Engineer

Report under review by:

Unsigned draft by

Peter Brooks, PE
Principal-In-Charge

NHC File Path:
Q:\2008561_Subbasin_46_3a_Watercourse_Stabilization_Design\80_Documentation\Design_Report\Design_Report_R0a.docx

DISCLAIMER

This document has been prepared by **Northwest Hydraulic Consultants Inc.** in accordance with generally accepted engineering practices and is intended for the exclusive use and benefit of City of Mercer Island and their authorized representatives for specific application to the Subbasin 46.3 Watercourse Stabilization project. The contents of this document are not to be relied upon or used, in whole or in part, by or for the benefit of others without specific written authorization from **Northwest Hydraulic Consultants Inc**. No other warranty, expressed or implied, is made.

Northwest Hydraulic Consultants Inc. and its officers, directors, employees, and agents assume no responsibility for the reliance upon this document or any of its contents by any parties other than City of Mercer Island.

CREDITS AND ACKNOWLEDGEMENTS

The authors would like to thank the City of Mercer Island for initiating this study and for the support provided during the project, in particular:

- Clint Morris Capital Division Manger, Public Works
- Elayne Grueber Utilities Engineer, Public Works

The following NHC personnel participated in the study:

- Dan Heckendorf Project Manager, Hydraulic Engineering
- Peter Brooks Principal-in-Charge, QA-QC
- Sarah Harbert Geology and Geomorphology
- Kenvin Geoghegan Hydrology
- Madalyn Ohrt GIS Services

NHC partnered with RH2 Engineering, Inc. on the environmental and permitting services:

- Alicia Pettibone Critical Areas and Permitting
- Steve Nelson Geohazards

TABLE OF CONTENTS

TABLES, FIGURES, AND PHOTOS IN TEXT

FIGURES

PHOTOS

APPENDIX SECTIONS

APPENDICES

Appendix A Design Drawings
Appendix B Design Calculations

1 INTRODUCTION

1.1 Overview

The City of Mercer Island (City) seeks to address erosion, reduce sediment maintenance, and improve water quality within the 'Subbasin 46a Watercourse' drainage (Figure 1.1). Northwest Hydraulic Consultants Inc. (NHC) has been retained by the City to investigate causes of erosion and prepare a mitigation design for the Subbasin 46.3a Watercourse Stabilization Design Project (Project). NHC has contracted with RH2 Engineering, Inc. (RH2) to provide environmental and permitting services for the project. NHC completed an options analysis, from which the City selected a channel stabilization option to be moved forward into design (NHC, 2024). This report documents the final design developed by NHC.

1.2 Site Description

The project area is located within Mercer Island city limits, about 1,000 feet east of the intersection of Island Crest Way and SE 53rd Place (Figure 1.1). The 'Subbasin 46a Watercourse' stream channel begins just east of the intersection of Island Crest Way and SE 53rd Place and flows approximately 1,500 feet to the East Mercer Way crossing, before ultimately discharging to Lake Washington about 2,000 feet downstream of this location. Stream characteristics pertinent to design are:

- The stream channel is not within a mapped Federal Emergency Management Agency (FEMA) flood hazard area.
- Mapped wetland areas are present throughout the project reach and are documented within the project Critical Area Study (RH2, 2024).
- The stream channel within the project reach exhibits characteristics presumed suitable for fish use (Type "F") per WAC 222-16-031.

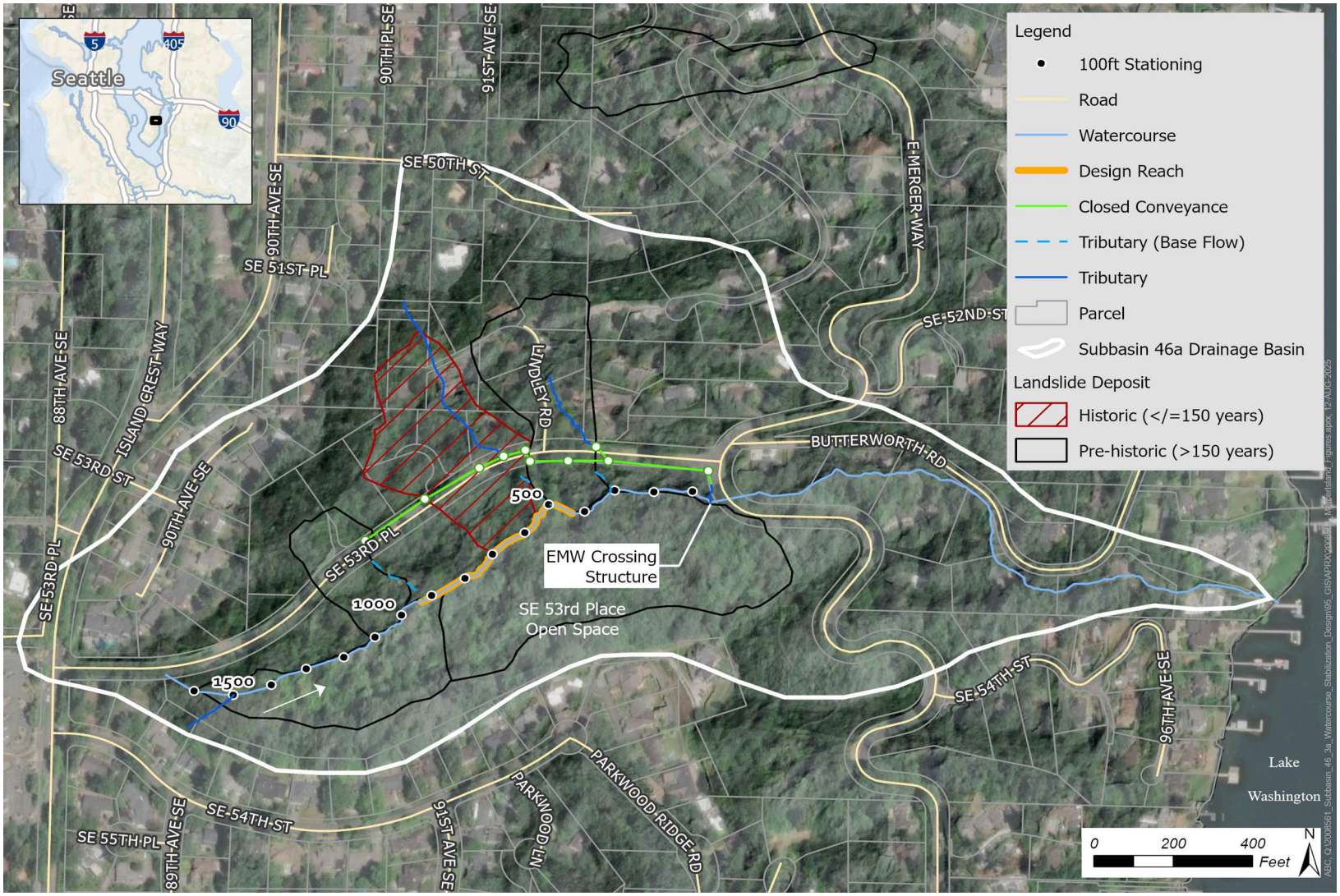

Figure 1.1. Location Map. Stream stationing begins at the East Mercer Way centerline and progresses in the upstream direction.

The project is located within a forested ravine surrounded by light residential development and paralleled by the SE 53rd Place roadway to the north. Three culverts along SE 53rd Place contribute flows from tributaries to the north (Figure 1.1). The stream channel is relatively steep and incised into the surrounding terrain. The East Mercer Way (EMW) structure is City-owned and consists of two 1.5-foot diameter, 240-foot long corrugated stainless steel (CST) pipe culverts., with an estimated average slope of 5.7%, based on surveyed invert elevations and available LiDAR. The inlet to the EMW culvert is an approximately 5-foot tall standpipe with trash rack surrounded by a sediment pond (Photo 1.1). The Washington Department of Fish and Wildlife (WDFW) currently lists the crossing (Site ID: 920822) as a total barrier to fish passage, due to an excessive drop in water level across the structure (WDFW, 2021).

Photo 1.1 Upstream view of East Mercer Way crossing and upstream sediment pond.

Over the past 25 years, the City has implemented various measures to stabilize the stream channel. In 2000, the City installed rock check dams and large woody material (LWM) from the EMW crossing to about 900 feet upstream (City of Mercer Island, 2000). In 2008, the City modified the three SE 53rd Place culvert crossings to directly route high flows along the road alignment to the EMW crossing inlet with the intent of reducing erosive high flows in the natural stream channel, i.e., peak flow reduction. These three tributary culvert crossings (Figure 1.1) now only contribute low, base flows (City of Mercer Island, 2008).

1.3 Historical Sediment Maintenance

City maintenance staff accounts indicate regular (i.e., annual) removal of sediment and debris from the EMW crossing and upstream sediment pond, with the most recent removals in 2023 being the highest in history (Grueber, E., Public Works, personal comm., 2024). Average annual sediment removals from the facility are estimated at about 29 cy/yr and primarily composed of fine sands and silt (Photo 1.2). Sediment removal volumes have remained relatively unchanged, despite prior mitigation efforts described above (Grueber, E., Public Works, personal comm., 2024).

Photo 1.2 Photo of fine sediments (sands and silts) observed within sediment pond. Note, 0.9 mm pencil lead shown for scale.

2 GEOMORPHIC ASSESSMENT

Figure 2.1 provides a longitudinal profile of the existing stream channel alignment from recent 2025 NHC channel survey and available 2021 LiDAR. From its headwaters to the EMW crossing, the stream channel is incised into the adjacent hillslopes (Photo 2.1). Channel depths range from

1 to 3 feet, with deeper sections observed within the middle of the project reach from about 500 to 1,000 feet upstream of EMW. Ravine top widths range from 30 to 150 feet. Banks are vegetated by shrubs and some trees (Photo 2.1).

Photo 2.1 Upstream view of stream channel, about 140 feet upstream of EMW.

Width to depth ratios are relatively low, ranging from 4:1 to 1:1. Channel banks range from 1 to 9 feet high, are steep, often vertical, and composed of glacial till, comprised of relatively cohesive matrix of fine sediments, with limited gravel and cobble. The channel is slightly sinuous, due to large trees creating obstructions within the channel. However, the channel does not appear to be actively migrating laterally. Gravel patches were visible on the bed, but mainly as stored deposits within the channel upstream of EMW (Photo 2.2). Overall, the supply of coarse gravelly material appears limited overall. The bed is typically flat without obvious pools or bars. Recent channel incision and bank erosion was observed from about 500 and 960 feet upstream of EMW, including active erosion of a landslide deposit (Photo 2.3), believed to be a major source of fine sediment to the sediment pond. Modeled unit discharge (calculated as depth times velocity) for the 2-year flood discharge was found to be relatively high from about 500 and 960 feet upstream of EMW, indicating higher levels of flow intensity and erosion potential (NHC, 2024).

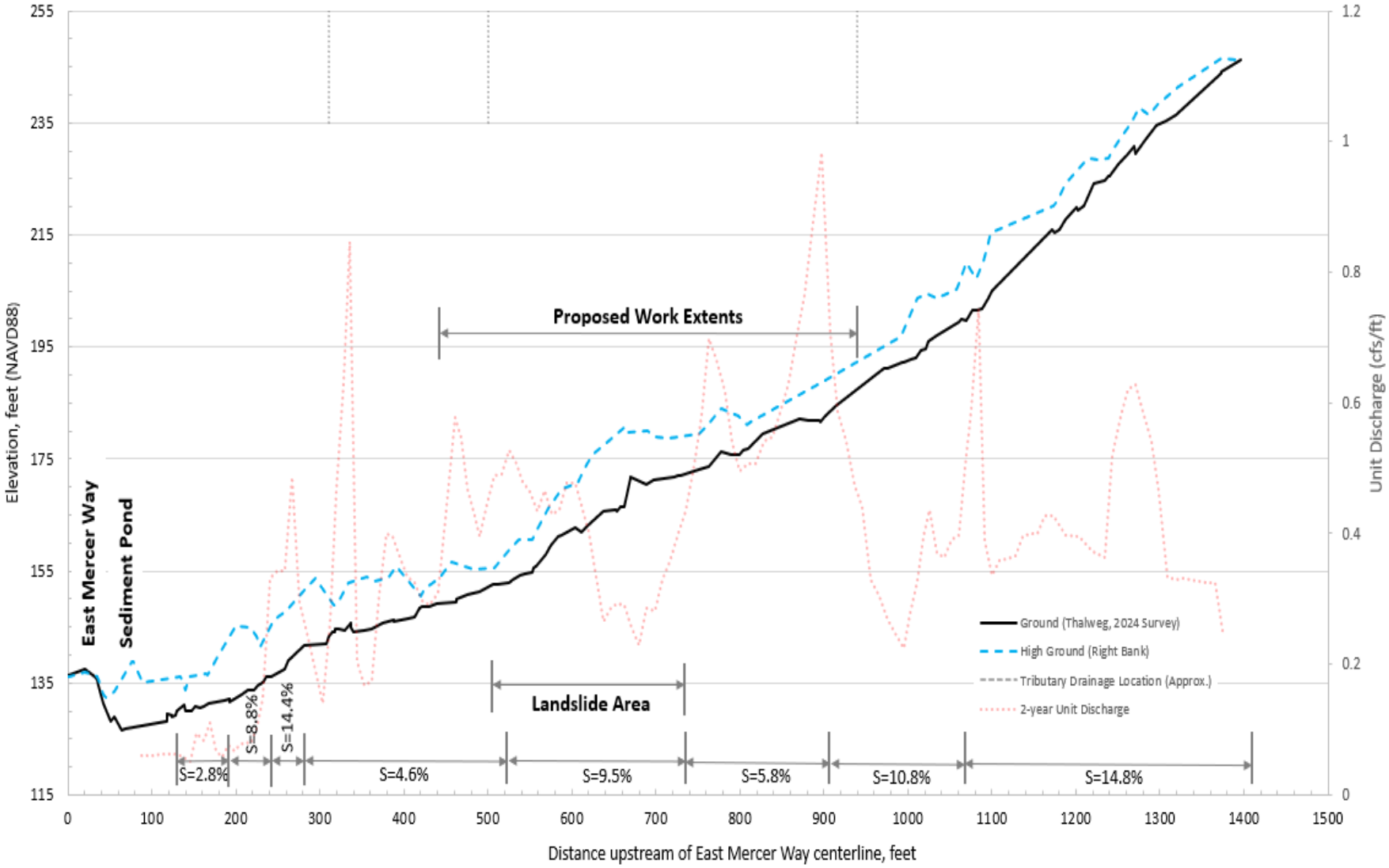

Figure 2.1 Stream channel longitudinal profile.

Photo 2.2 Upstream view of stream channel, about 560 feet upstream of EMW. Note, existing debris in channel providing limited grade control and some upstream sediment retention and flanking with erosion along channel banks.

Photo 2.3 Downstream view of stream channel, about 680 feet upstream of EMW. Note, erosion into exposed landslide deposit.

Channel incision appears to be the most significant geomorphic process currently affecting the project reach. City rock check dams and LWM, from about 200 and 500 feet upstream of EMW, appear to be currently acting as grade control and stalling upstream-migrating incision. These features were observed to be in good condition and are likely to persist as grade control for the stream channel.

Upstream of station 5+00 (i.e. 500 feet upstream of EMW), constructed mitigation measures were varied in condition, with damage, including flanking and erosion of the channel banks observed in some locations. Near about 600 feet upstream of EMW the channel has incised, leaving previously placed LWM suspended above the channel (Photo 2.4). The channel profile from about 560 to 960 feet upstream of EMW is convex, interpreted as a geologically young channel segment, still incising through a more recent historical landslide deposit. Loss of grade control within this section of the stream channel is expected to result in continued incision and a relatively high supply of fine sediment to the sediment pond.

Photo 2.4 Downstream view of stream channel, about 600 feet upstream of EMW. Note, channel incision and LWM suspended above channel.

3 CHANNEL STABILIZATION DESIGN

NHC developed a design intended to reduce maintenance requirements and enhance habitat within the project reach. Proposed work extents are from 440 to 940 feet upstream of EMW, corresponding with the primary upstream source of fine sediments. Minimizing project costs and impacts to the existing stream channel and upland vegetation is desirable, therefore, minimizing excavation and clearing for temporary construction access is preferred. Stabilization treatments do not require use of heavy equipment to limit the potential for destabilization of existing landslide deposits during construction.

Figure 3.1 shows the proposed channel stabilization design. Three treatment types are proposed: Type 1 ELJ, Type 2 ELJ, and repairs to existing, naturally occurring log weirs. Treatments will be interspersed within existing LWM structures, with access via SE 53rd Place. The proposed design is intended to provide grade control to limit further downcutting of the stream channel, store incoming sediments, and increase overall bank stability.

Design reviews have been completed by City permitting and maintenance staff, Washington Department of Fish & Wildlife (WDFW), and the Snoqualmie Indian Tribe. The following sections describe the final design prepared by the NHC team in coordination with the City. Final (90%) design drawings are provided within Appendix A.

All treatments are designed to be stable at the 100-year flood discharge (3.5 cubic feet per second [cfs]) (NHC, 2024). Design calculations are provided within Appendix B.

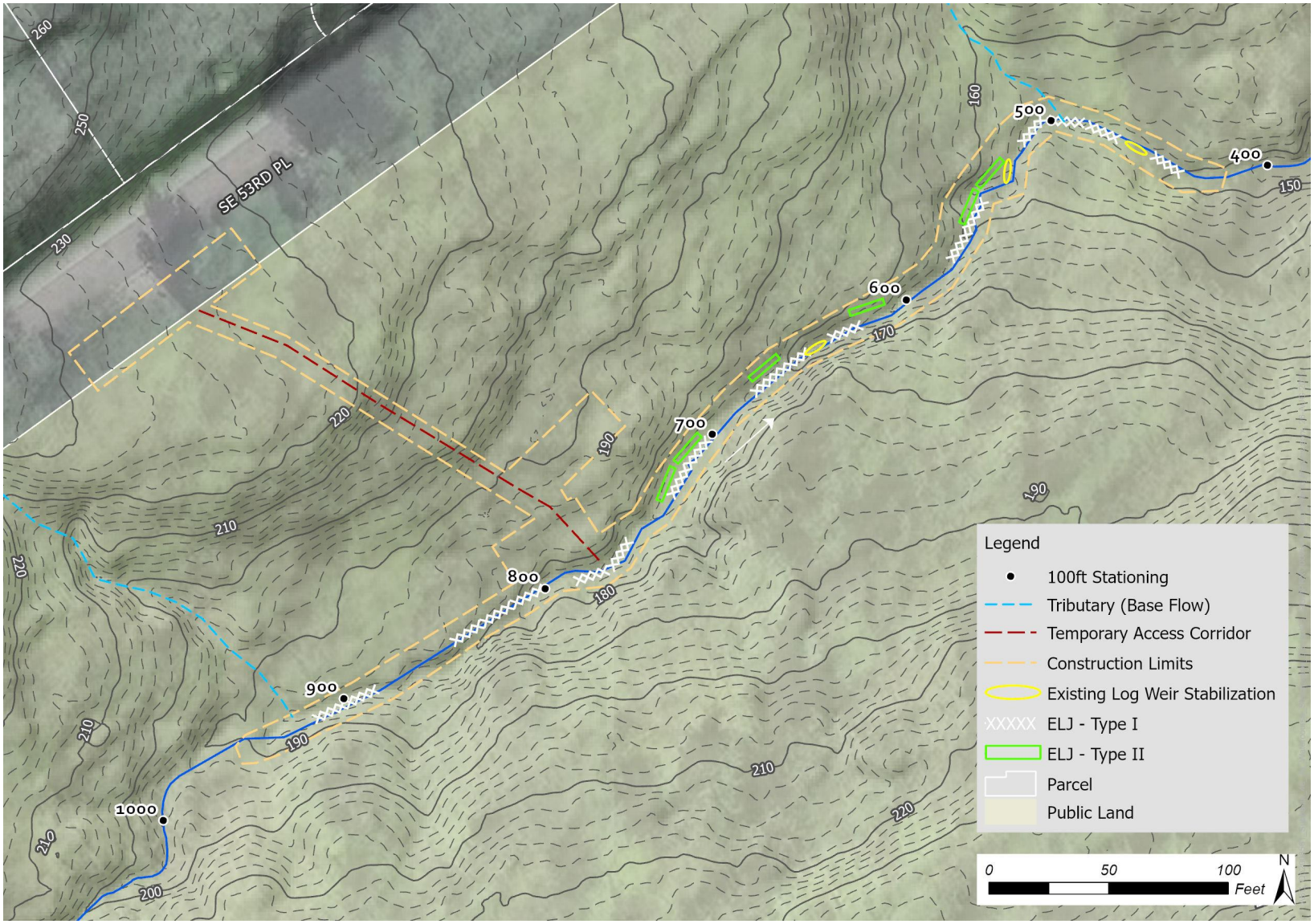

Figure 3.1 Proposed channel stabilization design.

3.1 Channel Stabilization Treatments

Proposed treatments are intended to mimic observed natural features and provide channel stabilization. Design descriptions for each treatment type are provided below.

The Type 1 ELJs (Engineered Log Jam) are new grade control structures that are intended to stabilize the channel, limit further channel incision, raise the existing channel bed, and store incoming sediment. These features are approximately 15 feet in length and span the average measured OHW (Ordinary High Water) width (6 ft) of the stream channel (Figure 3.2). The structure is comprised of a slash core, with larger (12 inch diameter) members placed across the top and secured with posts for stability. Log depth and orientation to flow is varied along the section (see Figure 3.3) to provide hydraulic diversity and suitable flow conditions for fish passage. Coir fabric is laid upon the bed prior to placement of the slash and logs to hold existing material on the bed. A total of 18 Type 1 ELJs are proposed (Figure 3.1).

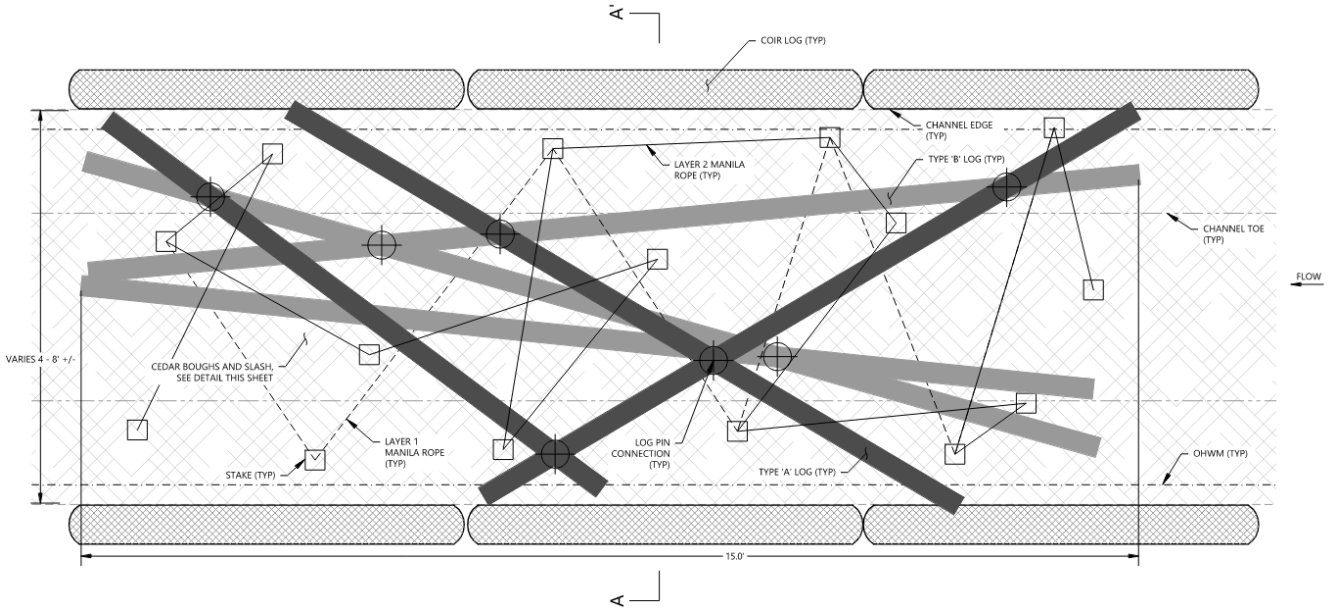

Figure 3.2 Type 1 ELJ plan view.

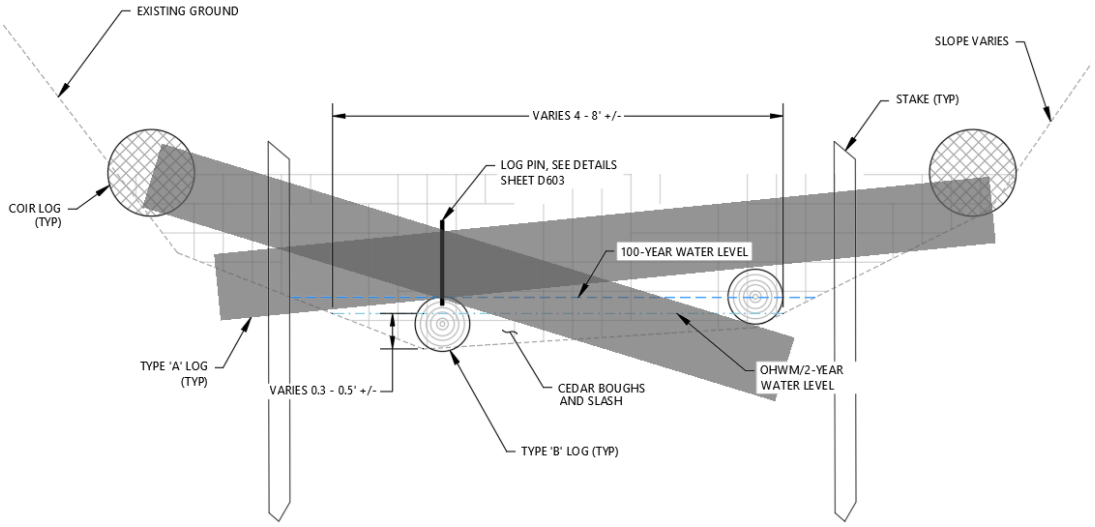

Figure 3.3 Type 1 ELJ typical section.

Type 2 ELJs are new channel toe structures intended to reduce erosion of the channel banks and retain bank sediments, increasing overall bank stability and reducing fine sediment supply to downstream reaches. Photo 3.1 shows an example of an existing, natural toe log feature observed within the stream channel. Existing features were used to inform Type 2 ELJ structure design. These structures are approximately 15 feet in length and span near 3-feet (Figure 3.4). These features are comprised of five 12-inch logs, with three parallel to the existing stream channel alignment and two embedded into the bank and secured to the channel bed via vertical posts. Slash is placed within the structure and coir log placed upon the assemblage at the bank line to enhance establishment of riparian plantings and encourage bank stability (see Figure 3.5). A total of six Type 2 ELJs are proposed (Figure 3.1).

Photo 3.1 Downstream view of stream channel, about 160 feet upstream of EMW. Note, existing toe log providing stability to bank.

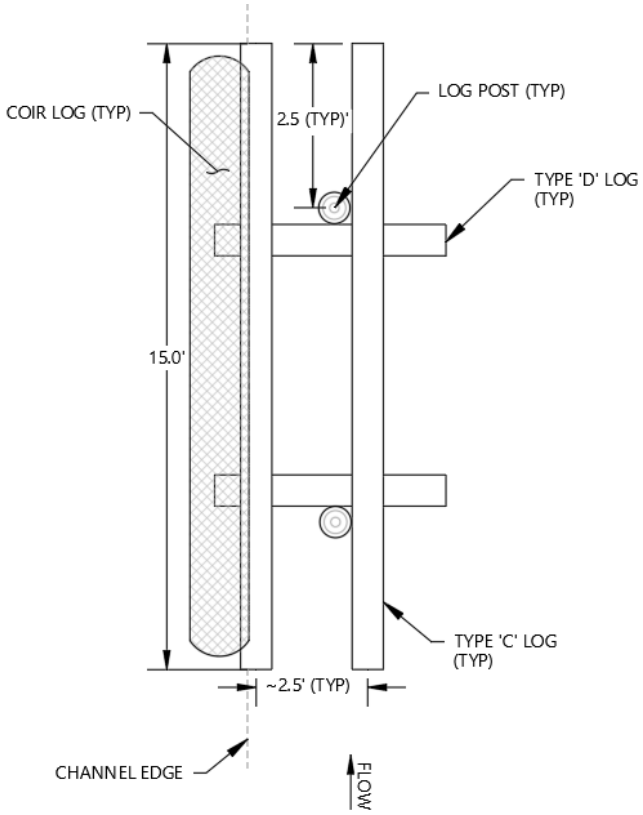

Figure 3.4 Type 2 ELJ plan view.

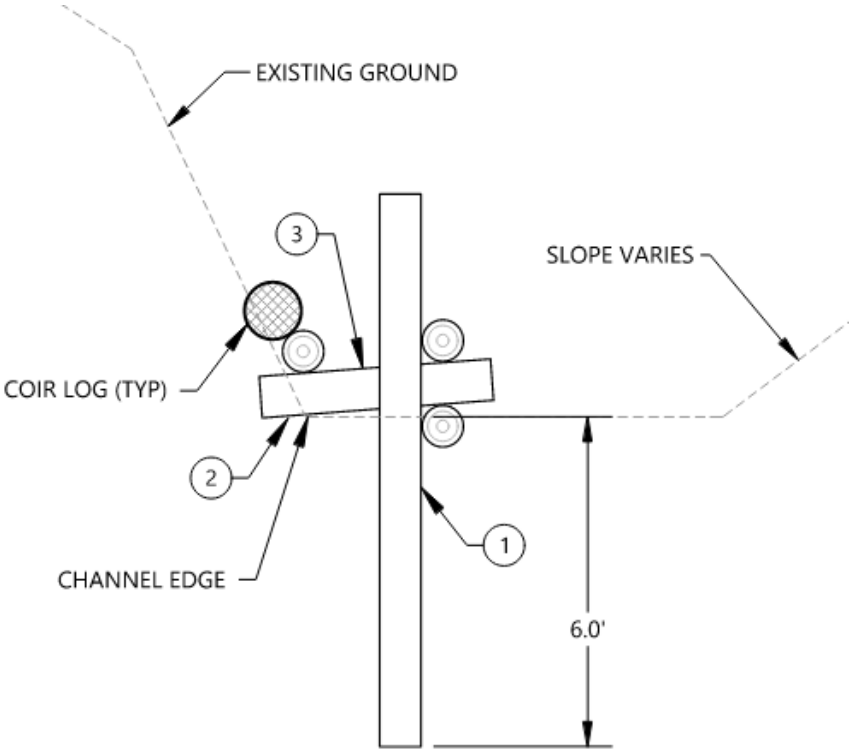

Figure 3.5 Type 2 ELJ typical section.

Existing log weir stabilization is intended to enhance the structural integrity of existing natural weir features, where near term failure and loss of existing grade control expected, such as that shown above in Photo 2.2. The streambed stabilization mixture is comprised of 50% Streambed Sediment, 45% 8-inch Cobble, and 5% Type 1 Stream Boulder. This mixture follows the Bathurst stable bed sizing methodology and WDFW natural bed gradation ratios presented in Barnard et al (2013). The design mixture is intended to be stable at the 100-year flood discharge, therefore significantly coarser than the existing bed material. Stabilization materials will be placed immediately downstream of the existing structure and tie into the channel banks to buttress it and limit the potential for outflanking. Materials will be placed at varying depths across the section to provide hydraulic diversity and suitable flow conditions for fish passage (Figure 3.6). Stabilization of three existing structures is proposed (Figure 3.1).

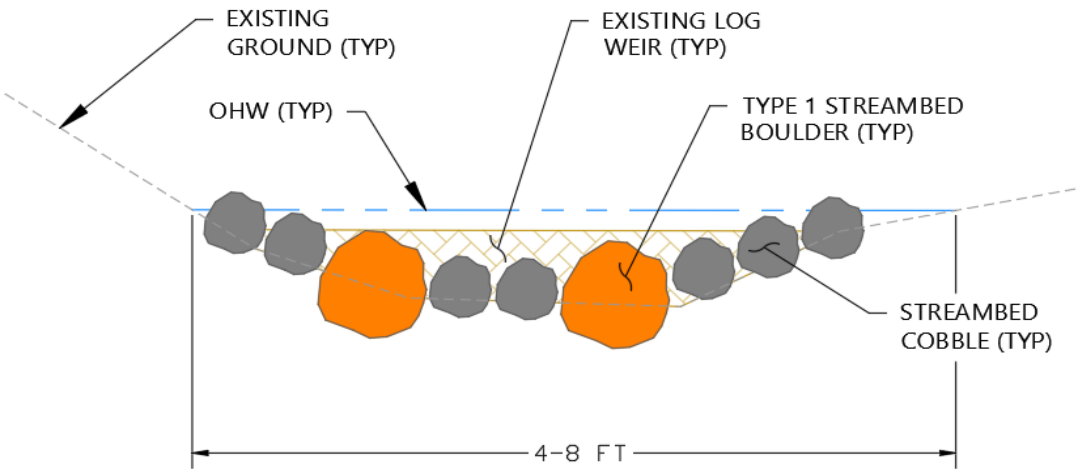

Figure 3.6 Existing log weir stabilization typical section.

3.2 Construction Impacts and Mitigation

The proposed temporary access corridor, staging areas, and construction limits are shown above on Figure 3.1. The project footprint covers approximately 14,000 sf. Use of heavy machinery is limited to the City right-of-way to minimize the potential for destabilization of hillslope soils and impacts to existing upland vegetation. However, clearing of the proposed temporary access corridor will result in temporary vegetation impacts and removal of six trees, between 6 and 8 inches diameter at breast height (dbh).

Project design avoids construction in delineated wetlands onsite (See Design Drawings, Appendix A). Work will occur within the channel of the watercourse but is anticipated to be completed during a low flow work window (generally July 1st to September 30th) and utilizing a stream bypass to allow for work in dry stream segments, thereby minimizing water quality and erosion impacts. Improvements to the watercourse involve bioengineered stream and bank stabilization techniques that utilize LWM and streambed rock; by their nature these types of improvements provide a functional uplift to riparian habitat and are self-mitigating. Work also will occur within City-regulated critical areas stream and wetland buffers; however, buffer impacts are temporary as areas will be restored following construction. Impacts to buffers will result from limited clearing to establish staging and stockpiling areas and to install the temporary access corridors.

Revegetation of the temporary construction and stream corridor areas is proposed utilizing native trees and shrubs.

3.3 Construction Cost Estimate

Assuming 2026 construction costs are estimated at $397,000 (2026 dollars), as summarized below in Figure 3.7. Unit costs were developed using available bid tabs for recently constructed projects with similar project elements. Quantities are based on the 90% design drawings provided within Appendix A.

Contract Title: Subbasin 46.3a Watercourse Stabilization Design
Contract Number: 02008561
Project Phase: 90% Design

Bid Item	Item Description	Specification Section	Unit	Est. Qty.	Unit Price	Amount
1	Mobilization		LS	1	--	--
2	Site Preparation, Tree Preservation, Access and Staging	2-01.4	LS	1	$42,000	$42,000
3	Project Temporary Traffic Control	1-10.4	LS	1	$10,000	$10,000
4	Construciton Survey		LS	1	$17,000	$17,000
5	Minor Changes	1-09.6	FA	1	$6,000	$6,000
6	Erosion Control and Water Pollution Prevention	8-01.4	LS	1	$21,000	$21,000
7	Water Management	8-01.4	LS	1	$22,000	$22,000
8	Type 1 ELJ	8-19.4	EA	18	$4,999	$89,982
9	Type 2 ELJ	8-19.4	EA	6	$4,561	$27,366
10	Streambed Sediment	2-03.4	TN	11	$554	$5,907
11	Streambed Cobble	2-03.4	TN	10	$673	$6,465
12	Streambed Boulder	2-03.4	TN	3	$696	$2,087
13	Topsoil	8-02.4	CY	7	$45	$315
14	Bark or woodchip mulch	8-02.4	CY	15	$50	$750
15	Live Stake	8-02.4	EA	120	$20	$2,400
16	PSIPE 1 gallon	8-02.4	EA	140	$85	$11,900
17	PSIPE 2 gallon (Wildlife Protection)	8-02.4	EA	20	$175	$3,500
18	Temporary Seeding	8-02.4	FA	1	$500	$500
19	Seeding	8-02.4	SY	675	$5	$3,375
20	Irrigation	8-03.X	LS	1	$2,000	$2,000

Direct Item Construction Subtotal	$ 272,546
Mobilization (10%)	$ 27,255
Direct Item Subtotal	$ 299,801
Estimate Uncertainty Contingency (20%)	$59,960
Contingency Subtotal	$359,761
WA State Sales Tax (10.1%)	$ 36,336
Construction Subtotal (2026 Dollars)	**$ 397,000**

Figure 3.7 Summary of estimated construction costs.

3.4 Monitoring and Maintenance

The project design is expected to reduce sediment loading to the collection pool through both reduction in fine sediment supply from within the proposed work extents and storage of sediment inputs from upstream of it. Assuming an approximate 50% reduction in annual fine sediment loading and structure trapping efficiency of 70%, the proposed design is anticipated to result in no sediment maintenance for a period of about 6 years post-construction. After this period, benefits are expected to be more limited, as sediment loading within the upstream and project action reaches is likely to continue, and once the available storage within the structures

is filled, material would continue to be transported downstream, with sediment maintenance likely similar to current average annual maintenance.

Inspection of large wood structures is recommended at a frequency of 5 years or less. Structure maintenance is expected to be minimal over the assumed project service life of 50 years. Repairs are likely to be limited to replacement of manilla rope lashing over this period.

Construction corridor restoration utilizing native trees and shrubs will be completed over approximately 7,000 sf (reflecting the area of disturbance anticipated). The City is planning to direct placement of restoration plantings in the construction corridor as the City's Parks Department has been engaged in restoration of this open space area for several years. Monitoring of restoration plantings is anticipated in concert with Parks maintenance of the 53rd Place Open Space area.

4 REFERENCES

City of Mercer Island. 2000. Drainage Basin Improvements, Drainage Basins 48 and 46A – Design Drawings. Prepared by Public Works Department.

City of Mercer Island. 2008. Basin Drainage Improvements, Wd524C – Design Drawings. Prepared by Public Works Department.

City of Mercer Island. 2011. Comprehensive Basin Review and Watercourse Monitoring – Project Summary Sheet. Prepared by Public Works Department.

City of Mercer Island. 2014. Comprehensive Basin Review and Watercourse Monitoring – Project Summary Sheet. Prepared by Public Works Department.

Mickelson, K. A., Jacobacci, K. E., Contreras, T. A., Gallin, W. N., and Slaughter, S. L. (2019). Landslide inventory of western King County, Washington (41). Report of Investigations. Washington Geological Survey.

Northwest Hydraulic Consultants, Inc. (NHC). 2024. Subbasin 46.3 Watercourse Stabilization Preliminary Basis of Design. Draft Report. February 2024.

RH2 Engineering, Inc. (RH2). 2025. Subbasin 46a.3 Watercourse Stabilization Critical Areas Study. November 2024.

WDFW. 2021. Site Description and Culvert Assessment Report. WDFW Site ID: 920822. November 2021.

Yount, J. C., Minard, J. P., and Dembroff, G. R. (1993). Geologic map of surficial deposits in the Seattle 30' by 60' quadrangle, Washington. 1:100,000. U.S. Geological Survey. [online] Available from: https://ngmdb.usgs.gov/Prodesc/proddesc_12654.htm (Accessed 2 February 2024).

APPENDIX A

DESIGN DRAWINGS

APPENDIX B

DESIGN CALCULATIONS