



11255 Kirkland Way, Suite 300
Kirkland, Washington 98033-3417

Engineering Report

5236 W. MERCER WAY STORM DRAINAGE REPORT

October 2017
Rev. February 2025



N5 Architecture
4200 Stone Way N
Seattle, Washington 98103



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October 2017
Rev. February 2025

Prepared for:

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Prepared By:



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PACE Project No. 17387

PROJECT CERTIFICATION

The technical material and data contained in this report was prepared by PACE Engineers, Inc., under the supervision of the below-listed individual. Those responsible staff members who are registered professional engineers are licensed in the State of Washington.



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5236 W MERCER WAY STORM DRAINAGE REPORT

1. PROJECT OVERVIEW

The 5236 W Mercer Way project proposes the development of a single-family residence. The subject property is located at 5236 W Mercer Way, King County, in the City of Mercer Island, Washington, on parcel #1924059324.

The existing subject property is approximately 37,350 SF, is primarily wooded and has no buildings or structures. The existing topography contains areas of steep slopes above 40 percent grade. A riverine wetland exists on the southern end of the site. The total disturbed site area is approximately 22,000 SF.

The developed site will consist of 3,250 SF of roof area, 3,200 SF of concrete driveway, and 1,600 SF of concrete sidewalk/patio for a total impervious area of 8,050 SF. New pervious surface will be approximately 9,030 SF of lawn/grass surface. Approximately 2,300 SF of the site will remain undisturbed.

2. CORE REQUIREMENTS

The City of Mercer Island has adopted the 2019 Stormwater Management Manual for Western Washington from the Department of Ecology (2019 SWMMWW). The project will comply with the 2019 SWMMWW for the design of the stormwater management system. Per Vol. I Chapter 3 of the 2019 SWMMWW, the project is required to comply with Minimum Requirement #1-9. Below are the Minimum Requirements and how the project meets each requirement.

2.1 MR #1 – Preparation of Stormwater Site Plans

Erosion and sediment control (ESC), grading, and storm drainage plans have been prepared and are included in Appendix A.

2.2 MR #2 – Construction Stormwater Pollution Prevention

The proposed project disturbs less than 1 acre. An erosion and sediment control plan is included in Appendix A. The narrative for the 13 elements of the SWPPP is outlined in Section 5 of this report.

2.3 MR #3 – Source Control of Pollution

Source controls are not applicable for residential projects.

2.4 MR #4 – Preservation of Natural Drainage Systems and Outfalls

The project's natural downstream drainage path routes to the northwesterly direction through a series of conveyance pipe and a natural watercourse. The proposed downstream flow path and site discharge location will remain preserved as in the existing condition.

2.5 MR #5 – Onsite Stormwater Management

Low Impact Development (LID) facilities are not feasible due to a municipal restriction on infiltration LID facilities in this specific geographical location. As feasible, disturbed landscape soils will be amended per BMP T5.13. Per City of Mercer Island municipal code section 15.09.050.A.2, an onsite detention BMP is required and added to list No. 2 for MR #5. The onsite detention BMP is provided by two onsite detention tanks sized per the City's standard detention pipe design table (based on the 1992 Stormwater Management Manual for Puget Sound Basin).

2.6 MR #6 – Runoff Treatment

Runoff treatment is not required since the project will have less than 5,000 square feet of pollution-generating impervious surfaces. Per City of Mercer Island standards, a catch basin with oil separator is proposed to provide oil/water separation for all onsite road and parking stormwater runoff.

2.7 MR #7 – Flow Control

Per City of Mercer Island municipal code section 15.09.050.A.2, onsite detention BMP is required and added to MR #5 requirements. Per 2019 SWMMWW, Flow Control is not required as the net increase in runoff does not exceed 0.15 cfs. In this circumstance, City of Mercer Island Code governs the stormwater flow control design and flow control onsite detention is required for all hardscape surfaces. Refer to section 2.5 for a design summary of the proposed onsite detention BMP.

2.8 MR #8 – Wetlands Protection

Wetlands will be protected via fencing and silt fencing.

2.9 MR #9 – Operation and Maintenance

Operations and maintenance will be required for onsite storm drainage components. See Section 8 of this report.

3. OFFSITE ANALYSIS

Upstream runoff enters the project site along the eastern property boundary. The tributary upstream basin is approximately 0.40 acres in size. A large portion of the upstream basin flows are tributary to the wetland/open channel system located along the

southern property boundary of the subject property. An insignificant amount of overland flow is conveyed onto the subject property and continues as overland flow in the westerly direction.

Downstream flows discharge the site along the Western property boundary and enter the roadside ditch along West Mercer Way, conjoining with adjacent basin flows. Combined roadside ditch flows enter a 12-inch concrete culvert and are conveyed to the northwest, crossing West Mercer Way and enter a catch basin (CB). Flows continue in the northwesterly direction via 12-inch concrete storm drainpipe, entering a CB, and then are released to a well-defined open channel watercourse conveyance system. The open channel flows continue in the northwesterly direction for approximately 600 LF and then head due west via open channel flow for approximately 300 LF. Open channel flows inlet a 24-inch concrete culvert and are conveyed approximately 200 LF to a nearby CB located to the west. Flows outlet the CB via a 30-inch corrugated metal pipe, are conveyed for approximately 150 LF, and outlet into Lake Washington.

A photo log of the downstream assessment is provided in Appendix B. Please reference the Downstream Analysis Map for respective locations of the field photos.

4. ONSITE STORMWATER MANAGEMENT

4.1 Lid Feasibility

The Onsite Stormwater Management requirement will be met by evaluating feasibility of each BMP in List #2 of 2019 SWMMWW Section I-3.4.5 for each type of surface on the project site.

4.1.1 Lawn/Grass

Post-Construction Soil Quality and Depth will be applied to proposed lawn and landscape areas in accordance with BMP T5.13.

4.1.2 Impervious Surfaces (Roof, Driveway, and Sidewalk)

All BMPs in List #2 are infeasible for the project because they involve either infiltration or dispersion. Dispersion is infeasible because the project site does not have a native vegetation flow path of at least 100 feet in length containing grades less than 20%. Infiltration is infeasible due to a municipal restriction on LID facilities involving infiltration for this specific geographical location (see Appendix C – City of Mercer Island Low Impact Development Infiltration Feasibility). No remaining List #2 items are feasible.

4.2 Detention System

Onsite detention BMP is required per City of Mercer Island municipal code section 15.09.050.A.2 because the subject property is tributary to a natural downstream

watercourse. The onsite detention system sizing method used is based on the 1992 Ecology Stormwater Management Manual for Puget Sound Basin per direction provided by City of Mercer Island Senior Development Engineer.

Onsite detention BMPs are provided via onsite detention tanks sized per the City's standard detention pipe design table (based on the 1992 Stormwater Management Manual for Puget Sound Basin). The eastern basin is mitigated via detention pipe facility and will provide flow control volume for the roof and patio hardscape surface. The east detention pipe receives surface runoff from approximately 4,850 SF of impervious area. Per the design table, for Type C soils, the detention pipe required is 60" in diameter and 31 feet in length. The driveway hardscape runoff will be routed to the western basin flow control detention pipe facility. The west detention pipe receives surface runoff from approximately 3,000 SF of impervious area. Per the design table, for Type C soils, the detention pipe required is 60" in diameter and 20 feet in length. A flow control basin map has been provided in Appendix A.

4.3 Conveyance

Conveyance design relies on conservative design for 6-inch PVC storm drainpipe containing slopes no less than 2.0%. Under this condition, conveyance capacity is nearly 0.9 cfs. Tributary developed 100-year peak flows will not exceed 0.9 cfs under any circumstance.

5. STORMWATER POLLUTION PREVENTION PLAN

A Construction Stormwater General Permit and full SWPPP are not required for the project since less than 1 acre of land will be disturbed. A Narrative and Temporary Erosion and Sediment Control (TESC) Plan is required, has been prepared, and is packaged with the Civil Engineering Plans. The narrative for the 13 elements is listed below with a short description of how each element is met.

1. Mark Clearing Limits
Orange construction fence or silt fence will be used along the clearing and grading limits which are defined on the TESC Plan. This is listed as one of the first steps in the construction sequence.
2. Establish Construction Access
A construction entrance with quarry spalls and geotextile fabric is called out on the TESC Plan. Access will be from W Mercer Way at the proposed driveway location.
3. Control Flow Rates
A small sediment trap will provide control of flow rates for construction runoff during construction.

4. Install Sediment Controls
Sediment controls will be installed prior to any grading activities. Installation of the sediment controls shall be per the construction sequence shown on the TESC Plans. Silt fence will be the primary method of sediment control.
5. Stabilize Soils
Temporary groundcover will include plastic sheeting or mulch. Any soils that will be exposed long-term, over 30 days, will be sprayed with hydroseed and allowed to grow prior to the wet season.
6. Protect Slopes
Slopes will be protected with plastic sheeting or mulch.
7. Protect Drain Inlets
Storm drain inlet protection will be installed in catch basins in the vicinity of the project site.
8. Stabilize Channels and Outlets
Straw wattles and compost socks will be used to stabilize channels. The outlet is a hard pipe so stabilization of outlet will not be required.
9. Control Pollutants
Construction equipment will be kept in good working order to prevent oil drippings.
10. Control Dewatering
Any dewatering activities will be directed to the proposed sediment trap to remove sediments. The detention will be cleaned once the site is stabilized.
11. Maintain BMPs
The CESCL or Monitoring Personnel shall be responsible for keeping track of construction BMPs.
12. Manage the Project
The contractor, CESCL, and parties involved shall be mindful of construction activities, the time of year, and to maintain TESC facilities to function as designed.
13. Protect Low Impact Development BMPs
N/A. There are no LID BMPs proposed for the project.

6. SPECIAL REPORTS AND STUDIES

- Geotechnical Engineering Report dated October 5, 2017 by PanGEO Inc. See Appendix C in this report for a copy of the study.

7. OTHER PERMITS

- Building Permit (City of Mercer Island)
- Right-of-Way Permit (City of Mercer Island)
- Water and Sewer Connection Permits (City of Mercer Island)

8. OPERATIONS AND MAINTENANCE

O & M Checklists from the 2019 SWMMWW have been inserted into Appendix D of this Report.

N5 Architecture
Storm Drainage Report
5236 W. Mercer Way

**Appendix A:
Erosion and Sediment Control Plan
Grading and Storm Drainage Plans**

LEGEND

- SILT FENCE
- CONSTRUCTION LIMITS AND TREE PROTECTION CHAIN LINK FENCE
- INTERCEPTOR SWALE
- TEMPORARY CONSTRUCTION ENTRANCE
- INLET PROTECTION
- TREE PROTECTION LIMITS
- DRIVEWAY BASE COURSE OR ATB PRELEVEL

TESC AND CONSTRUCTION

MANAGEMENT NOTES

1. CONSTRUCTION CENTERLINE PER DETAILS ON THIS SHEET. TEMPORARY SHORING WALLS.
2. CONSTRUCT STABILIZED CONSTRUCTION ENTRANCE PER DETAIL 4 ON SHEET C1.1.
3. INSTALL HIGH VISIBILITY SILT FENCE PER DETAIL 1 ON SHEET C1.1.
4. CONSTRUCTION LIMITS AND TREE PROTECTION CHAIN LINK FENCE PER DETAIL ON SHEET C0.2.
5. INSTALL STRAW WATTLES PER DETAIL 5 ON SHEET C1.1.
6. CONSTRUCTION STAGING AND PARKING AREA.
7. MATERIAL STOCKPILE LOCATION.
8. INSTALL INTERCEPTOR SWALE WITH ROCK CHECK DAMS PER DETAIL 3 ON SHEET C1.1.
9. USE BMP T5.13 POST CONSTRUCTION SOIL QUALITY AND DEPTH OR BETTER FOR ALL DISTURBED LANDSCAPE AREAS PER DETAIL 1 ON THIS SHEET.
10. TURBIDITY TESTING LOCATION IF DETERMINED NECESSARY BY ON-SITE INSPECTION OR ESC SUPERVISOR

GENERAL NOTES:

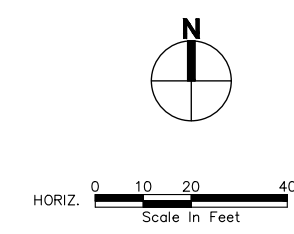
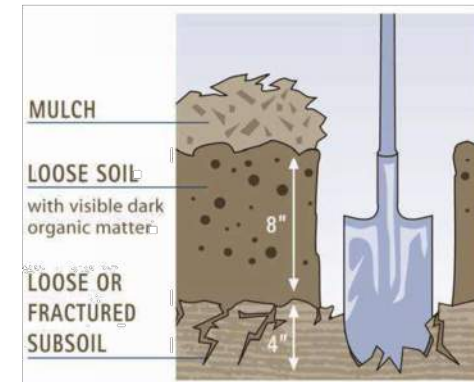
1. TREE REMOVAL TO BE COORDINATED WITH ARBORIST AND THE CITY OF MERCER ISLAND.

CONSTRUCTION SEQUENCE

1. INSTALL CONSTRUCTION LIMITS AND TREE PROTECTION CHAIN LINK FENCE, ALONG IDENTIFIED CONSTRUCTION LIMITS.
2. INSTALL PERMANENT DOWNSTREAM PIPED CONVEYANCE INCLUDING CB5 AND CB2. SEE SHEET C2.0.
3. INSTALL STORM DRAIN INLET PROTECTION.
4. GRADE AND INSTALL CONSTRUCTION ENTRANCE AND PERMANENT DRIVEWAY CULVERT.
5. GRADE AND INSTALL CONSTRUCTION STAGING / PARKING AREA.
6. GRADE AND DESIGNATE STOCKPILE AREAS.
7. INSTALL TEMPORARY INTERCEPTOR SWALE AND SEDIMENT CONTROL MEASURES.
8. BEGIN DRIVEWAY CLEARING AND GRADING.
9. INSTALL UTILITIES LOCATED IN DRIVEWAY CORRIDOR.
10. INSTALL DRIVEWAY, GRADE WALLS, DRIVEWAY ACCESS BASE COURSE OR ATB PRELEVEL.
11. INSTALL GABION BASKET WALLS.
12. INSTALL BUILDING FOUNDATION SHORING.
13. CONSTRUCT BUILDING AND REMAINING HARDSCAPE FEATURES.
14. CONNECT UTILITIES.
15. STABILIZE SITE.
16. REMOVE REMAINING TESC FEATURES.
17. CONDUCT ALL ACTIVITIES IN ACCORDANCE WITH ESC NOTES, THIS SHEET.

BMP T5.13 IMPLEMENTATION NOTES:

1. Leave undisturbed native vegetation and soil, and protect from compaction during construction.
2. Amend existing site topsoil or subsoil either at default "pre-approved" rates, or at custom calculated rates based on tests of the soil and amendment.
3. Stockpile existing topsoil during grading, and replace it prior to planting. Stockpiled topsoil must also be amended if needed to meet the organic matter or depth requirements, either at a default "pre-approved" rate or at a custom calculated rate.
4. Import topsoil mix of sufficient organic content and depth to meet the requirements.
5. More than one method may be used on different portions of the same site. Soil that already meets the depth and organic matter quality standards, and is not compacted, does not need to be amended.



1 DETAIL
NTS

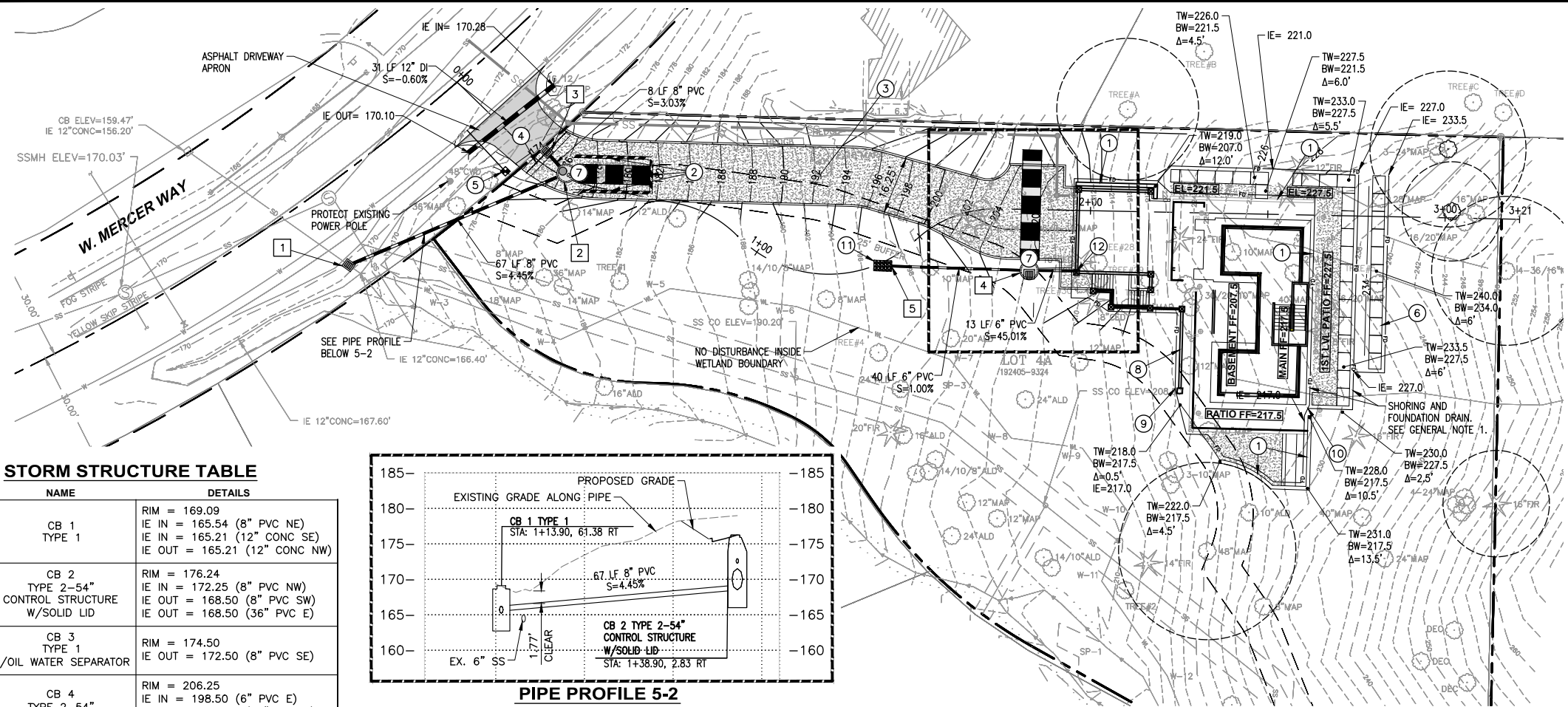
EROSION AND SEDIMENTATION CONTROL NOTES:

1. APPROVAL OF THIS EROSION AND SEDIMENTATION CONTROL (ESC) PLAN DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN (E.G. SIZE AND LOCATION OF ROADS, PIPES, RESTRICTORS, CHANNELS, RETENTION FACILITIES, UTILITIES, ETC.)
2. THE IMPLEMENTATION OF THESE ESC PLANS AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF THESE ESC FACILITIES IS THE RESPONSIBILITY OF THE APPLICANT/ESC SUPERVISOR UNTIL THE SITE IS STABILIZED.
3. THE BOUNDARIES OF THE CLEARING LIMITS SHOWN ON THIS PLAN SHALL BE CLEARLY FLAGGED BY SURVEY TAPE OR FENCING, IF REQUIRED, PRIOR TO CONSTRUCTION (SWDM APPENDIX D). DURING THE CONSTRUCTION PERIOD, NO DISTURBANCE BEYOND THE CLEARING LIMITS SHALL BE PERMITTED. THE CLEARING LIMITS SHALL BE MAINTAINED BY THE APPLICANT/ESC SUPERVISOR FOR THE DURATION OF CONSTRUCTION.
4. STABILIZED CONSTRUCTION ENTRANCES SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES, SUCH AS CONSTRUCTED WHEEL WASH SYSTEMS OR WASH PADS, MAY BE REQUIRED TO ENSURE THAT ALL PAVED AREAS ARE KEPT CLEAN AND TRACK OUT TO ROAD RIGHT OF WAY DOES NOT OCCUR FOR THE DURATION OF THE PROJECT.
5. THE ESC FACILITIES SHOWN ON THIS PLAN MUST BE CONSTRUCTED PRIOR TO OR IN CONJUNCTION WITH ALL CLEARING AND GRADING SO AS TO ENSURE THAT THE TRANSPORT OF SEDIMENT TO SURFACE WATERS, DRAINAGE SYSTEMS, AND ADJACENT PROPERTIES IS MINIMIZED.
6. THE ESC FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND MODIFIED TO ACCOUNT FOR CHANGING SITE CONDITIONS (E.G. ADDITIONAL COVER MEASURES, RELOCATION OF DITCHES AND SILT FENCES, PERIMETER PROTECTION ETC.).
7. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE APPLICANT/ESC SUPERVISOR AND MAINTAINED TO ENSURE CONTINUED PROPER FUNCTIONING. WRITTEN RECORDS SHALL BE KEPT OF WEEKLY REVIEWS OF THE ESC FACILITIES.
8. ANY AREAS OF EXPOSED SOILS, INCLUDING ROADWAY EMBANKMENTS, THAT WILL NOT BE DISTURBED FOR TWO DAYS DURING THE WET SEASON OR SEVEN DAYS DURING THE DRY SEASON SHALL BE IMMEDIATELY STABILIZED WITH THE APPROVED ESC COVER METHODS (E.G., SEEDING, MULCHING, PLASTIC COVERING, ETC.).
9. ANY AREA NEEDING ESC MEASURES, NOT REQUIRING IMMEDIATE ATTENTION, SHALL BE ADDRESSED WITHIN SEVEN (7) DAYS.
10. THE ESC FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED A MINIMUM OF ONCE A MONTH OR WITHIN 24 HOURS FOLLOWING A STORM EVENT.
11. AT NO TIME SHALL MORE THAN ONE (1) FOOT OF SEDIMENT BE ALLOWED TO ACCUMULATE WITHIN A CATCH BASIN. ALL CATCH BASINS AND CONVEYANCE LINES SHALL BE CLEANED PRIOR TO PAVING. THE CLEANING OPERATION SHALL NOT FLUSH SEDIMENT-LADEN WATER INTO THE DOWNSTREAM SYSTEM.
12. COVER MEASURES WILL BE APPLIED IN CONFORMANCE WITH APPENDIX D OF THE SURFACE WATER DESIGN MANUAL.
13. PRIOR TO THE BEGINNING OF THE WET SEASON (OCT. 1), ALL DISTURBED AREAS SHALL BE REVIEWED TO IDENTIFY WHICH ONES CAN BE SEEDED IN PREPARATION FOR THE WINTER RAINS. DISTURBED AREAS SHALL BE SEEDED WITHIN ONE WEEK OF THE BEGINNING OF THE WET SEASON. A SKETCH MAP OF THOSE AREAS TO BE SEEDED AND THOSE AREAS TO REMAIN UNCOVERED SHALL BE SUBMITTED TO THE DDES INSPECTOR FOR REVIEW.

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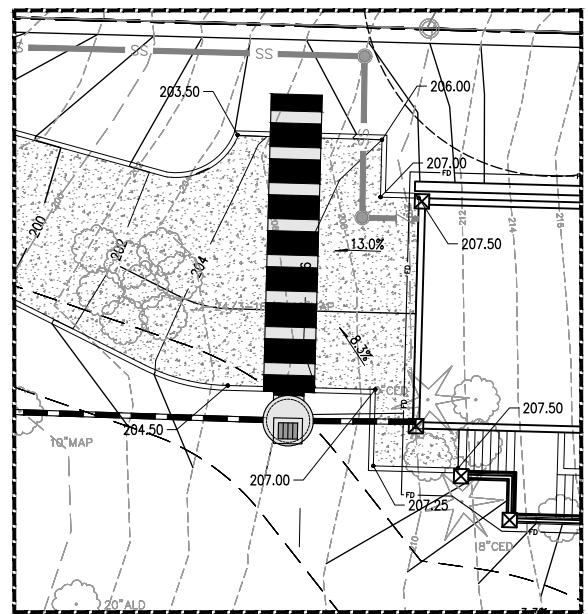
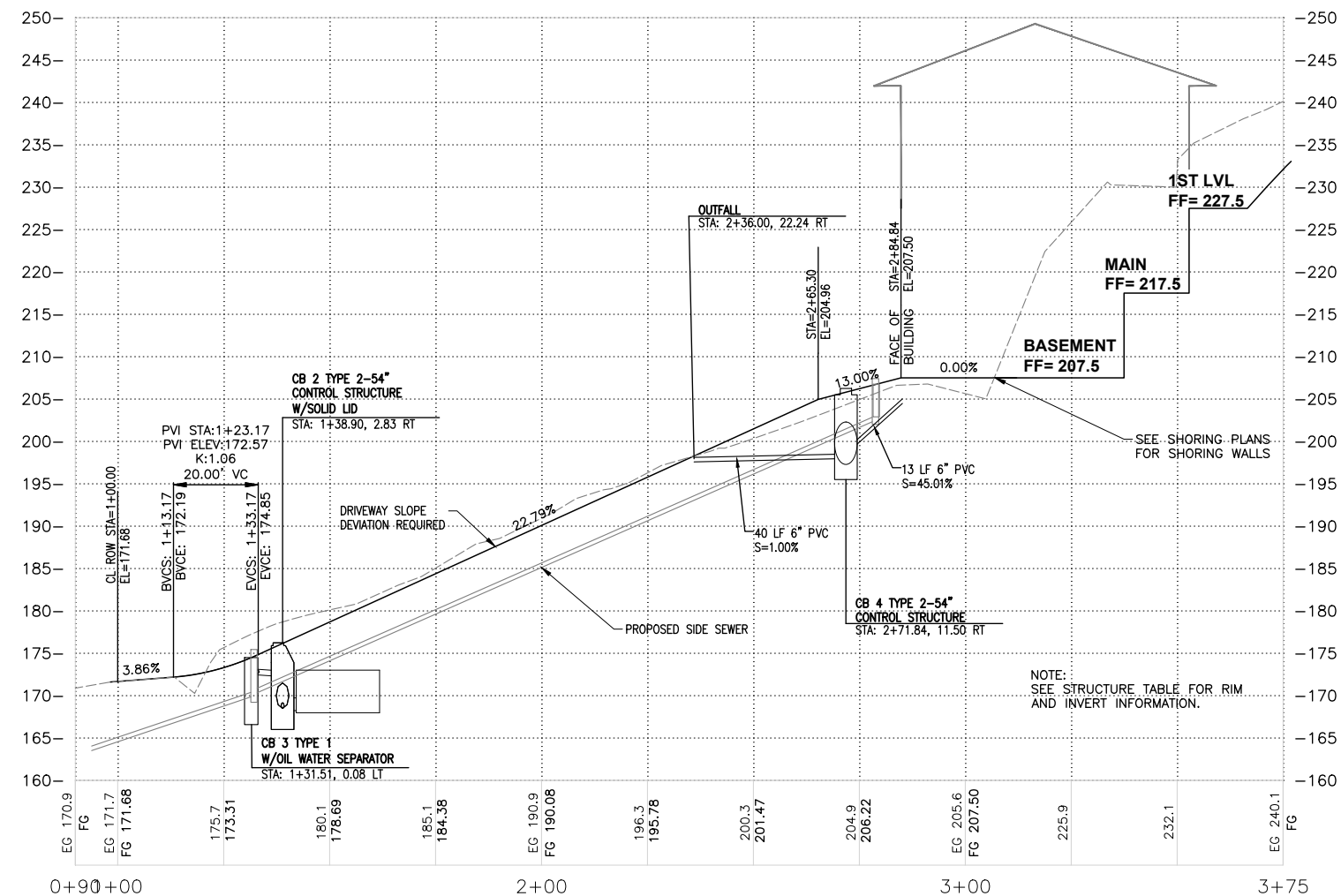
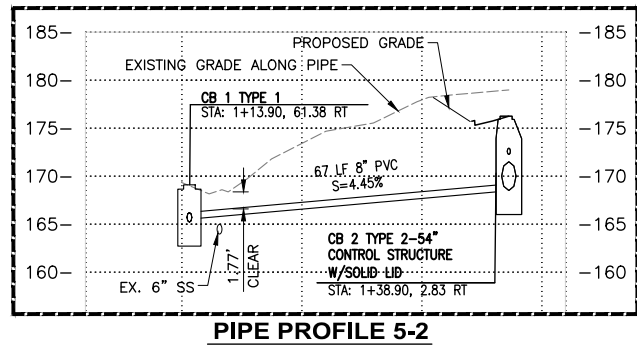
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	REVISION
	SYM
<p>PACE Engineers 1725 Kirkland Way, Suite 300 Kirkland, WA 98033 P: 425.827.2014 www.paceengs.com</p>	
ORIGINAL COPY OF DIGITALLY SIGNED DOCUMENT AVAILABLE UPON REQUEST	
<p>N5 ARCHITECTURE 4200 STONE WAY N SEATTLE, WA 98103</p>	
<p>5236 W MERCER WAY SINGLE FAMILY RESIDENCE</p>	<p>TESC AND CONSTRUCTION MANAGEMENT PLAN</p>
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STORM STRUCTURE TABLE

NAME	DETAILS
1 CB 1 TYPE 1	RIM = 169.09 IE IN = 165.54 (8" PVC NE) IE IN = 165.21 (12" CONC SE) IE OUT = 165.21 (12" CONC NW)
2 CB 2 TYPE 2-54" CONTROL STRUCTURE W/SOLID LID	RIM = 176.24 IE IN = 172.25 (8" PVC NW) IE OUT = 168.50 (8" PVC SE) IE OUT = 168.50 (36" PVC E)
3 CB 3 TYPE 1 W/OIL WATER SEPARATOR	RIM = 174.50 IE OUT = 172.50 (8" PVC SE)
4 CB 4 TYPE 2-54" CONTROL STRUCTURE	RIM = 206.25 IE IN = 198.50 (6" PVC E) IE OUT = 198.00 (36" PVC N) IE OUT = 198.00 (6" PVC W)
5 OUTFALL	IE IN = 197.60 (6" PVC E)



DRIVEWAY GRADING
1"=10'

KEY NOTES

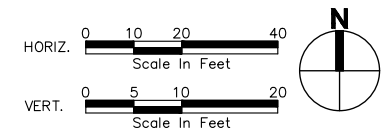
- PERMANENT SHORING WALLS
- TEMPORARY SHORING WALLS
- 6" CONCRETE DRIVEWAY WITH 3/8" TRACTION GROOVES ON SECTIONS WITH SLOPES GREATER THAN 20%, AND VERTICAL CURB AND GUTTER. SEE DETAIL 5, SHEET C2.1.
- VALLEY GUTTER AT EDGE OF ASPHALT. SEE DETAIL 3, SHEET C2.1.
- 1" WATER METER, MINIMUM.
- GABION BASKET WALL (TYP), SEE DETAIL 4, SHEET C2.1.
- CMP DETENTION PIPE, SEE DETAILS ON SHEET C2.1.
- FINAL WALL DESIGN SHALL BE COMPLETED BY THE BLOCK WALL MANUFACTURER, BASED ON GEOTECHNICAL PARAMETERS PRESENTED IN THE GEOTECHNICAL REPORT, SECTION 6.6.
- CONNECT FOOTING DRAIN TO WALL DRAIN.
- CONNECT GABION BASKET WALL FOOTING DRAINS TO SOLDIER PILE SHORING FOOTING DRAIN.
- CRUSHED ROCK RIP ROCK PAD AT PIPE OUTFALL.
- 6" ROOF DRAIN OUTLET, S=2.00% MIN.

GENERAL NOTES:

- REFERENCE SHORING AND STRUCTURAL DETAILS FOR SHORING AND FOUNDATION DRAIN OUTLET DETAILS.
- BASEMENT FLOOR SHORING-FOUNDATION DRAIN OUTLET SD @ 2.0% MIN.
- YARD DRAIN OUTLET SD @ 2.0% MIN
- STORM CONVEYANCE PIPE SHALL BE SDR 35 PVC.
- GABION BASKET WALL CONSTRUCTED PRIOR TO PERMANENT SHORING CONSTRUCTION. SEE SHORING AND STRUCTURAL PLANS.
- BMP T5.13 POST CONSTRUCTION SOIL QUALITY AND DEPTH OR BETTER FOR ALL DISTURBED LANDSCAPE AREAS.

LEGEND

- PERMANENT SHORING
- TEMP. SHORING
- SANITARY SIDE SEWER
- SS CLEANOUT
- STORM DRAIN
- TRENCH DRAIN
- FOOTING DRAIN
- WALL DRAIN
- SD CLEANOUT
- YARD DRAIN
- CB TYPE 1
- CB TYPE 2
- CAST-IN-PLACE WALL



DATE	REVISION	SYM

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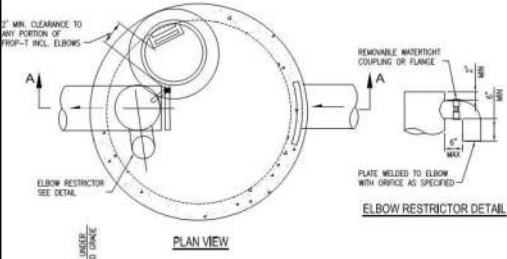
N5 ARCHITECTURE
 4200 STONE WAY N
 SEATTLE, WA 98103

5236 W MERCER WAY
SINGLE FAMILY RESIDENCE
ROAD, GRADING, AND STORM PLAN

VERIFY SCALE
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 CHECKED BY: JA
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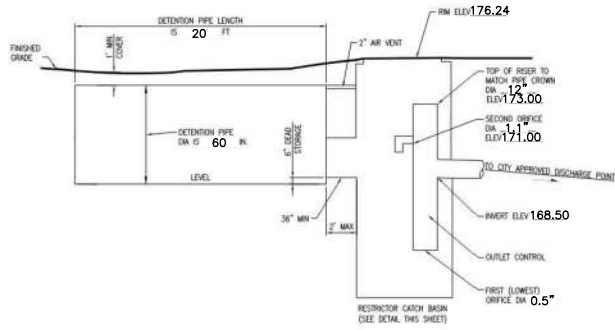
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Attachment 1
CITY OF MERCER ISLAND
STANDARD DETENTION SYSTEM WORKSHEET
(FOR IMPERVIOUS AREA OF 5,000 SF OR LESS)

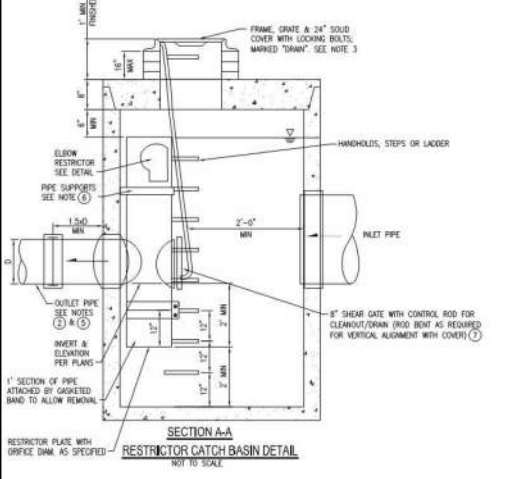


OWNER: _____	ADDRESS: 5236 W. MERCER WAY	PREPARED BY: JOHN ANDERSON
PERMIT # _____	MERCER ISLAND, WA	PHONE: 425.827.2014
		DATE: 10/24/2024
IMPERVIOUS SURFACE AREA (SF): 3,000	DETENTION PIPE DIA (INCH): 60	DETENTION PIPE LENGTH (FT): 20
	PIPE MATERIAL: CORRUGATED ALUMINUM PIPE	ORFICE #1 DIA 0.5 INCH, ELEV 168.50
		ORFICE #2 DIA 1.1 INCH, ELEV 171.00

FOOTING DRAINS SHALL NOT BE CONNECTED TO DETENTION SYSTEM



STANDARD PIPE DETENTION SYSTEM
 NOT TO SCALE (ENGINEER TO FILL IN BLANKS)



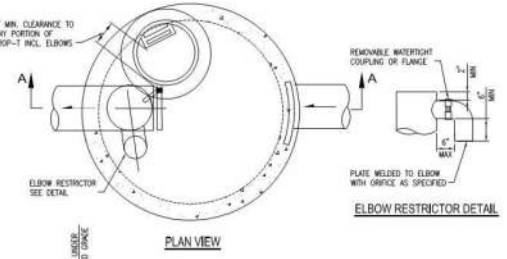
RESTRICTOR CATCH BASIN NOTES:

- USE A MINIMUM OF A 72 IN. DIA. TYPE 2 CATCH BASIN WHEN CONNECTING PIPE MATERIAL IS CONCRETE OR LOUPE. A 24 IN. DIA. TYPE 2 CATCH BASIN MAY BE USED FOR OTHER CIRCULAR SHAPE WALL PIPE (SUCH AS CORRUGATED ALUMINUM PIPE).
- OUTLET PIPE: MIN. 6 INCH.
- METAL PARTS: CORROSION RESISTANT, NON-DALUMINIZED PARTS PREFERRED. GALVANIZED PIPE PARTS TO HAVE ASPHALT TREATMENT.
- FRAME AND LADDER OR STEPS OFFSET 50.
- IF METAL OUTLET PIPE CONNECTS TO CONCRETE PIPE, OUTLET PIPE TO HAVE SMOOTH O.D. EQUAL TO CONCRETE PIPE I.D. LESS 1/4 IN.
- PROVIDE AT LEAST ONE 3 X 0.090 GAUGE SUPPORT BRACKET ANCHORED TO CONCRETE WALL WITH 5/8 IN. STAINLESS STEEL EXPANSION BOLTS OR EMBEDDED SUPPORTS 2 IN. INTO CATCH BASIN WALL (MINIMUM 3"-4" VERTICAL SPACING).
- THE SHEAR GATE SHALL BE MADE OF ALUMINUM ALLOY IN ACCORDANCE WITH ASTM B 208 AND ASTM B 275, DESIGNATION 2020A, OR CAST IRON IN ACCORDANCE WITH ASTM A 48, CLASS 300. THE LEFT HANDLE SHALL BE MADE OF A SIMILAR METAL TO THE GATE. (TO PREVENT GALVANIC CORROSION), IT MAY BE OF SOLID ROD OR HOLLOW TUBING WITH ADJUSTABLE HOOK AS REQUIRED. A NEOPRENE RUBBER GASKET IS REQUIRED BETWEEN THE RISER MOUNTING FLANGE AND THE GATE FLANGE. INSTALL THE GATE SO THAT THE LEVEL-LINE MARK IS LEVEL WHEN THE GATE IS CLOSED. THE MATING SURFACES OF THE LG AND THE BODY SHALL BE MACHINED FOR PROPER FIT. ALL SHEAR GATE BOLTS SHALL BE STAINLESS STEEL.

STANDARD DETENTION SYSTEM NOTES:

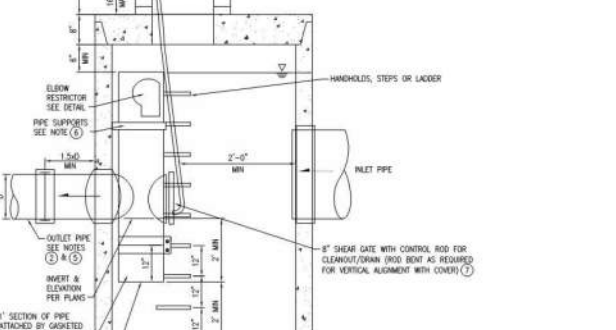
- CALL DEVELOPMENT SERVICES (206-275-7600) 24 HOURS IN ADVANCE FOR A DETENTION SYSTEM INSPECTION BEFORE BACKFILLING AND FOR FINAL INSPECTIONS.
- RESPONSIBILITY FOR OPERATION AND MAINTENANCE OF DRAINAGE SYSTEMS ON PRIVATE PROPERTY IS RESPONSIBILITY OF THE PROPERTY OWNER. MATERIAL ACCUMULATED IN THE STORAGE PIPE MUST BE REMOVED FROM CATCH BASINS TO ALLOW PROPER OPERATION. THE OUTLET CONTROL ORFICE MUST BE KEPT OPEN AT ALL TIMES.
- PIPE MATERIAL, JOINT, AND PROTECTIVE TREATMENT SHALL BE IN ACCORDANCE WITH SECTION 7.04 AND 8.09 OF THE WSDOT STANDARD SPECIFICATIONS FOR ROAD, BRIDGE, AND MUNICIPAL CONSTRUCTION, LATEST VERSION. SUCH MATERIALS INCLUDE THE FOLLOWING: LINED CORRUGATED POLYETHYLENE PIPE (LOPE), ALUMINUM TYPE 2 CORRUGATED STEEL PIPE AND PIPE WHICH MEETS ABOVE DESIGNATIONS WITH AND WITH, CORRUGATED OR SPIRAL REINFORCED ALUMINUM PIPE, OR REINFORCED CONCRETE PIPE. CORRUGATED STEEL PIPE IS NOT ALLOWED.

Attachment 1
CITY OF MERCER ISLAND
STANDARD DETENTION SYSTEM WORKSHEET
(FOR IMPERVIOUS AREA OF 5,000 SF OR LESS)

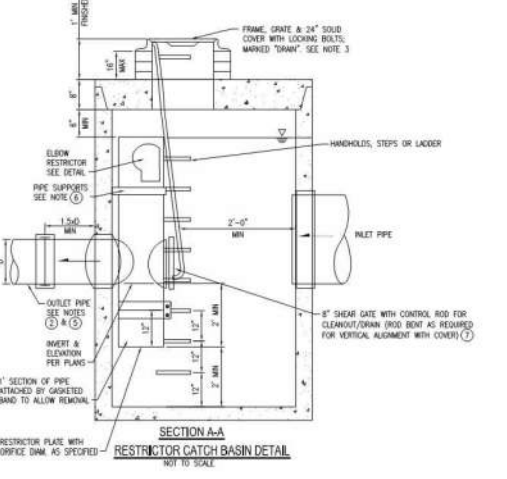


OWNER: _____	ADDRESS: 5236 W. MERCER WAY	PREPARED BY: JOHN ANDERSON
PERMIT # _____	MERCER ISLAND, WA	PHONE: 425.827.2014
		DATE: 10/24/2024
IMPERVIOUS SURFACE AREA (SF): 4,850	DETENTION PIPE DIA (INCH): 60	DETENTION PIPE LENGTH (FT): 31
	PIPE MATERIAL: CORRUGATED ALUMINUM PIPE	ORFICE #1 DIA 0.5 INCH, ELEV 198.0
		ORFICE #2 DIA 2.2 INCH, ELEV 200.5

FOOTING DRAINS SHALL NOT BE CONNECTED TO DETENTION SYSTEM



STANDARD PIPE DETENTION SYSTEM
 NOT TO SCALE (ENGINEER TO FILL IN BLANKS)



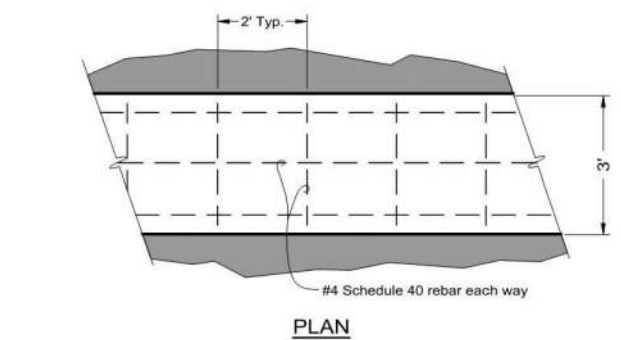
RESTRICTOR CATCH BASIN NOTES:

- USE A MINIMUM OF A 72 IN. DIA. TYPE 2 CATCH BASIN WHEN CONNECTING PIPE MATERIAL IS CONCRETE OR LOUPE. A 24 IN. DIA. TYPE 2 CATCH BASIN MAY BE USED FOR OTHER CIRCULAR SHAPE WALL PIPE (SUCH AS CORRUGATED ALUMINUM PIPE).
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- FRAME AND LADDER OR STEPS OFFSET 50.
- IF METAL OUTLET PIPE CONNECTS TO CONCRETE PIPE, OUTLET PIPE TO HAVE SMOOTH O.D. EQUAL TO CONCRETE PIPE I.D. LESS 1/4 IN.
- PROVIDE AT LEAST ONE 3 X 0.090 GAUGE SUPPORT BRACKET ANCHORED TO CONCRETE WALL WITH 5/8 IN. STAINLESS STEEL EXPANSION BOLTS OR EMBEDDED SUPPORTS 2 IN. INTO CATCH BASIN WALL (MINIMUM 3"-4" VERTICAL SPACING).
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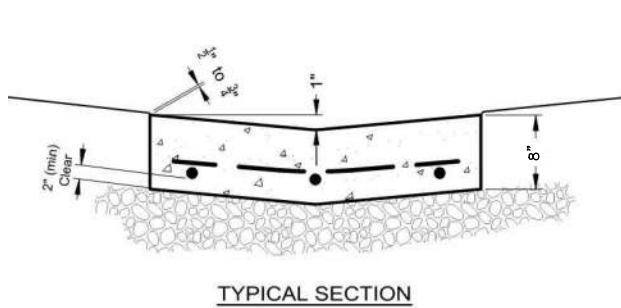
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- CALL DEVELOPMENT SERVICES (206-275-7600) 24 HOURS IN ADVANCE FOR A DETENTION SYSTEM INSPECTION BEFORE BACKFILLING AND FOR FINAL INSPECTIONS.
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1 DETENTION SYSTEM DETAIL (WEST)
 NTS



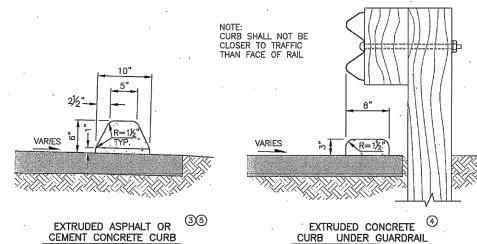
PLAN



TYPICAL SECTION

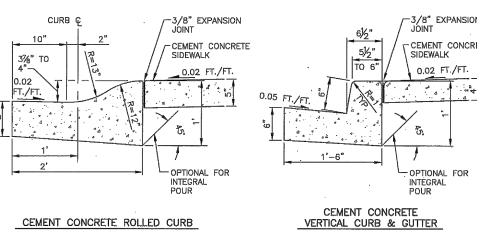
3 VALLEY GUTTER CURB
 NTS

2 DETENTION SYSTEM DETAIL (EAST)
 NTS



EXTRUDED ASPHALT OR CEMENT CONCRETE CURB

EXTRUDED CONCRETE CURB UNDER GUARDRAIL



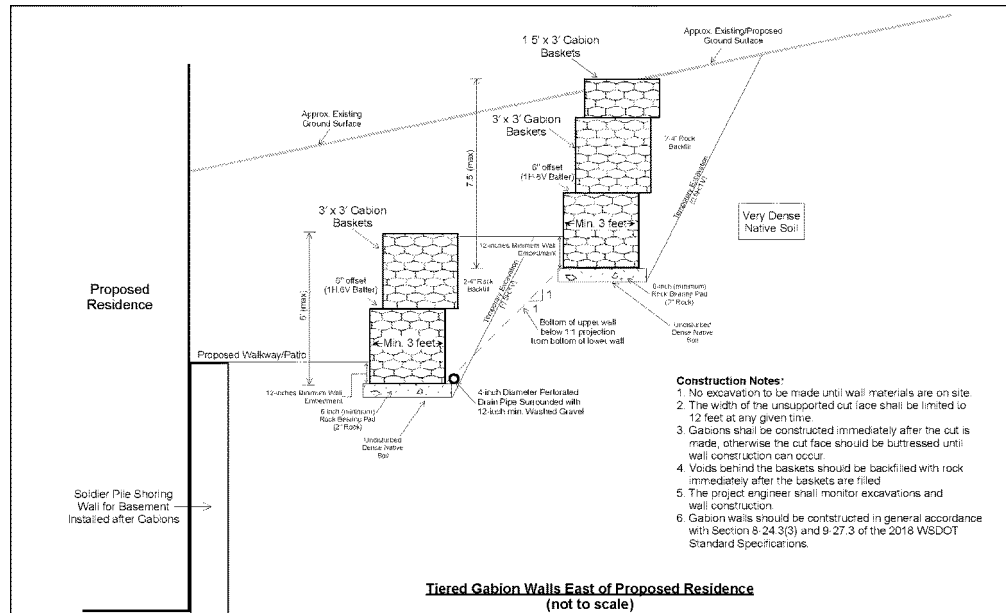
CEMENT CONCRETE ROLLED CURB

CEMENT CONCRETE VERTICAL CURB & GUTTER

- NOTES:**
- SEE SEC. 3.04 K.C.R.S. FOR JOINT REQUIREMENTS.
 - ROLL AND VERTICAL GUTTER TO MATCH POSITIVE SUPERELEVATION.
 - SEE FIG. NO. 2-005 FOR CONFIGURATION OF FILL AND WALKWAY BEHIND CURB IF REQUIRED.
 - THIS IS A CURB LOCATION DETAIL, NOT A GUARDRAIL DETAIL.
 - SEE SEC. 3.03 FOR EXTRUDED CURB ANCHORAGE.

CURB DETAILS FIG. 3-002

Department of Transportation
 Road Services Division
 2018 Design and Construction Standards
 3-13



Tiered Gabion Walls East of Proposed Residence
 (not to scale)

PanGEO	Proposed Residence 5236 West Mercer Way Mercer Island, Washington	TYPICAL SCHEMATIC SECTION GABION BASKET WALLS
	Project No. 17-143 200	Sheet No. A

4 GABION BASKET WALLS
 NTS

5 VERTICAL CURB
 NTS

PACE Engineers
 17255 Kirkland Way, Suite 300
 Kirkland, WA 98033
 P: 425.827.2014
 www.paceengs.com



ORIGINAL COPY OF DIGITALLY SIGNED DOCUMENT AVAILABLE UPON REQUEST

N5 ARCHITECTURE
 4200 STONE WAY N
 SEATTLE, WA 98103

5236 W MERCER WAY
SINGLE FAMILY RESIDENCE
STORM DRAINAGE DETAILS

VERIFY SCALE	
BAR IS ONE INCH ON ORIGINAL DRAWING.	1"
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.	
SCALE: AS SHOWN	DATE: 11/20/2024
DESIGNED BY: JF	CHECKED BY: JA
PACE PROJECT NO. 17387	

SHEET C2.1

FILE NAME: D:\WORK\17387_5236_WEST_MERCER_WAY_SFR_CAD\ENGINEERING\SHEETS\17387-DET.DWG
 SAVE TIME: 11/19/2024 1:34:16 PM
 USER NAME: TYLER CHRISTOFFERSON

Table 1

ON-SITE DETENTION DESIGN FOR PROJECTS BETWEEN 500 SF AND 9,500 SF NEW PLUS REPLACED IMPERVIOUS SURFACE AREA

New and Replaced Impervious Surface Area (sf)	Detention Pipe Diameter (in)	Detention Pipe Length (ft)		Lowest Orifice Diameter (in) ⁽³⁾		Distance from Outlet Invert to Second Orifice (ft)		Second Orifice Diameter (in)	
		B soils	C soils	B soils	C soils	B soils	C soils	B soils	C soils
500 to 1,000 sf	36"	30	22	0.5	0.5	2.2	2.0	0.5	0.8
	48"	18	11	0.5	0.5	3.3	3.2	0.9	0.8
	60"	11	7	0.5	0.5	4.2	3.4	0.5	0.6
1,001 to 2,000 sf	36"	66	43	0.5	0.5	2.2	2.3	0.9	1.4
	48"	34	23	0.5	0.5	3.2	3.3	0.9	1.2
	60"	22	14	0.5	0.5	4.3	3.6	0.9	0.9
2,001 to 3,000 sf	36"	90	66	0.5	0.5	2.2	2.4	0.9	1.9
	48"	48	36	0.5	0.5	3.1	2.8	0.9	1.5
	60"	30	20	0.5	0.5	4.2	3.7	0.9	1.1
3,001 to 4,000 sf	36"	120	78	0.5	0.5	2.4	2.2	1.4	1.6
	48"	62	42	0.5	0.5	2.8	2.9	0.8	1.3
	60"	42	26	0.5	0.5	3.8	3.9	0.9	1.3
4,001 to 5,000 sf	36"	134	91	0.5	0.5	2.8	2.2	1.7	1.5
	48"	73	49	0.5	0.5	3.6	2.9	1.6	1.5
	60"	46	31	0.5	0.5	4.6	3.5	1.6	1.3
5,001 to 6,000 sf	36"	162	109	0.5	0.5	2.7	2.2	1.8	1.6
	48"	90	59	0.5	0.5	3.5	2.9	1.7	1.5
	60"	54	37	0.5	0.5	4.6	3.6	1.6	1.4
6,001 to 7,000 sf	36"	192	128	0.5	0.5	2.7	2.2	1.9	1.8
	48"	102	68	0.5	0.5	3.7	2.9	1.9	1.6
	60"	64	43	0.5	0.5	4.6	3.6	1.8	1.5
7,001 to 8,000 sf	36"	216	146	0.5	0.5	2.8	2.2	2.0	1.9
	48"	119	79	0.5	0.5	3.8	2.9	2.2	1.7
	60"	73	49	0.5	0.5	4.5	3.6	2.0	1.6
8,001 to 8,500 sf ⁽¹⁾	36"	228	155	0.5	0.5	2.8	2.2	2.1	1.9
	48"	124	84	0.5	0.5	3.7	2.9	1.9	1.8
	60"	77	53	0.5	0.5	4.6	3.6	2.0	1.6
8,501 to 9,000 sf	36"	NA ⁽¹⁾	164	0.5	0.5	NA ⁽¹⁾	2.2	NA ⁽¹⁾	1.9
	48"	NA ⁽¹⁾	89	0.5	0.5	NA ⁽¹⁾	2.9	NA ⁽¹⁾	1.9
	60"	NA ⁽¹⁾	55	0.5	0.5	NA ⁽¹⁾	3.6	NA ⁽¹⁾	1.7
9,001 to 9,500 sf ⁽²⁾	36"	NA ⁽¹⁾	174	0.5	0.5	NA ⁽¹⁾	2.2	NA ⁽¹⁾	2.1
	48"	NA ⁽¹⁾	94	0.5	0.5	NA ⁽¹⁾	2.9	NA ⁽¹⁾	2.0
	60"	NA ⁽¹⁾	58	0.5	0.5	NA ⁽¹⁾	3.7	NA ⁽¹⁾	1.7

Notes:

▪ Minimum Requirement #7 (Flow Control) is required when the 100-year flow frequency causes a 0.15 cubic feet per second increase (when modeled in WWHM with a 15-minute timestep). Breakpoints shown in this table are based on a flat slope (0-5%). The 100-year flow frequency will need to be evaluated on a site-specific basis for projects on moderate (5-15%) or steep (> 15%) slopes.

- Soil type to be determined by geotechnical analysis or soil map.
- Sizing includes a Volume Correction Factor of 120%.
- Upper bound contributing area used for sizing.

⁽¹⁾ On Type B soils, new plus replaced impervious surface areas exceeding 8,500 sf trigger Minimum Requirement #7 (Flow Control)

⁽²⁾ On Type C soils, new plus replaced impervious surface areas exceeding 9,500 sf trigger Minimum Requirement #7 (Flow Control)

⁽³⁾ Minimum orifice diameter = 0.5 inches

in = inch

ft = feet

sf = square feet

Basis of Sizing Assumptions:

Sized per MR#5 in the Stormwater Management Manual for Puget Sound Basin (1992 Ecology Manual)

SBUH, Type 1A, 24-hour hydrograph

2-year, 24-hour storm = 2 in; 10-year, 24-hour storm = 3 in; 100-year, 24-hour storm = 4 in

Predeveloped = second growth forest (CN = 72 for Type B soils, CN = 81 for Type C soils)

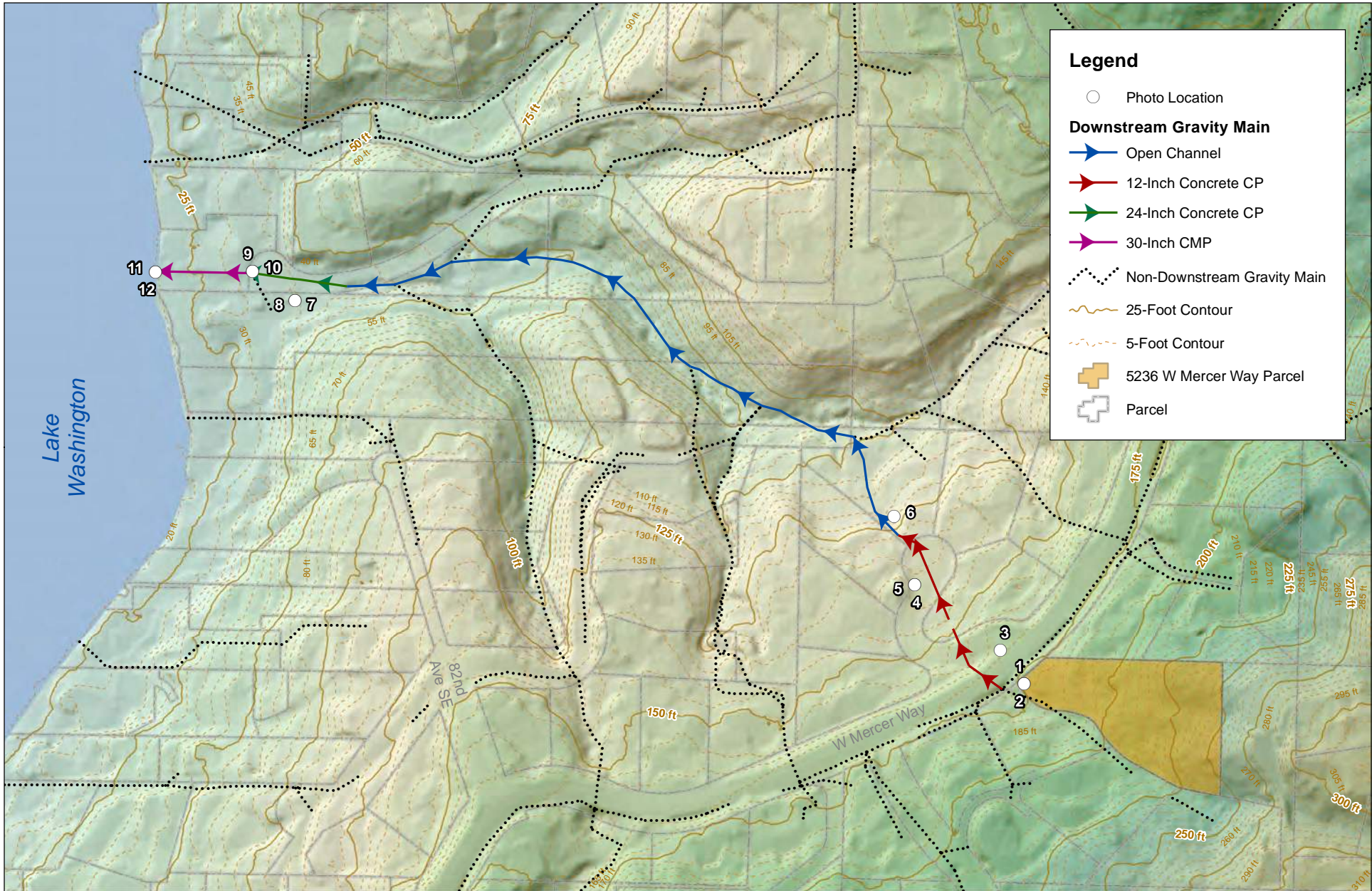
Developed = impervious (CN = 98)

0.5 foot of sediment storage in detention pipe

Overland slope = 5%

N5 Architecture
Storm Drainage Report
5236 W. Mercer Way

Appendix B:
Downstream Analysis Map
Photo Log of Downstream Assessment



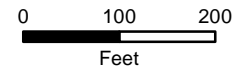
Legend

- Photo Location
- Downstream Gravity Main**
 - ▶ Open Channel
 - ▶ 12-Inch Concrete CP
 - ▶ 24-Inch Concrete CP
 - ▶ 30-Inch CMP
- ⋯ Non-Downstream Gravity Main
- 25-Foot Contour
- - - 5-Foot Contour
- 5236 W Mercer Way Parcel
- Parcel



Downstream Analysis Map

5236 W Mercer Way, Mercer Island, WA



Note: These layers represent themes requiring further planning and design. They are conceptual and under no circumstances should be construed as final plans for specific sites or areas.



Image 1: Onsite runoff enters W Mercer Way roadside ditch



Image 2: Downstream flows are conveyed northwesterly, crossing W Mercer Way via 12" concrete culvert



Image 3: Flows enter this CB located just northwest of W Mercer Way



Image 4: Downstream flows are conveyed to this CB via a 12" concrete pipe



Image 5: Concrete pipe conveys flows through this CB

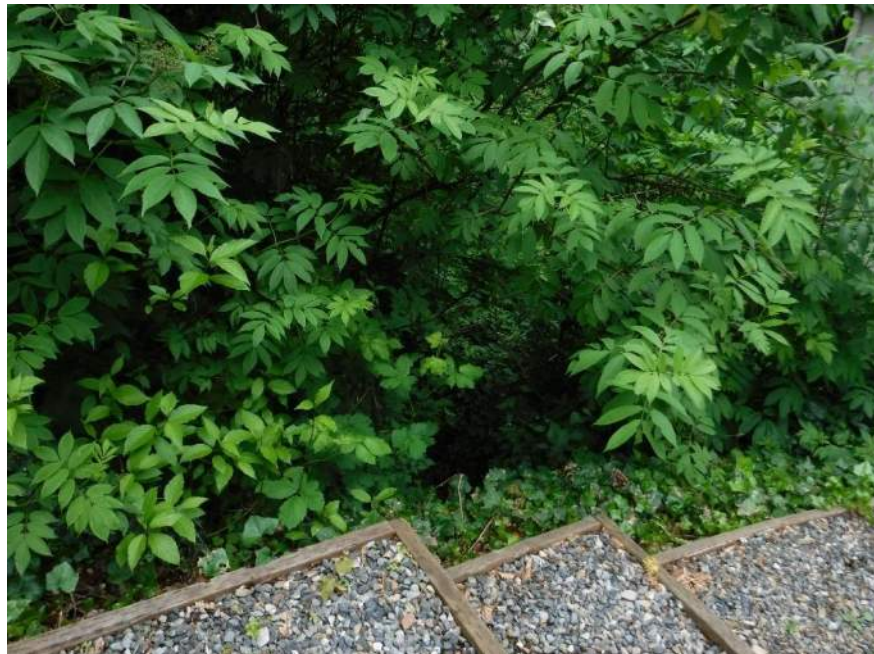


Image 6: Downstream flows outlet to this open channel private watercourse located at 5200 W Mercer Place



Image 7: Downstream flows are conveyed through this well-defined and protected open channel



Image 8: Open channel flows inlet this 24" concrete culvert



Image 9: 24" concrete culvert pipe enters this CB and flows continue in the westerly direction via 30" corrugated aluminum pipe through a private drainage easement located at 5067 SE 51st St



Image 10: flows outlet the CB via a 30" corrugated aluminum pipe



Image 11: Flows outlet the 30" corrugated aluminum pipe and enter Lake Washington



Image 12: Downstream flows outfall into Lake Washington at 5067 SE 51st St

N5 Architecture
Storm Drainage Report
5236 W. Mercer Way

Appendix C1:
Geotechnical Engineering Report
PanGEO, Inc., October 5, 2017

Appendix C2:
Mercer Island Low Impact Development Infiltration Feasibility

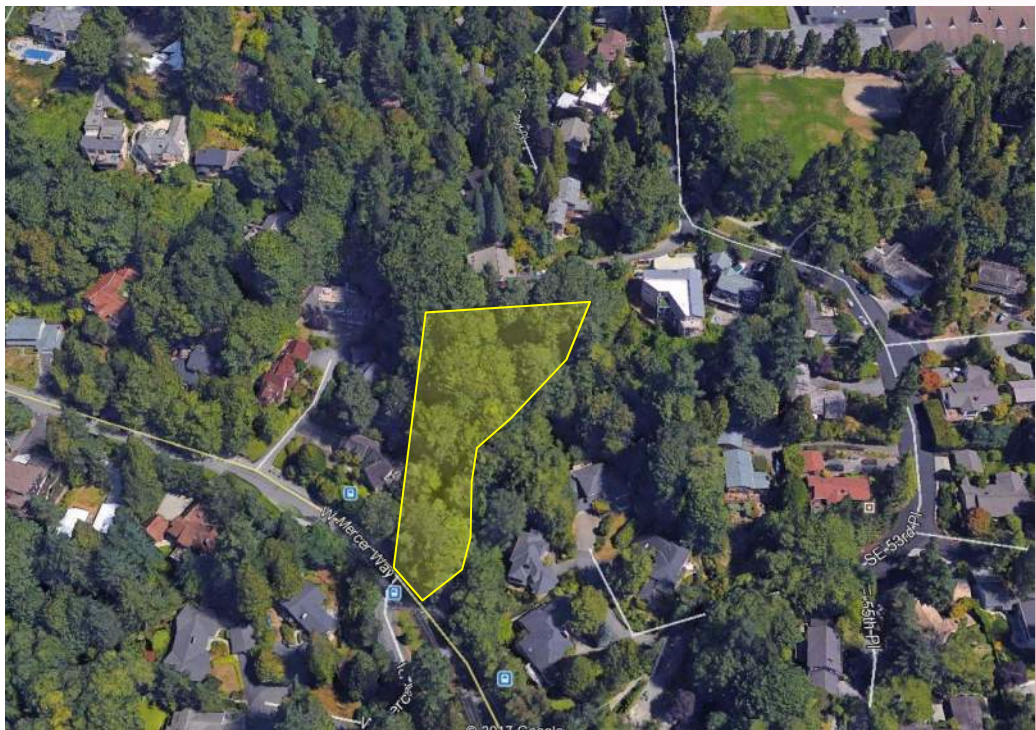
GEOTECHNICAL ENGINEERING REPORT

PROPOSED RESIDENCE

5236 WEST MERCER WAY

MERCER ISLAND, WASHINGTON

Project No. 17-143.200
October 5, 2017



Credit: Google Earth

Prepared for:
The Mills Family



3213 Eastlake Avenue East, Ste B
Seattle, Washington 98102-7127
Tel: 206.262.0370 Fax: 206.262.0374

*Geotechnical & Earthquake
Engineering Consultants*

October 5, 2017
PanGEO Project No. 17-143.200

The Mills Family

c/o Mr. Joseph Greif
Greif Architects / Living Architecture
921 NE Boat Street
Seattle, Washington 98105

**Subject: Geotechnical Engineering Report
Proposed Residence
5236 West Mercer Way
Mercer Island, Washington 98125**

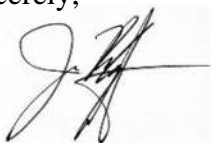
Dear Mr. Greif:

As requested, PanGEO has completed a geotechnical engineering study for the proposed single-family residence at the above address. In preparing this report, we performed a reconnaissance of the site, drilled six test borings at and adjacent to the site, and conducted engineering analyses. The results of our study and our design recommendations are presented in the attached report.

In summary, the proposed house footprint is underlain by medium dense to very dense silty sand at shallow depths. In our opinion, the new structure may be supported by a conventional shallow foundation system. A soldier pile wall represents a feasible excavation support system to allow for the construction of the proposed house basement while maintaining stability of the site.

We appreciate the opportunity to be of service. Should you have any questions, please do not hesitate to call.

Sincerely,



Jon C. Rehkopf, P.E.
Senior Project Geotechnical Engineer

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ATTACHMENTS:

- Figure 1 Vicinity Map
- Figure 2 Site and Exploration Plan
- Figure 3 Generalized Subsurface Profile Section A-A'
- Figure 4 Design Lateral Parameters – Cantilevered Soldier Pile Wall

APPENDIX A – TEST BORING LOGS

- Figure A-1 - Terms and Symbols for Boring and Test Pit Logs
- Figures A-2 through A-7 - Logs of Test Borings PG-1 through PG-6

GEOTECHNICAL ENGINEERING REPORT
PROPOSED RESIDENCE
5236 WEST MERCER WAY
MERCER ISLAND, WASHINGTON

1.0 GENERAL

PanGEO, Inc. is pleased to present the following geotechnical engineering report to assist the project team with the design and permitting of the proposed residence at 5236 West Mercer Way, in Mercer Island, Washington. This study was prepared in general accordance with our mutually agreed scope of services outlined in our proposal dated April 24, 2017, which was approved on May 1, 2017. Our scope of services included reviewing readily available geologic and geotechnical data, conducting a site reconnaissance, advancing test borings at the site, conducting engineering analyses, and preparing the following geotechnical report.

2.0 SITE AND PROJECT DESCRIPTION

The subject site is located at 5236 West Mercer Way, in Mercer Island, Washington, as shown on Figure 1, Vicinity Map. The site consists of an irregularly shaped parcel that measures a maximum of about 260 feet in the east-west direction, and up to about 195 feet in the north-south direction. The property includes about 55 feet of frontage along West Mercer Way. Single-family homes are located to the north and east of the property, and undeveloped land and two single-family residences are located to the south of the property.

The site is currently undeveloped, and cannot be accessed by vehicle at the present time due to a lack of driveway and the presence of a drainage ditch between the property and West Mercer Way. The majority of the site is forested with moderately mature to mature native evergreen and deciduous trees, and includes an understory of ferns, salal and other native plant species.

The topography of the site slopes down moderately to gently from the east to west, with the exception of eastern portions of the site that slope down at grades of 40% or slightly more. Based on our review of the topographic survey, prepared by PACE Engineering, site grades along the eastern property line range from about 240 to 250 feet (NAVD88) and site grades along the western property line are around 175 feet.

Plate 1 on the following page depicts current site conditions.



Plate 1. Looking northeast near the middle of the site at the general location of the proposed residence.

We understand that the proposed project includes the construction of a three-level single-family residence with a daylight basement in the northeastern portion of the subject property. Figure 2 depicts the approximate location of the proposed house in relation to the property boundaries and existing site features. The basement finished floor elevation will be around 207.5 feet, and the main floor will have a finished floor elevation of about 218 feet (NAVD88). Due to the sloping topography of the site, and the depressed basement floor elevation, which we understand was required to match the required driveway grade, the basement and first floor will be cut into the slope, and will daylight to the west. The excavation necessary to construct the basement will extend up to about 20 feet below existing grades. Based on our discussions with the project team, we understand that the basement excavation will be supported by a combination of open cut slopes and soldier pile walls.

3.0 SUBSURFACE EXPLORATIONS

A subsurface exploration program was completed on May 10 and 11, 2017. The subsurface exploration program included four test borings (PG-1 through PG-4) that were advanced on the subject site. In addition, two borings, PG-5 and PG-6, were advanced on the adjacent property to the east for a different geotechnical study, but were also utilized for this study to further understand subsurface conditions in the project area. The approximate test boring locations were measured from existing site features and are indicated on the attached Site and Exploration Plan (Figure 2). The borings were drilled to depths of about 9 to 17 feet below surface grades using a portable acker drill rig owned and operated by CN Drilling, of Seattle, Washington. The drill rig was equipped with a 4-inch outside diameter hollow stem auger, and soil samples were obtained from the borings at 2½ and 5-foot intervals in general accordance with Standard Penetration Test (SPT) sampling methods (ASTM test method D-1586) in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven into the soil a distance of 18 inches using a 140-pound weight falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

An engineer from PanGEO was present during the field explorations to observe the test borings, obtain representative samples, and to describe and document the soils encountered in the explorations. The completed borings were backfilled with bentonite chips.

The soil samples retrieved from the borings were described using the system outlined on Figure A-1 of Appendix A and the summary boring logs are included as Figures A-2 through A-7.

4.0 SUBSURFACE CONDITIONS

4.1 SITE GEOLOGY

The Geologic Map of Mercer Island (Troost and Wisher, 2006) mapped the surficial geologic units on the eastern portion of the subject site as Vashon advance outwash deposits (map unit Q_{va}) and Lawton Clay (map unit Q_{vic}) was mapped over the western portion of the site. Approximately one block east of the project site, the surficial geology is mapped as Vashon glacial till (map unit Q_{vt}).

Advance outwash deposits (Q_{va}) are described by Troost, et al. as dense to very dense, well sorted deposits of sand and gravel, with occasional silt lenses. Lawton clay (Q_{vlc}) typically consists of very stiff to hard laminated to massive silty clay and clayey silt. Vashon glacial till (Q_{vt}) consists of a very dense, heterogeneous mixture of sand, silt and gravel.

4.2 SOIL CONDITIONS

The subsurface explorations at the site generally encountered a sequence of forest duff over alluvium, glacial till and advance outwash deposits. The glacial till and advanced outwash deposits appeared to be consistent with the mapped geology described above.

The soils encountered at each of the subsurface exploration locations are described in the boring logs presented in Appendix A of this report. The attached Figure 3 presents a generalized subsurface profile across the site (Section A-A') based on our interpretation of the subsurface conditions encountered in the explorations.

A summary of the generalized soil units encountered in our test borings are presented below.

Forest Duff: A surficial layer of organic rich soil was encountered in all borings advanced at the site (PG-1 through PG-4). This layer was interpreted to be forest duff, and was found to be very loose, consist primarily of silty sand with prevalent organics, and varied in thickness from about 6 inches to 12 inches. One exception was at boring PG-1, where organic rich soil was encountered up to 3 feet below the ground surface.

Alluvium: Below the forest duff in all borings except PG-1, a soil unit consisting of soft to stiff sandy silt with some gravel, and loose sand with gravel, was encountered to depths ranging from 2 to 6 feet below the existing ground surface. We interpreted this soil unit to be alluvium, likely associated with the seasonal stream south of the property.

Glacial Till: Underlying the forest duff and alluvium, the test borings advanced within the upper, eastern portion of the site (PG-1 and PG-2), encountered very dense silty sand with some gravel, that we interpreted to be glacial till. The glacial till was encountered to the termination depth of the explorations.

Advance Outwash: Underlying the forest duff and alluvium within the western portion of the site, test borings PG-3 and PG-4 encountered generally medium

dense to dense, fine to medium sand with trace to some gravel and silt. We interpreted this dense sand unit to be the mapped advance outwash deposit. We anticipate that the dense advance outwash deposit underlies the glacial till encountered within the eastern portion of the site as well, and was encountered in test boring PG-6, advanced east of the subject site.

4.3 GROUNDWATER CONDITIONS

At the time of our subsurface investigations (May, 2017), groundwater was not encountered in test borings PG-1 through PG-3. In test boring PG-4, however, which was located within the western, lower portion of the site near West Mercer Way, we observed water at an elevation of approximately 171 feet (NAVD88). Based on the observed soil conditions in all explorations, we anticipate that groundwater becomes perched on the underlying till layer during certain times of the year. Additionally, sporadic zones of perched water are likely to occur within sandy and gravelly layers of the native till deposit. As such, some groundwater seepage due to perched water may occur within the depth of the proposed excavation. Groundwater levels will fluctuate depending on the season and precipitation. In general, groundwater levels are higher during late winter and spring.

5.0 GEOLOGIC HAZARDS ASSESSMENT

5.1 POTENTIAL LANDSLIDE HAZARDS

The subject site is mapped within a potential landslide hazard area according to the City of Mercer Island's Geologic Hazards Map. The map indicates that slopes of 15% or more and slopes between 40-79% are present at the site. The map does not indicate that landslide or mass wasting deposits exist at the site, nor does the map indicate the presence of a landslide scarp. According to the map, the site does not contain a previously documented landslide location.

A site reconnaissance of the subject property was conducted on May 10, 2017. During our site reconnaissance, we did not observe any apparent evidence of slope instability or ground movement at the site. Based on our field observations, the general topography of the site and vicinity, and the results of our subsurface explorations, in our opinion the subject site is globally stable in its current configuration. Furthermore, it is our opinion that the proposed development as currently planned is feasible from a geotechnical engineering standpoint, and in our opinion will not adversely affect the overall stability of

the site or adjacent properties, provided the recommendations outlined herein are followed and the proposed development is properly design and constructed. Our recommendations include the use of a soldier pile wall to provide temporary support for the proposed basement excavation.

5.2 SEISMIC HAZARDS

Based on our review of the City of Mercer Island's Geologic Hazards Maps, the project site is not mapped as a seismic hazard area. The City of Mercer Island Code defines seismic hazard areas as those areas subject to risk of damage as a result of earthquake-induced ground shaking, slope failure, soil liquefaction or surface faulting. Based on the dense to very dense glacial soils underlying the proposed building site, in our opinion, the potential for soil liquefaction during an IBC-code level earthquake is considered very low. It is also our opinion that the potential for seismic-induced landsliding is low at the site due to the dense to very dense underlying soils and lack of steep slopes greater than 80%. Therefore, we concur with the Geologic Hazard Map, and in our opinion special design considerations associated with soil liquefaction and seismic-induced landsliding are not necessary for this project.

5.3 EROSION HAZARDS

The subject site is mapped within a potential erosion hazard area according to the City of Mercer Island's Geologic Hazards Map. Based on soil conditions encountered in the borings, the near-surface site soils are likely to exhibit moderate erosion potential. In our opinion, the erosion hazards at the site can be effectively mitigated with the best management practice during construction and with properly designed and implemented landscaping for permanent erosion control. During construction, the temporary erosion hazard can be effectively managed with an appropriate erosion and sediment control plan, including but not limited to installing silt fence at the construction perimeter, limiting removal of vegetation to the construction area, placing gravel or hay bales at the disturbed/traffic areas, covering stockpile soil or cut slopes with plastic sheets, constructing a temporary drainage pond to control surface runoff and sediment trap, placing quarry spalls at the construction entrance, etc. Permanent erosion control measures should include establishing vegetation, landscape plants, and hardscape established at the end of project, and reducing surface runoff to the minimum extent possible.

6.0 GEOTECHNICAL RECOMMENDATIONS

6.1 SEISMIC DESIGN PARAMETERS

The 2015 International Building Code (IBC) seismic design section provides a basis for seismic design of structures. Table 1 below provides seismic design parameters for the site that are in conformance with the 2015 IBC, which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps.

Table 1 – Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. [g]	Spectral Acceleration at 1.0 sec. [g]	Site Coefficients		Design Spectral Response Parameters	
	S_s	S_1	F_a	F_v	S_{DS}	S_{D1}
D	1.44	0.55	1.0	1.5	0.96	0.55

The spectral response accelerations were obtained from the USGS Earthquake Hazards Program website (2008 data) for the project latitude and longitude.

Liquefaction Potential: Liquefaction is a process that can occur when soils lose shear strength for short periods of time during a seismic event. Ground shaking of sufficient strength and duration results in the loss of grain-to-grain contact and an increase in pore water pressure, causing the soil to behave as a fluid. Soils with a potential for liquefaction are typically cohesionless, predominately silt and sand sized, loose to medium dense, and must be saturated. Because the proposed building site is not underlain by saturated silt or loose to medium dense sand, in our opinion the liquefaction potential below the proposed structure is low, and design considerations related to soil liquefaction are not necessary for this project.

6.2 SPREAD FOOTINGS

Based on our understanding of the subsurface conditions at the site, in our opinion the proposed residence may be supported by conventional spread and strip footings. Footings should be founded on the medium dense to dense sandy soils anticipated to be present at the proposed foundation elevation.

6.2.1 Allowable Bearing Pressure

We recommend a maximum allowable soil bearing pressure of 3,000 pounds per square foot (psf) be used to size the footings. The recommended allowable bearing pressure is for dead plus live loads. For allowable stress design, the recommended bearing pressure may be increased by one-third for transient loading, such as wind or seismic forces. Continuous and individual spread footings should have minimum widths of 18 and 24 inches, respectively.

Total and differential settlements are anticipated to be within tolerable limits for footings designed and constructed as discussed above. Footing settlement under static loading conditions is estimated to be less than about ¾-inch. We anticipate differential settlement across the footprint of the house should be less than about ½-inch. Most settlement will occur during construction as loads are applied.

6.2.2 Lateral Resistance

Lateral loads on the structure may be resisted by passive earth pressure developed against the embedded portion of the foundation system and by frictional resistance between the bottom of the foundation and the supporting subgrade soils. Footings bearing on the medium dense to very dense native soils, may be designed using a frictional coefficient of 0.35 to evaluate sliding resistance developed between the concrete and the subgrade soil. Passive soil resistance may be calculated using an equivalent fluid weight of 300 pcf, assuming foundations are backfilled with structural fill. The above values include a factor of safety of 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

6.2.3 Perimeter Footing Drains

Footing drains should be installed around the perimeter of the residence, at or just below the invert of the footings. Under no circumstances should roof downspout drain lines be connected to the footing drain systems. Roof downspouts must be separately tightlined to appropriate discharge locations. Cleanouts should be installed at strategic locations to allow for periodic maintenance of the footing drain and downspout tightline systems.

6.2.4 Footing Subgrade Preparation

Footing subgrades should be in a dense and stable condition prior to setting forms and placing reinforcing steel. Any loose or softened soil should be removed from the footing excavations. The adequacy of the footing subgrade soils should be verified by a representative of PanGEO, prior to placing forms or rebar.

If loose or disturbed soil is encountered at the footing elevation, the footing may be lowered to bear on the undisturbed soils, or the unsuitable soils should be removed and replaced with properly compacted structural fill, or lean-mix concrete.

6.3 FLOORS SLABS

We anticipate that competent, native soil will be encountered at the slab level. Structural fill placed below the slab should be properly compacted in accordance with the structural fill recommendations presented in this report. The exposed subgrade should be compacted to a firm condition prior to placing the backfill or capillary break layer.

Interior concrete slab-on-grade floors should be underlain by a capillary break consisting of at least of 4 inches of pea gravel or compacted 5/8-inch, clean crushed rock (less than 3 percent fines). The capillary break material should meet the gradational requirements provided in Table 2, below.

Table 2 – Capillary Break Gradation

Sieve Size	Percent Passing
¾-inch	100
No. 4	0 – 10
No. 100	0 – 5
No. 200	0 – 3

The capillary break should be placed on the subgrade that has been compacted to a dense and unyielding condition.

We recommend that a 10-mil polyethylene vapor barrier should also be placed directly below the slab. Construction joints should be incorporated into the floor slab to control cracking.

6.4 BASEMENT WALL DESIGN PARAMETERS

Below-grade walls should be properly designed to resist the lateral earth pressures exerted by the soils behind the wall. Proper drainage provisions should also be provided behind the walls to intercept and remove groundwater from behind the wall. Our geotechnical recommendations for the design and construction of the below-grade walls are presented below.

6.4.1 Lateral Earth Pressures

A temporary soldier pile wall will be used for shoring around the majority of the basement perimeter. The below grade portions of basement walls cast against the shoring walls may be designed for an earth pressure based upon an equivalent fluid weight of 40 pcf, assuming a maximum backslope of 2H:1V. For a basement wall that is constructed in an open cut and then backfilled, which might be used along the western portion of the south wall, the wall may be designed for an earth pressure based upon an equivalent fluid weight of 35pcf for a wall that is allowed to yield, and 50 pcf for a wall that is restrained (assuming level backslope). The recommended lateral pressures assume that the backfill behind the wall consists of a free draining and properly compacted fill with adequate drainage provisions.

A uniform pressure of 7H psf should be added to all basement walls to reflect the increase loading for seismic conditions, where H corresponds to the buried depth of the wall.

If surcharge loads or building foundations will be located within a horizontal distance equal to the height of the backfilled wall, lateral earth pressures will need to be increased based upon the type and magnitude of surcharge.

6.4.2 Lateral Resistance

Lateral forces from wind or seismic loading may be resisted by the combination of passive earth pressures acting against the embedded portions of the foundations and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 300 pounds per cubic foot (pcf). This value includes a factor of safety of at least 1.5 assuming that a properly compacted structural fill will be placed adjacent to the sides of the footings. A coefficient friction of 0.35 may be used to determine the frictional resistance at the base of the footings. This coefficient includes a factor of safety of approximate 1.5.

6.4.3 Wall Backfill

Based on the results of our test borings, the on-site soils consist of sandy silt, silty sand, and sand. The silty soils would not be suitable to be re-used as wall backfill, but the clean sand (native advance outwash) may be suitable for re-use, if the silt content is low, and the soil can be adequately compacted. For budgeting purpose, we recommend that wall backfill consist of imported free draining granular soils such as Seattle Mineral Aggregate Type 17 or Gravel Borrow as defined in Section 9-03.14(1) of the WSDOT *Standard Specifications for Road, Bridge, and Municipal Construction* (WSDOT, 2016) In areas where the space is limited between the wall and the face of excavation, clean crushed 5/8-inch rock may be used as backfill without compaction.

Wall backfill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. Within 5 feet of the wall, the backfill should be compacted to 90 percent of the maximum dry density.

6.4.4 Wall Drainage & Damp Proofing

Provisions for permanent control of subsurface water should be incorporated into the design and construction of the below-grade walls. As a minimum, 4-inch diameter perforated drainpipes should be installed behind and at the base of the wall footings, embedded in 12 to 18 inches of pea or washed gravel. The gravel should be wrapped in a geotextile filter fabric to prevent the migration of fines into the drain system. The drainpipe should be graded to direct water to a suitable outlet.

Where the below-grade wall will be constructed against a soldier pile wall, we recommend that prefabricated drainage mats, such as Mirafi 6000 or equivalent, be installed behind the walls (full face coverage) and the collected water should be directed through weep holes inside the building beneath the floor slab and tight-lined to an appropriate outlet.

Please note that waterproofing considerations are beyond our scope of work. We recommend that a building envelope specialist be consulted to determine appropriate damp-proofing or water-proofing measures.

6.5 DRIVEWAY PAVEMENT

Based on our review of the preliminary grading plans, a driveway will be constructed from West Mercer Way to the proposed residence. We understand that the driveway grade will generally be several feet below the existing ground surface. Areas to receive fill or pavement should be stripped and cleared of vegetation, organic matter, and other deleterious material, if not removed during grading. Based on our test borings in the area, we anticipate that loose to medium dense soils may be encountered below the driveway alignment. Following the stripping operation and excavations necessary to achieve construction subgrade elevations, the ground surface where structural fill or pavements are to be placed should be compacted to a dense condition with a large roller. Any loose or soft areas that cannot be adequately compacted should be over-excavated to a maximum of 2 feet and replaced with properly compacted granular structural fill. A geotextile fabric may need to be placed below the structural fill if soft or wet subgrade conditions are present.

If concrete pavement is used, which would likely be more durable considering the steep driveway grade, we recommend a minimum 4-inch thick concrete slab over overlying a 6-inch thick layer of 1¼-inch crushed surfacing base course (CSBC). Both the subgrade/structural fill and crushed rock base should be compacted to a minimum of 95% of the materials maximum dry density (Modified Proctor ASTM D-1557).

To increase the performance of the driveway, the slab could be thickened, and/or the crushed rock layer increased. The pavement may also be constructed with increased steel reinforcing, to resist cracking, and control joints should be incorporated to control potential cracking.

6.6 DRIVEWAY RETAINING WALLS

We understand that low retaining walls may be needed along the proposed driveway alignment to retain cuts or fills. Based on our review of the preliminary driveway alignment, we estimate that retaining walls will be less than about 4 feet tall. Although a number of wall types are considered technically feasible for this project, based on our experience, it is our opinion that the most cost-effective wall type will be a gravity wall.

6.6.1 Gravity Wall

The principal advantage of a gravity wall is the ease and speed of construction, and the low construction cost. If a gravity wall will be used for this project, we recommend that either a concrete block wall or a rock-filled gabion wall be used.

Precast concrete blocks of various sizes may be used for this project. One commonly used product is Ultra Block (www.ultrablock.com), which has a typical dimension of 2½ feet by 2½ feet by 5 feet. Blocks made of returned concrete, and have dimensions of 2 feet by 2 feet by 6 feet (i.e. ecology blocks) should not be used. Concrete blocks can be made with various finishes or texture to provide the desired aesthetics. All concrete block walls should be battered no steeper than 6V:1H.

Alternatively, small concrete blocks such as those manufactured by Keystone (www.keystonewalls.com) or other suppliers may also be used provided that there is no traffic surcharge near the top of the wall (i.e. edge pavement should be located at least 4 feet from the wall face). Alternatively, if the wall backfill is reinforced with geogrid, the wall could be specifically designed to resist the surcharge load. Although we don't expect wall heights to be greater than about 4 feet, because these blocks are typically quite narrow, it may be necessary to double up the blocks if the wall exceeds about 4 feet of exposed height, depending on the individual block size. We recommend that, if small blocks will be used, the walls be designed by the supplier using the geotechnical design parameters outlined below.

Gabion walls should be constructed in general accordance with WSDOT Standard Plan Sheet D-6, and Section 8-24.3(3) Gabion Cribbing of the 2016 *WSDOT Standard Specifications*. Each gabion basket should be placed horizontally and with a minimum of 6 inches of setback from the basket below, hence creating an average wall face inclination of no steeper than 6V:1H. Dimensions of gabion baskets may vary depending on the suppliers.

Minimum Width – In general, as a minimum, all gabion baskets and concrete blocks should have a minimum width equal to the greater of 2 feet or one-third the wall height.

Minimum Embedment & Subgrade Improvement - Gravity walls should have a minimum of one foot of embedment. All walls should be founded on competent native soils or properly compacted fill. We anticipate that loose soils may be present along the driveway alignment within 5 feet of surface grades. To provide a firm base for the retaining walls, we recommend a 12-inch thick layer of 2- to 4-inch quarry spalls be placed below the wall

alignment. A geotextile fabric should be placed over the subgrade prior to rock placement. If needed, a 6-inch layer of granular structural fill such as crushed rock may be placed as a leveling course before placing the base course of blocks.

Geotechnical Design Parameters – We recommend that the following geotechnical parameters be used for design of gravity walls:

Active earth pressure:	35 pcf
Allowable Passive Pressure:	300 pcf
Allowable Friction Coefficient:	0.40
Allowable Bearing Capacity:	2500 psf

6.6.2 Wall Backfill and Drainage Considerations

Where backfill is needed behind gravity walls, free draining granular material is recommended. A drainage system should be provided behind the base of all walls greater than 2 feet in height to prevent buildup of hydrostatic pressures. As a minimum, the drain should consist of 4-inch diameter perforated PVC pipe, encased in washed drain rock wrapped in filter fabric. The footing drain should discharge to a storm drain or appropriate outlet.

6.7 ON-SITE INFILTRATION CONSIDERATIONS

Based on our review of the City of Mercer Island Low Impact Development (LID) infiltration feasibility map, the project site is located in an area where infiltrating LID is not permitted.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 TEMPORARY UNSUPPORTED EXCAVATIONS

Temporary excavations should be constructed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring. It is our opinion temporary excavations at the site parallel to the overall slope angle may be cut at a maximum 2H:1V inclination, to remain stable, and reduce the potential of destabilizing the site. Temporary excavations perpendicular to the overall slope angle (i.e. excavations that will not be surcharged by a backslope), may be cut at a maximum of 1H:1V.

Temporary excavations should be evaluated in the field during construction based on actual observed soil conditions. If seepage is encountered, excavation slope inclinations may need to be reduced. During wet weather, the cut slopes may need to be flattened to reduce potential erosion and should be covered with plastic sheeting.

7.2 TEMPORARY EXCAVATION SHORING

We understand that 2H:1V slopes will be cut adjacent to the proposed house footprint to reduce the height of the basement walls. As such, excavations ranging up to about 10 feet deep may be needed to construct the house foundation and basement walls, which we recommend be supported by a cantilevered soldier pile wall. We believe that a soldier pile wall with timber lagging represents the most appropriate method to support the excavation and maintain stability of the slope.

7.2.1 Soldier Pile Wall

A soldier pile wall consists of vertical steel beams, typically spaced from 6 to 8 feet apart along the proposed excavation wall, spanned by timber lagging. Prior to the start of excavation, the steel beams are installed into holes drilled to a design depth and then backfilled with lean mix or structural concrete. As the excavation proceeds downward and the steel piles are subsequently exposed, timber lagging is installed between the piles to support the soils between piles.

7.2.2 Design Lateral Pressures

The attached Figure 4 should be used to design a cantilevered temporary shoring walls at the site, or a wall with a single level of tiebacks. The design lateral earth pressure considers the back slope surcharge pressure from the existing slope. If tiebacks will be needed for wall stability, or to create a more cost-effective wall design, PanGEO will provide additional recommendations for tieback design upon request.

Above the bottom of excavation, the recommended active earth and surcharge pressures should be applied over the full width of pile spacing. Below the bottom of excavation, the active pressures should be applied over one pile spacing, and the passive resistance should be applied over two times the pile diameter.

For the soldier pile wall along the eastern building line (Gridline E), we recommend the top 5 feet of passive resistance be ignored to account for the adjacent wall along building line "D".

We also recommend that the lagging be sized using the recommendations depicted on Figure 4.

7.2.3 Permanent Wall Considerations

We understand that a permanent soldier pile wall will be constructed to the south of the new house to retain soils adjacent to the proposed patio area. The same recommendations apply to permanent walls as temporary walls, except that an additional surcharge pressure due to seismic loading must be included in design, as indicated on Figure 4. In addition, the piles should include corrosion protection, or be over-sized to account for long-term corrosion. Lagging for permanent walls may consist of pressure-treated timber, cast-in-place or pre-cast concrete beams, or steel sheets.

7.2.4 Soldier Pile Installation Considerations

The drilling of soldier piles is anticipated to encounter several feet of loose silty sand over medium dense to very dense silty sand with gravel (glacial till) underlain by dense sand (advance outwash). Boulders and cobbles are often present in glacial till deposits, and may be encountered during drilling. Caving in the upper loose soils, as well as within wet sandy or gravel layers in the till or outwash may occur during drilling. As a result, the drilling contractor should be prepared to use temporary casings to stabilize the holes.

Groundwater may accumulate at the bottom of drill holes depending on the time of construction. We recommend that the lean concrete or structural concrete backfill be placed with tremie pipes if more than one foot of water is present at the bottom of the holes.

When placing timber lagging, the height of each lift may need to be limited when the wet soils are encountered. The actual allowable vertical cut for timber lagging placement should be determined in the field, based on the actual conditions observed.

7.3 GROUNDWATER CONTROL

Perched groundwater seepage may be encountered within the foundation excavations, and should be anticipated. Groundwater seepage, although expected to be relatively minor, may be controlled by sloping the base of the excavation to a low point and removing the water using a sump and pump.

7.4 MATERIAL REUSE

The native soils underlying the site are moisture sensitive, particularly the alluvium and glacial till, and will become disturbed and soft when exposed to inclement weather conditions. For planning purposes, we do not recommend reusing the native soils as structural fill. If it is planned to use the native soil in non-structural areas, the excavated soil should be stockpiled and protected with plastic sheeting to prevent it from becoming saturated by precipitation or runoff.

7.5 STRUCTURAL FILL AND COMPACTION

During dry weather, some native soils that are compactable and non-organic may be suitable as structural fill, except for locations under footings. Some of the native soils contain a high percentage of fines and will degrade if exposed to excessive moisture, and compaction and grading will be difficult or impossible if the moisture content increases above the optimum condition. The native soils may potentially be used as backfill provided grading operations are conducted during dry weather and the contractor can control the moisture content of the soils to near the optimum moisture level for compaction.

If the site soils are exposed to moisture (groundwater, precipitation or surface runoff) and cannot be adequately compacted for use as structural fill, then it may be necessary to import a soil that can be compacted. Fill for use during wet weather should consist of a fairly well graded granular material having a maximum grain size of three inches and no more than 5 percent fines passing the US No. 200 sieve based on the minus 3/4-inch fraction. A contingency in the earthwork budget should be included for this possibility.

Structural fill should be placed in 8- to 12-inch thick loose lifts and compacted to at least 95 percent maximum dry density, per ASTM D-1557 (Modified Proctor). In non-structural areas, the recommended compaction level may be reduced to 90 percent. Heavy compaction equipment should operate directly over utilities until a minimum of 2 feet of backfill has been placed.

The procedure to achieve proper density of a compacted fill depends on the size and type of compaction equipment, the number of passes, thickness of the lifts being compacted, and certain soil properties. If the excavation to be backfilled is constricted and limits the use of heavy equipment, smaller equipment can be used, but the lift thickness will need to be reduced to achieve the required relative compaction.

Generally, loosely compacted soils are a result of poor construction technique or improper moisture content. Soils with high fines contents are particularly susceptible to becoming too wet and coarse-grained materials easily become too dry, for proper compaction. Silty or clayey soils with a moisture content too high for adequate compaction should be dried as necessary, or moisture conditioned by mixing with drier materials, or other methods.

The surficial duff layer is not suitable for use as structural fill, nor should it be mixed with materials to be used as structural fill.

7.6 WET WEATHER CONSTRUCTION

General recommendations relative to earthwork performed in wet weather or in wet conditions are presented below. The following procedures are best management practices recommended for use in wet weather construction:

- Earthwork should be performed in small areas to minimize subgrade exposure to wet weather. Excavation or the removal of unsuitable soil should be followed promptly by the placement and compaction of clean structural fill. The size and type of construction equipment used may have to be limited to prevent soil disturbance.
- During wet weather, the allowable fines content of the structural fill should be reduced to no more than 5 percent by weight based on the portion passing the 0.75-inch sieve. The fines should be non-plastic.
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water.
- Geotextile silt fences should be installed at strategic locations around the site to control erosion and the movement of soil.
- Excavation slopes and soils stockpiled on site should be covered with plastic sheeting.

7.7 EROSION CONSIDERATIONS

Surface runoff can be controlled during construction by careful grading practices. Typically, this includes the construction of shallow, upgrade perimeter ditches or low earthen berms in conjunction with silt fences to collect runoff and prevent water from entering excavations or to prevent runoff from the construction area leaving the immediate

work site. Temporary erosion control may require the use of hay bales on the downhill side of the project to prevent water from leaving the site and potential storm water detention to trap sand and silt before the water is discharged to a suitable outlet. All collected water should be directed under control to a positive and permanent discharge system.

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is collected and directed away from the structure to a suitable outlet. Potential issues associated with erosion may also be reduced by establishing vegetation within disturbed areas immediately following grading operations.

8.0 ADDITIONAL SERVICES

To confirm that our recommendations are properly incorporated into the design and construction of the proposed structure, PanGEO should be retained to conduct a review of the final project plans and specifications, and to monitor the construction of geotechnical elements. The City of Mercer Island, as part of the permitting process, may also require geotechnical construction inspection services. PanGEO can provide you a cost estimate for construction monitoring services at a later date.

9.0 CLOSURE

We have prepared this report for the Mills Family and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of services.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques,

sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our services specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances. We are not mold consultants nor are our recommendations to be interpreted as being preventative of mold development. A mold specialist should be consulted for all mold-related issues.

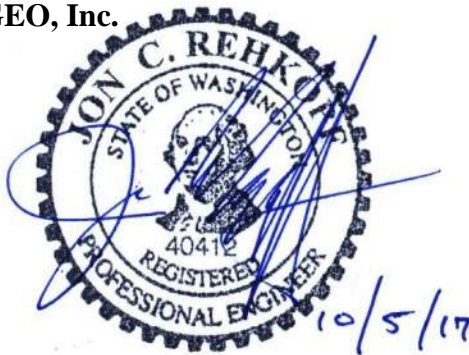
This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use this report.

Sincerely,

PanGEO, Inc.



Jon C. Rehkopf, P.E.
Senior Project Geotechnical Engineer

A handwritten signature in black ink, appearing to read "Siew L Tan", written over a horizontal line.

Siew L Tan, P.E.
Principal Geotechnical Engineer

10.0 REFERENCES

International Code Council, 2015, *International Building Code (IBC)*, 2015.

Troost, K.G., and Wisner, A. P, 2006. *Geologic Map of Mercer Island, Washington, scale 1:24,000*.

United States Geological Survey, *Earthquake Hazards Program, 2008 Data*, accessed via:
<http://earthquake.usgs.gov/designmaps/us/application.php>

WSDOT, 2016, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10*.



Google Terrain Map



Not to Scale




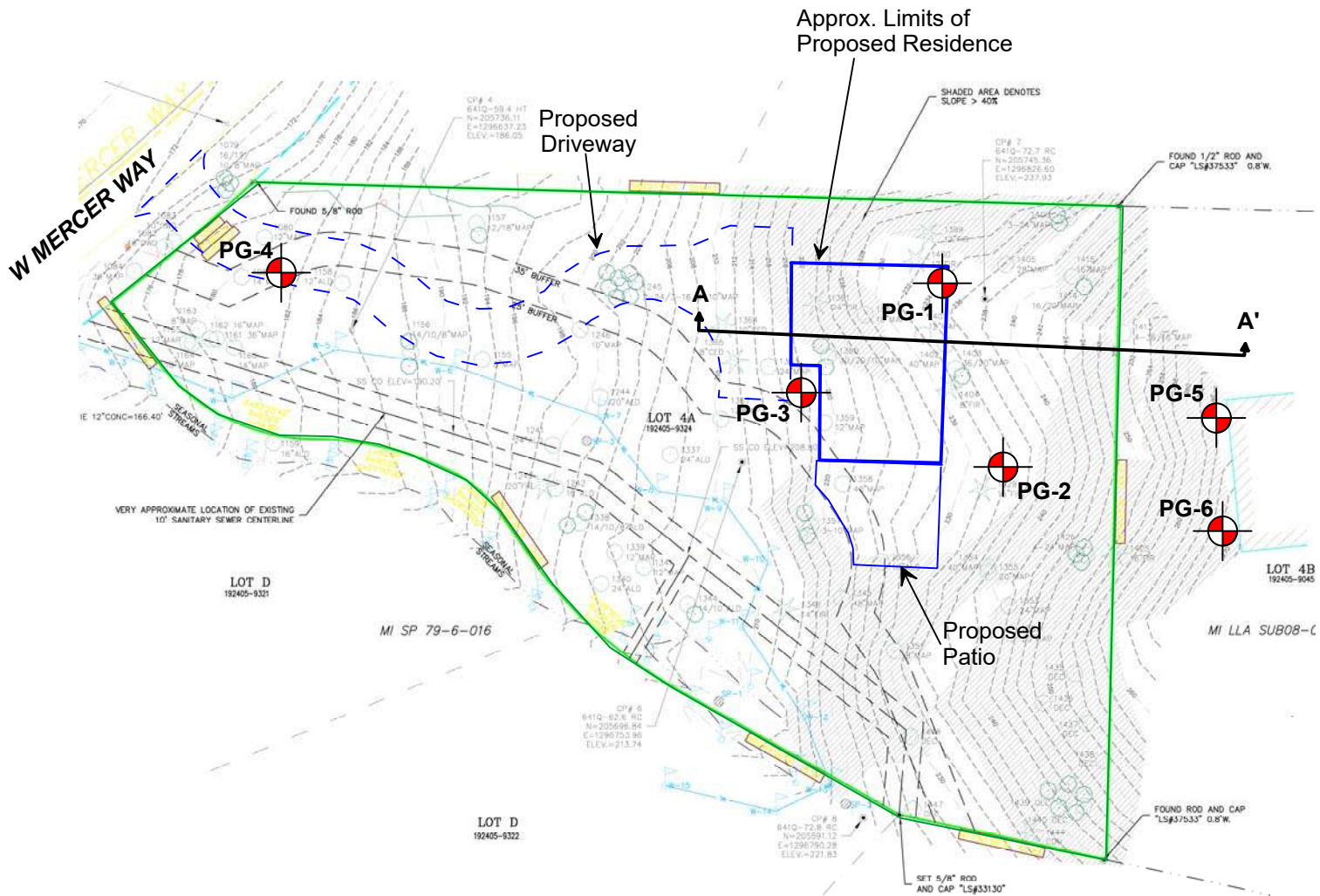
Proposed Residence
5236 West Mercer Way
Mercer Island, WA

VICINITY MAP

17-143.200

1


 Approx. Scale
 1" = 50'



Note: Site survey prepared by PACE (2017).

Legend:



Approx. Boring Locations
(PanGEO Inc., 2017)

Subsurface Profile (see Figure 3)

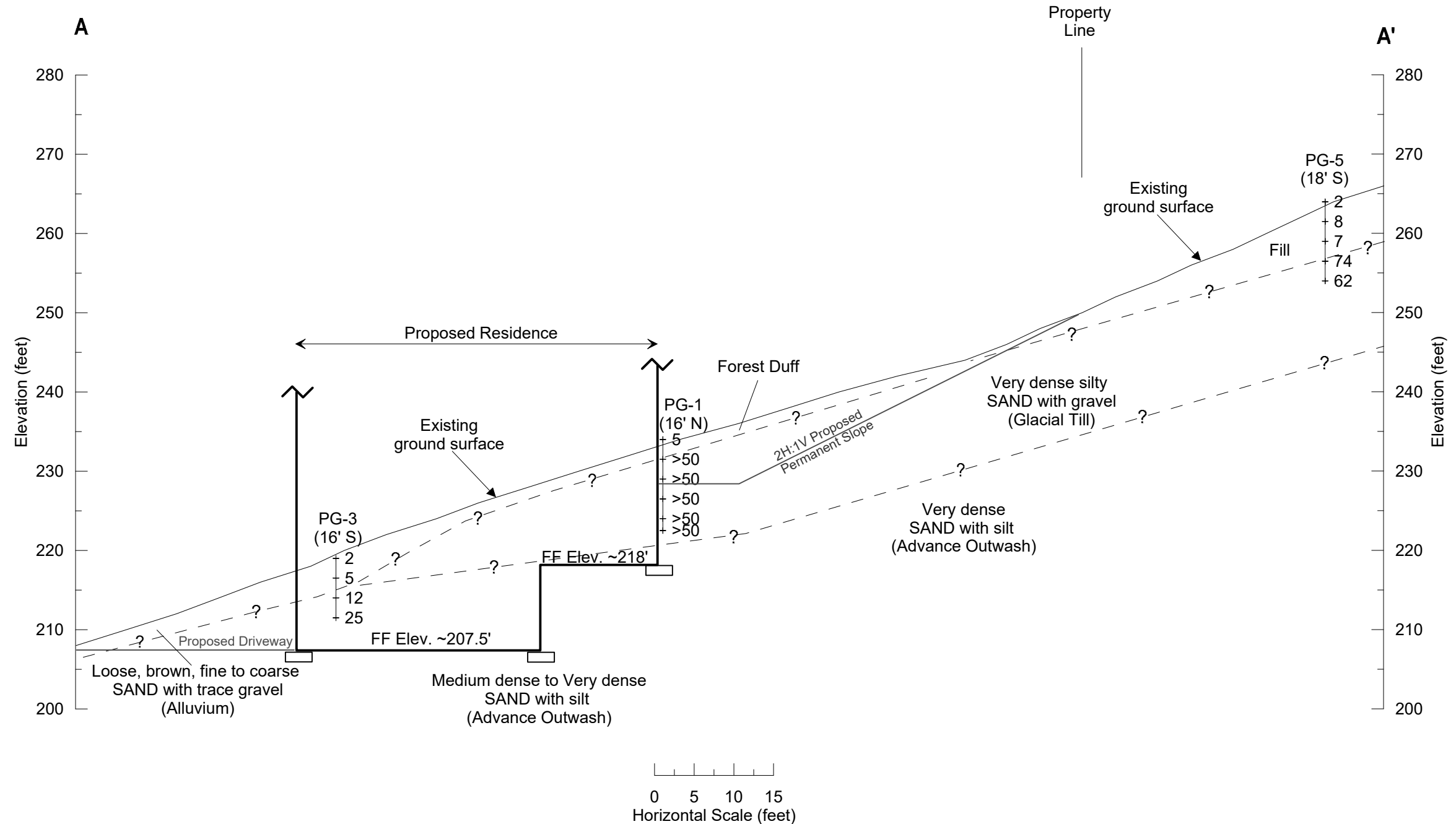


Proposed Residence
5236 West Mercer Way
Mercer Island, WA

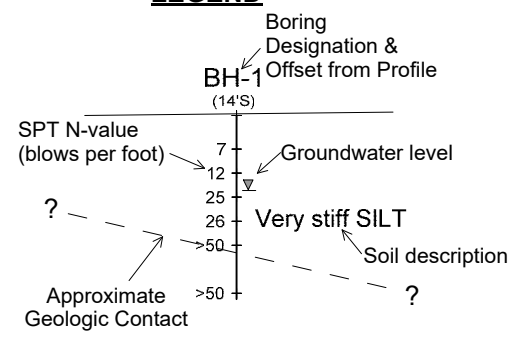
SITE AND EXPLORATION PLAN

Project No. **17-143.200**

Figure No. **2**

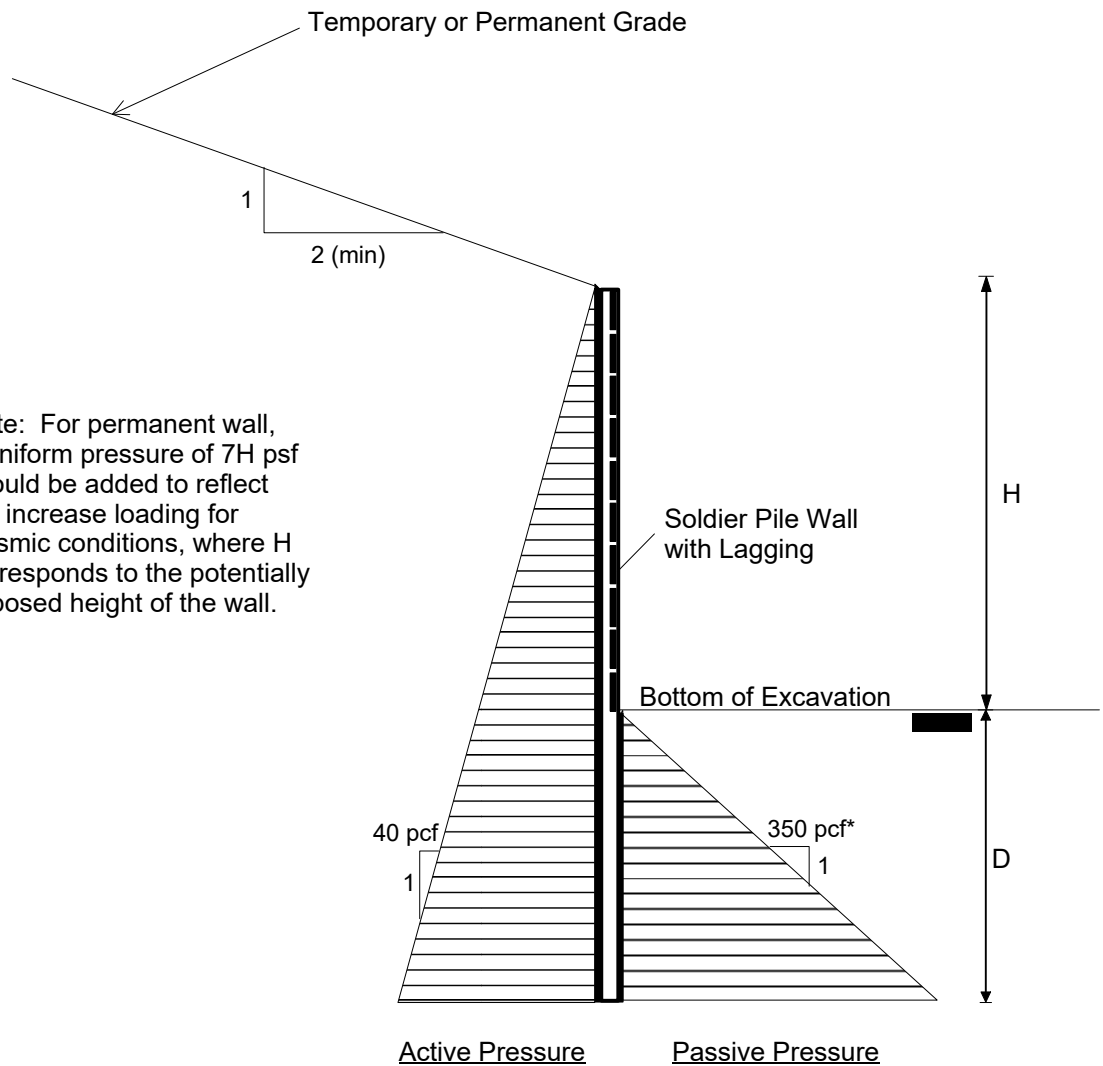


LEGEND



- Notes:
- Existing ground profile based on the topographic survey of 5236 West Mercer Way prepared by PACE Engineers, Inc. (2017).
 - See Figure 2 for location of Section A - A'.
 - See report text for a detailed explanation of the subsurface profile across the site.
 - The generalized soil profile is based on widely-spaced borings. Soil conditions may vary over a small distance, and the actual subsurface conditions may be different from the generalized soil profile depicted in this figure.

	Proposed Residence 5236 West Mercer Way Mercer Island, WA	GENERALIZED SUBSURFACE PROFILE SECTION A - A'	
		Project No. 17-143	Figure No. 3



Note: For permanent wall, a uniform pressure of $7H$ psf should be added to reflect the increase loading for seismic conditions, where H corresponds to the potentially exposed height of the wall.

* For wall along building line "E", ignore top 5 feet of embedment due to wall along building line "D".

Notes:

1. Embedment (D) should be determined by summation of moments at the bottom of the soldier piles. Minimum embedment should be at least 10 feet.
2. A factor of safety of 1.5 has been applied to the recommended passive earth pressure value. No factor of safety has been applied to the recommended active earth pressure values.
3. Active and surcharge pressures should be applied over the full width of the pile spacing above the bottom of excavation, and over one pile diameter below potential slide plane.
4. Passive pressure should be applied to two times the diameter of the soldier piles.
5. Use 50% of the lateral earth pressure for lagging design with soldier piles spaced at 8 feet or less.
6. Refer to report text for additional discussions.

Fig_4_EP_diagram.grf 10/3/17 (14:10) JCR



**Proposed Residence
5236 West Mercer Way
Mercer Island, Washington**

**DESIGN LATERAL PRESSURES
CANTILEVERED SOLDIER PILE WALL**

Project No. **17-143.200**

Figure No. **4**

APPENDIX A

TEST BORING LOGS

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS	
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	GW: Well-graded GRAVEL	GP: Poorly-graded GRAVEL
	GRAVEL (>12% fines)	GM: Silty GRAVEL	GC: Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	SW: Well-graded SAND	SP: Poorly-graded SAND
	SAND (>12% fines)	SM: Silty SAND	SC: Clayey SAND
		Liquid Limit < 50	ML: SILT
Silt and Clay 50% or more passing #200 sieve	Liquid Limit > 50	OL: Organic SILT or CLAY	MH: Elastic SILT
		CH: Fat CLAY	OH: Organic SILT or CLAY
	Highly Organic Soils	PT: PEAT	

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

- ATT Atterberg Limit Test
- Comp Compaction Tests
- Con Consolidation
- DD Dry Density
- DS Direct Shear
- %F Fines Content
- GS Grain Size
- Perm Permeability
- PP Pocket Penetrometer
- R R-value
- SG Specific Gravity
- TV Torvane
- TXC Triaxial Compression
- UCC Unconfined Compression

SYMBOLS

Sample/In Situ test types and intervals

- 2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
- 3.25-inch OD Split Spoon (300-lb hammer, 30" drop)
- Non-standard penetration test (see boring log for details)
- Thin wall (Shelby) tube
- Grab
- Rock core
- Vane Shear

- Notes:**
- Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.
 - The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered: Units of material distinguished by color and/or composition from material units above and below	Fissured: Breaks along defined planes
Laminated: Layers of soil typically 0.05 to 1mm thick, max. 1 cm	Slickensided: Fracture planes that are polished or glossy
Lens: Layer of soil that pinches out laterally	Blocky: Angular soil lumps that resist breakdown
Interlayered: Alternating layers of differing soil material	Disrupted: Soil that is broken and mixed
Pocket: Erratic, discontinuous deposit of limited extent	Scattered: Less than one per foot
Homogeneous: Soil with uniform color and composition throughout	Numerous: More than one per foot
	BCN: Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	Sand	
Cobbles:	3 to 12 inches	Coarse Sand:	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel	3 to 3/4 inches	Medium Sand:	#10 to #40 sieve (2.0 to 0.42 mm)
		Fine Sand:	#40 to #200 sieve (0.42 to 0.074 mm)
Coarse Gravel:	3 to 3/4 inches	Silt	0.074 to 0.002 mm
Fine Gravel:	3/4 inches to #4 sieve	Clay	<0.002 mm

MONITORING WELL

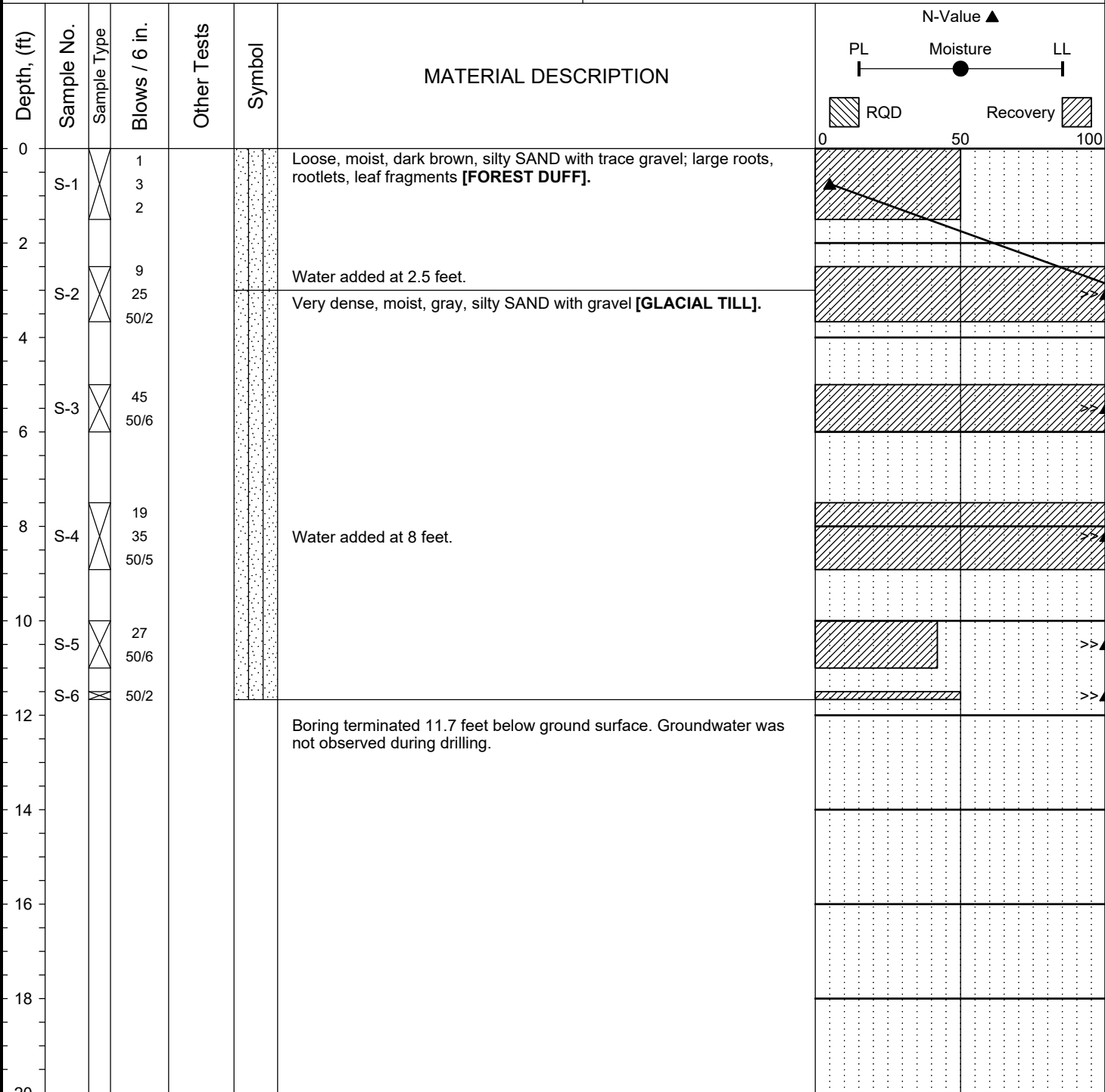
- Groundwater Level at time of drilling (ATD)
- Static Groundwater Level
- Cement / Concrete Seal
- Bentonite grout / seal
- Silica sand backfill
- Slotted tip
- Slough
- Bottom of Boring

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

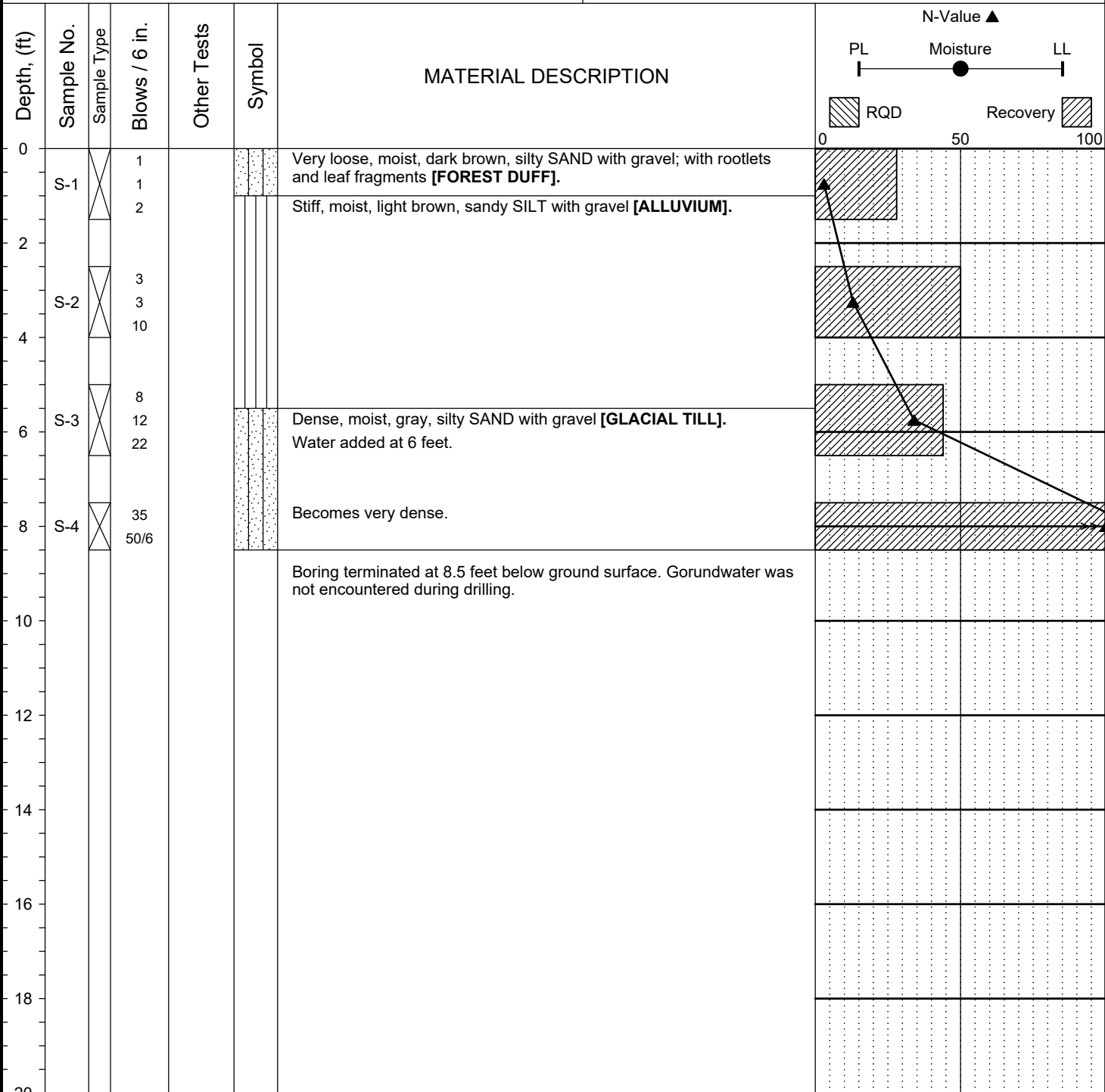
LOG KEY 08-118 LOG.GPJ - PANGEО.GDT 11/12/13

Project:	Mills Property, Mercer Island	Surface Elevation:	234.0ft
Job Number:	17-143.200	Top of Casing Elev.:	N/A
Location:	5236 West Mercer Way	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



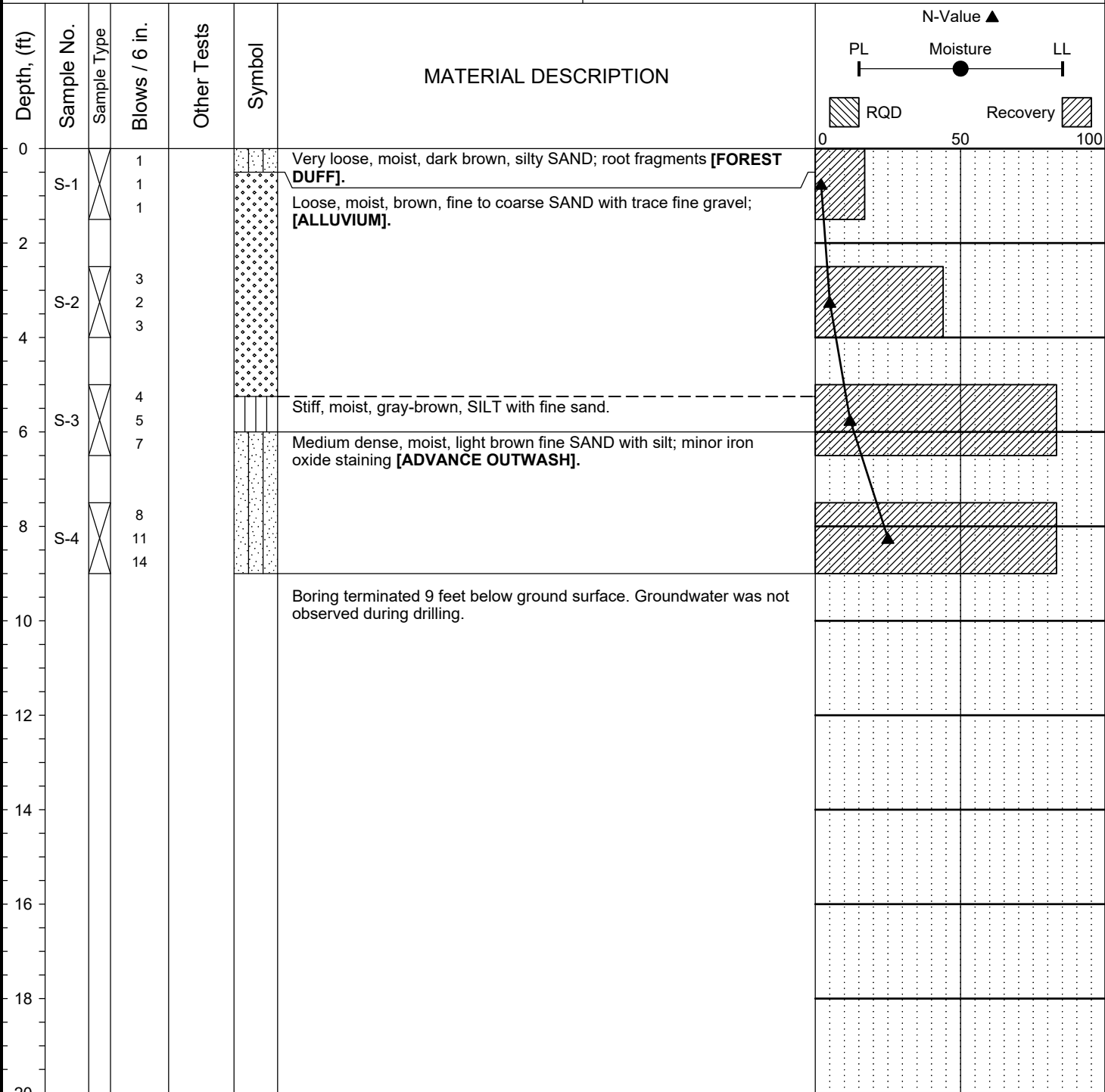
Completion Depth:	13.0ft	Remarks: Boring was drilled with an Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.
Date Borehole Started:	5/10/17	
Date Borehole Completed:	5/10/17	
Logged By:	J. Manke	
Drilling Company:	CN Drilling	

Project:	Mills Property, Mercer Island	Surface Elevation:	233.0ft
Job Number:	17-143.200	Top of Casing Elev.:	N/A
Location:	5236 West Mercer Way	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



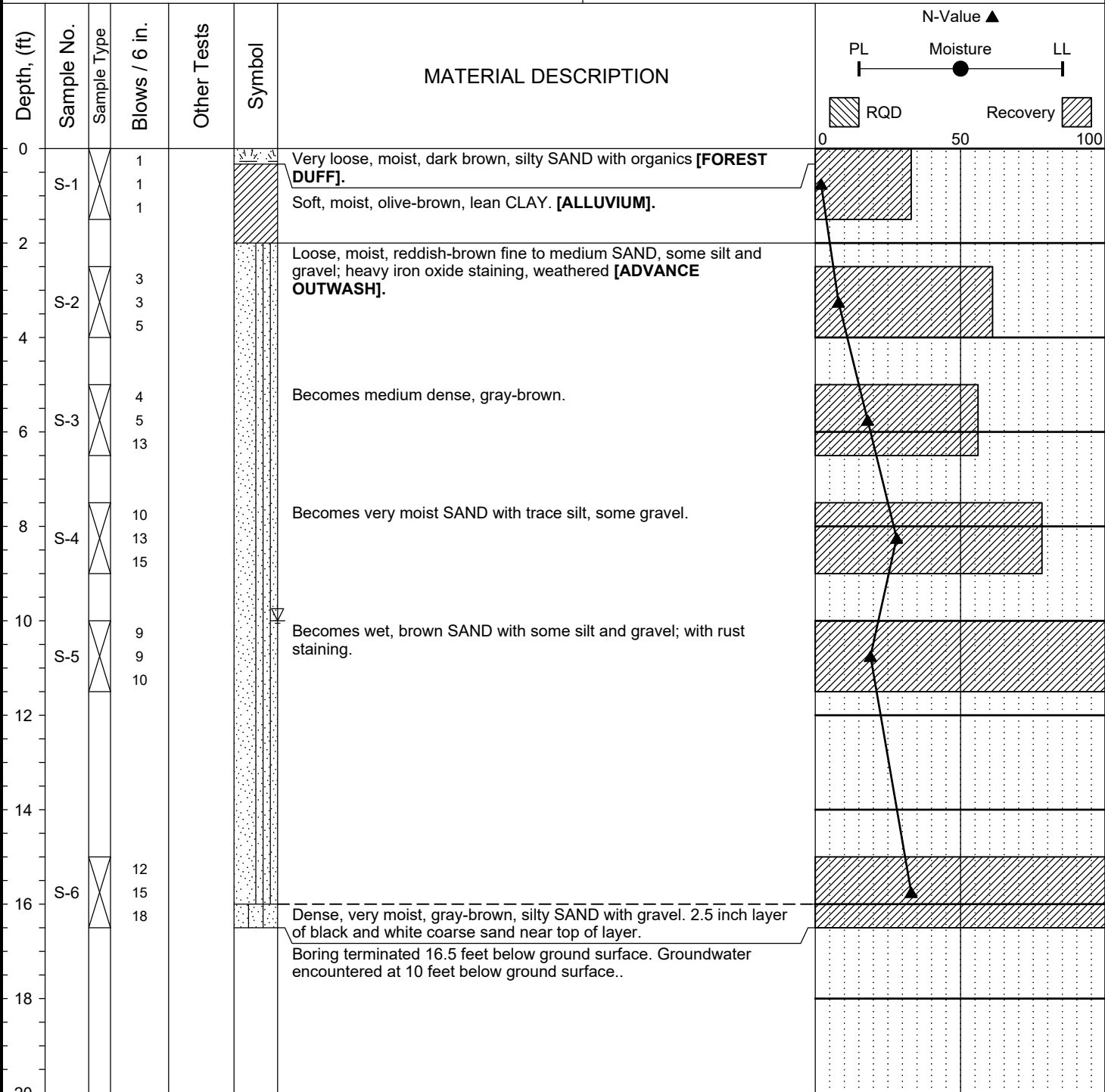
Completion Depth:	8.5ft	Remarks: Boring was drilled with an Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.
Date Borehole Started:	5/10/17	
Date Borehole Completed:	5/10/17	
Logged By:	J. Manke	
Drilling Company:	CN Drilling	

Project:	Mills Property, Mercer Island	Surface Elevation:	218.0ft
Job Number:	17-143.200	Top of Casing Elev.:	N/A
Location:	5236 West Mercer Way	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



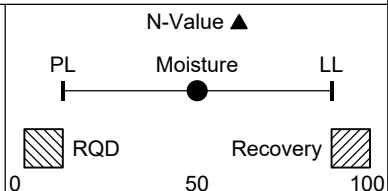
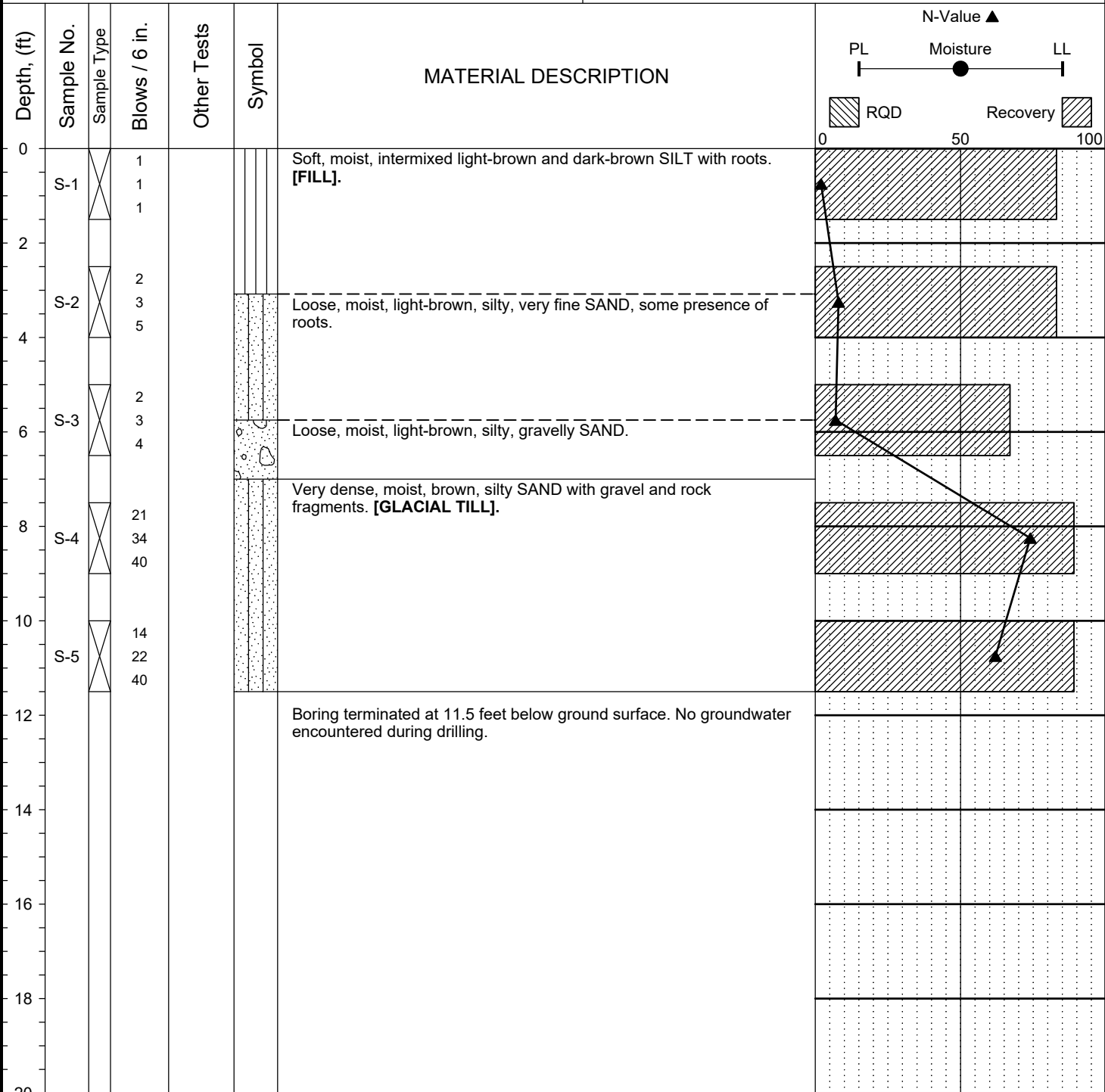
Completion Depth:	9.0ft	Remarks: Boring was drilled with an Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.
Date Borehole Started:	5/10/17	
Date Borehole Completed:	5/10/17	
Logged By:	J. Manke	
Drilling Company:	CN Drilling	

Project:	Mills Property, Mercer Island	Surface Elevation:	181.0ft
Job Number:	17-143.200	Top of Casing Elev.:	N/A
Location:	5236 West Mercer Way	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



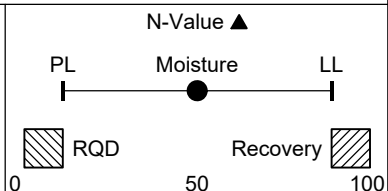
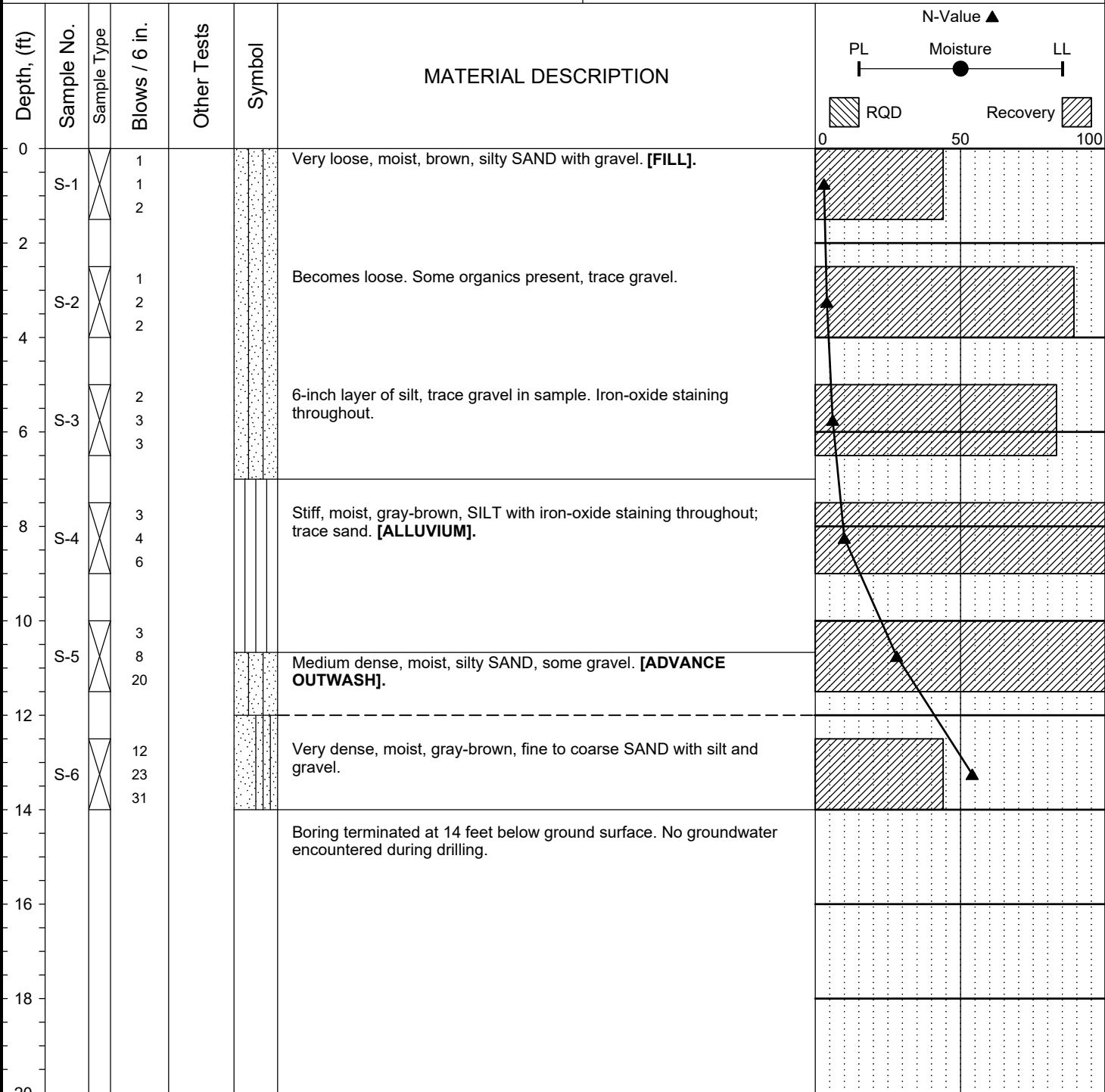
Completion Depth:	16.5ft	Remarks: Boring was drilled with an Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.
Date Borehole Started:	5/11/17	
Date Borehole Completed:	5/11/17	
Logged By:	Bjarni Kristjansson	
Drilling Company:	CN Drilling	

Project:	Mills Property, Mercer Island	Surface Elevation:	264.0ft
Job Number:	17-143.100	Top of Casing Elev.:	N/A
Location:	8440 Southeast 53rd Place	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

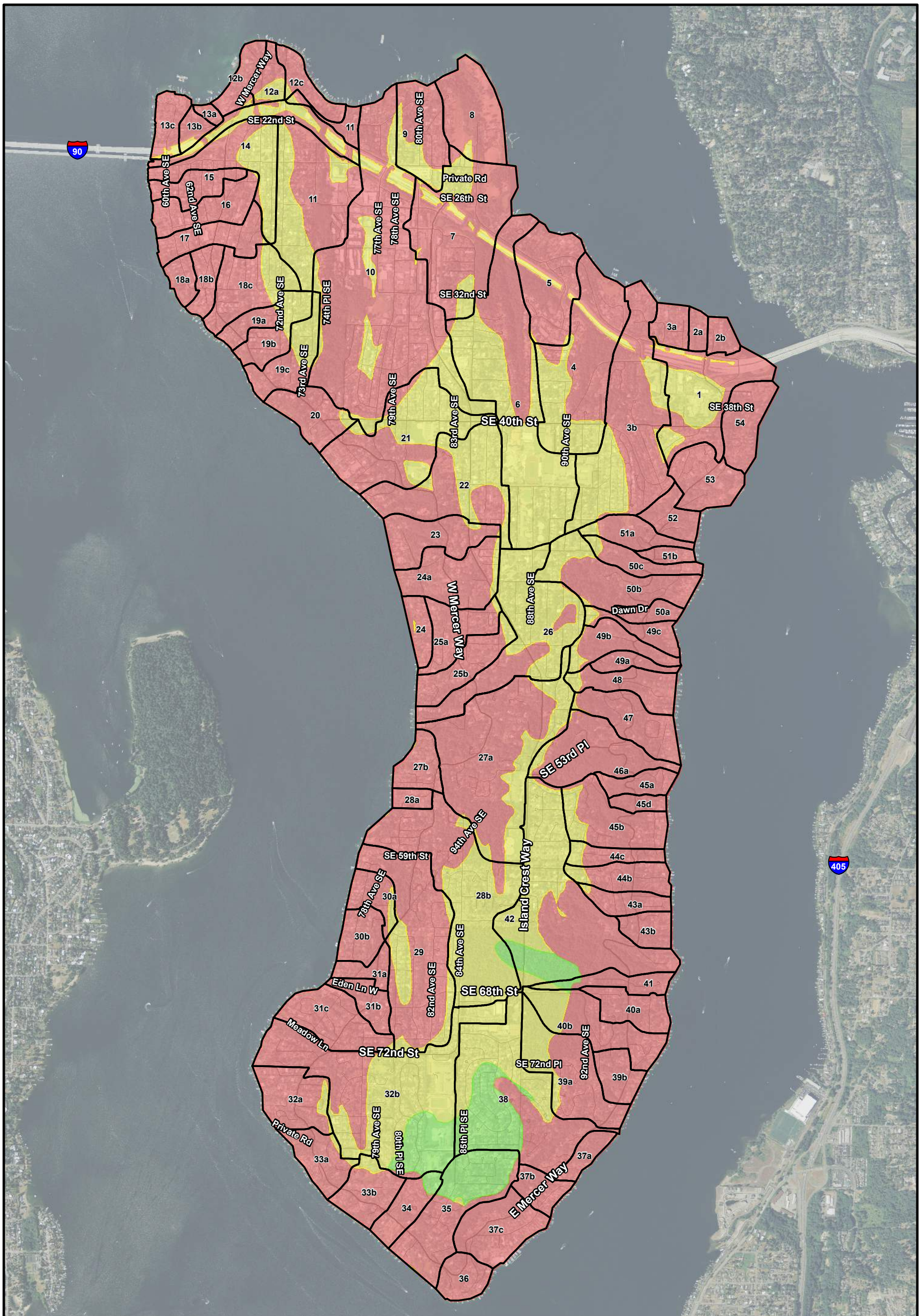


Completion Depth:	11.5ft	Remarks: Boring was drilled with a Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.
Date Borehole Started:	5/11/17	
Date Borehole Completed:	5/11/17	
Logged By:	Bjarni Kristjansson	
Drilling Company:	CN Drilling	

Project:	Mills Property, Mercer Island	Surface Elevation:	269.0ft
Job Number:	17-143.100	Top of Casing Elev.:	N/A
Location:	8440 Southeast 53rd Place	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT



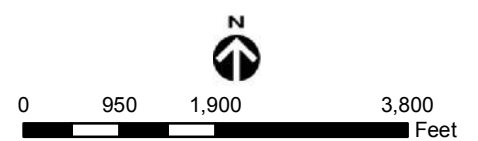
Completion Depth:	14.0ft	Remarks: Boring was drilled with a Acker portable drill rig. Standard Penetration Test (SPT) sampler driven with a 140 lb hammer using a rope and cathead dropping 30 inches per stroke.
Date Borehole Started:	5/11/17	
Date Borehole Completed:	5/11/17	
Logged By:	Bjarni Kristjansson	
Drilling Company:	CN Drilling	



Legend

- Infiltrating LID facilities may be feasible, and soil has high infiltration potential
- Infiltrating LID facilities may be feasible, and soil has moderate infiltration potential
- Infiltrating LID facilities are not permitted
- Storm drainage basin

Figure 3. Low impact development infiltration feasibility on Mercer Island.



Aerial photography: USDA (2009)
 K:\Projects\10-04816-000\Project\lid_feasibility-report-11x17.mxd

* Map is intended to be used for planning purposes only. Site-specific analysis is required prior to design and construction of LID facilities.

N5 Architecture
Storm Drainage Report
5236 W. Mercer Way

Appendix D:
O&M Checklists
Stormwater Management Manual for Western Washington
Washington Department of Ecology

Appendix V-A: BMP Maintenance Tables

V-A.1 How To Use The BMP Maintenance Tables

The Best Management Practice (BMP) specific maintenance criteria contained in this appendix are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the required condition of the BMP at all times between inspections. In other words, exceeding these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these criteria. However, based on inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a BMP is in a condition that requires a maintenance action.

V-A.2 Maintenance Standards - Detention Ponds

Table V-A.1: Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash and Debris	Any trash and debris which exceed 5 cubic feet (cf) per 1,000 square feet (sf), which is about equal to the amount of trash it would take to fill up one standard size garbage can. In general, there should be no visual evidence of dumping. If less than the threshold above, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted integrated pest management (IPM) policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department). Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants. (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if the pond is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department and Ecology Dam Safety Office if pond exceeds 10 acre-feet).
	Beaver Dams	Dam results in change or function of the BMP.	BMP is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies).
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance and inspection access, or interferes with maintenance activity (i.e. slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. If dead, diseased, or dying trees are identified. (Use a certified arborist to determine health of tree or removal requirements)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g. alders for firewood). Remove hazard trees.
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	Slopes should be stabilized using appropriate erosion control measure(s); e.g. rock reinforcement, planting of grass, compaction.

Table V-A.1: Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		Any erosion observed on a compacted berm embankment.	If erosion is occurring on compacted berms a licensed engineer in the state of Washington should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the BMP.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if applicable)	Liner is visible and has more than three 0.25-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed engineer in the state of Washington should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.
Emergency Overflow/Spillway	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed engineer in the state of Washington should be consulted for proper berm/spillway restoration.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a geotechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.
	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of outflow path of spillway. (Riprap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See Side Slopes of Pond	

V-A.3 Maintenance Standards - Infiltration

Table V-A.2: Maintenance Standards - Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See V-A.2 Maintenance Standards - Detention Ponds	
	Poisonous/Noxious Vegetation	See V-A.2 Maintenance Standards - Detention Ponds	
	Contaminants and Pollution	See V-A.2 Maintenance Standards - Detention Ponds	

Table V-A.2: Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	Rodent Holes	See V-A.2 Maintenance Standards - Detention Ponds	
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. (A percolation test pit or test of the pond indicates that the pond is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Sediment is removed and/or pond is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled With Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See V-A.2 Maintenance Standards - Detention Ponds	
Emergency Overflow Spillway and Berms over 4 feet in height	Tree Growth	See V-A.2 Maintenance Standards - Detention Ponds	
	Piping	See V-A.2 Maintenance Standards - Detention Ponds	
Emergency Overflow Spillway	Rock Missing	See V-A.2 Maintenance Standards - Detention Ponds	
	Erosion	See V-A.2 Maintenance Standards - Detention Ponds	
Pre-settling Ponds and Vaults	Facility of Sump Filled with Sediment and/or Debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

V-A.4 Maintenance Standards - Evaporation Ponds

Table V-A.3: Maintenance Standards - Evaporation Ponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	See V-A.2 Maintenance Standards - Detention Ponds	
	Poisonous/ Noxious Vegetation	See V-A.2 Maintenance Standards - Detention Ponds	
	Contaminants and Pollution	See V-A.2 Maintenance Standards - Detention Ponds	
	Rodent Holes	See V-A.2 Maintenance Standards - Detention Ponds	
Side Slopes of Pond	Erosion	See V-A.2 Maintenance Standards - Detention Ponds	
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the pond.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if applicable)	Liner is visible and has > three 0.25-inch holes in it.	Liner repaired or replaced. Liner is fully covered.

Table V-A.3: Maintenance Standards - Evaporation Ponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Pond Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed engineer in the state of Washington should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a licensed engineer in the state of Washington with geotechnical expertise be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
General	Inlet Pipe	Inlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or Vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as <i>Juncus effusus</i> (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom that exceeds 6 inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.
	Snow	Snow removal operations deposit snow into evaporation pond.	This added factor must be considered in the water budget, especially if snow from another basin is put into the system. Temporary sediment ponds should be included in the design, to prevent sediment-laden runoff from entering the pond and storm disposal system during construction.

V-A.5 Maintenance Standards - Tanks and Vaults

Table V-A.4: Maintenance Standards - Tanks and Vaults

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point, or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for one-half the length of the storage vault, or any point depth exceeds 15% of the diameter. (Example: 72-inch diameter storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 the length of the tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into the tank/vault. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 0.5-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 0.25-inch wide at the joint of the inlet/outlet pipe.
Access Opening(s)	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 0.5-inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See V-A.7 Maintenance Standards - Catch Basins		

V-A.6 Maintenance Standards - Control Structures

Table V-A.5: Maintenance Standards - Control Structures

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (includes sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.

Table V-A.5: Maintenance Standards - Control Structures (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Clean-out Gate	Damaged or Missing	Clean-out gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Access Opening	See V-A.5 Maintenance Standards - Tanks and Vaults		
Catch Basin	See V-A.7 Maintenance Standards - Catch Basins		

V-A.7 Maintenance Standards - Catch Basins

Table V-A.6: Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g. methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60% of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). Frame not sitting flush on top slab, i.e. separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached.	Top slab is free of holes and cracks. Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regouted and secure at basin wall.
Settlement/ Mis-alignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.	
Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.	
Contamination and Pol-	See V-A.2 Maintenance Standards - Detention Ponds		No pollution present.

Table V-A.6: Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	lution		
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Cover/grate is in place, meets design standards, and is secured.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (if applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place, meets the design standards, and is installed and aligned with the flow path.

V-A.8 Maintenance Standards - Debris Barriers (e.g. Trash Racks)

Table V-A.7: Maintenance Standards - Debris Barriers (e.g. Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

V-A.9 Maintenance Standards - Energy Dissipators

Table V-A.8: Maintenance Standards - Energy Dissipators

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
<i>External</i>			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/flushed so that it matches design.

Table V-A.8: Maintenance Standards - Energy Dissipators (continued)

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.
	Water Flowing out Top of "Distributor" Catch Basin	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or is causing or appears likely to cause damage.	Energy dissipator rebuilt or redesigned to standards.
	Receiving Area Oversaturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal			
Manhole/Chamber	Worn or Damaged Post, Baffles, or Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot, which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See V-A.7 Maintenance Standards - Catch Basins	

V-A.10 Maintenance Standards - Typical Biofiltration Swale

Table V-A.9: Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the biofiltration swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains, or convert to a wet biofiltration swale.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire swale width.	Level the spreader and clean so that flows are spread evenly over entire swale width.
	Constant Baseflow	When small quantities of water continually flow through the swale, even when it has been dry for weeks, and an eroded, muddy channel has formed in the swale bottom.	Add a low-flow pea-gravel drain the length of the swale or by-pass the baseflow around the swale.
	Poor Vegetation Coverage	When grass is sparse or bare or eroded patches occur in more than 10% of the swale bottom.	Determine why grass growth is poor and correct that condition. Re-plant with plugs of grass from the upper slope: plant in the swale bottom at 8-inch intervals. Or re-seed into loosened, fertile soil.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow vegetation or remove nuisance vegetation so that the flow is not impeded. Grass should be mowed to a height of 3 to 4 inches. Remove grass clippings.
	Excessive Shading	Grass growth is poor because sunlight does not reach swale.	If possible, trim back over-hanging limbs and remove brushy vegetation on adjacent slopes.
	Inlet/Outlet	Inlet/outlet areas clogged with sediment and/or debris.	Remove material so that there is no clogging or blockage in the inlet and outlet area.
	Trash and Debris Accumulation	Trash and debris accumulated in the bio-swale.	Remove trash and debris from biofiltration swale.
Erosion/Scouring	Eroded or scoured swale bottom due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. If bare areas are large, generally greater than 12 inches wide, the swale should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident, or take plugs of grass from the upper slope and plant in the swale bottom at 8-inch intervals.	

V-A.11 Maintenance Standards - Wet Biofiltration Swale

Table V-A.10: Maintenance Standards - Wet Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation	Sediment depth exceeds 2-inches in 10% of the swale treatment area.	Remove sediment deposits in treatment area.
	Water Depth	Water not retained to a depth of about 4 inches during the wet season.	Build up or repair outlet berm so that water is retained in the wet swale.
	Wetland Vegetation	Vegetation becomes sparse and does not provide adequate filtration, OR vegetation is crowded out by very dense clumps of cattail, which do not allow water to flow through the clumps.	Determine cause of lack of vigor of vegetation and correct. Replant as needed. For excessive cattail growth, cut cattail shoots back and compost off-site. Note: normally wetland vegetation does not need to be harvested unless die-back is causing oxygen depletion in downstream waters.
	Inlet/Outlet	Inlet/outlet area clogged with sediment and/or debris.	Remove clogging or blockage in the inlet and outlet areas.
	Trash and Debris Accumulation	See V-A.2 Maintenance Standards - Detention Ponds	Remove trash and debris from wet swale.
	Erosion/Scouring	Swale has eroded or scoured due to flow channelization, or higher flows.	Check design flows to assure swale is large enough to handle flows. By-pass excess flows or enlarge swale. Replant eroded areas with fibrous-rooted plants such as Juncus effusus (soft rush) in wet areas or snowberry (Symphoricarpos albus) in dryer areas.

V-A.12 Maintenance Standards - Vegetated Filter Strips

Table V-A.11: Maintenance Standards - Vegetated Filter Strips

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits, re-level so slope is even and flows pass evenly through strip.
	Vegetation	When the grass becomes excessively tall (greater than 10-inches); when nuisance weeds and other vegetation starts to take over.	Mow grass, control nuisance vegetation, such that flow not impeded. Grass should be mowed to a height between 3-4 inches.
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, overseed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

V-A.13 Maintenance Standards - Wetponds

Table V-A.12: Maintenance Standards - Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water Level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Any trash and debris > 5 cubic feet (cf) per 1,000 square feet (sf). (This is about equal to the amount of trash it would take to fill up one standard size garbage can). In general, there should be no visual evidence of dumping. If less than threshold, all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site.
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vacuor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as <i>Juncus effusus</i> (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4 inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.
	Poisonous Vegetation and Noxious Weeds	Any poisonous or nuisance vegetation that may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by state or local regulations. (Apply requirements of adopted integrated pest management policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department). Complete eradication of noxious weeds may not be possible. Compliance with state or local eradication policies required.
	Contaminants and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	No contaminants or pollutants present.
	Rodent Holes	Any evidence of rodent holes if wetpond is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with the Washington State Department of Ecology Dam Safety Office if pond ≥ 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the wetpond.	Wetpond is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies.)
Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site.	

Table V-A.12: Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			Apply insecticides in compliance with adopted integrated pest management policies.
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, Vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove. If dead, diseased, or dying trees are identified. (Use a certified arborist to determine health of tree or removal requirements.)	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard trees.
Side Slopes of Pond	Erosion	Eroded damage > 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms, a licensed engineer in the state of Washington should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment > 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the wetpond.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if applicable)	Liner is visible and has > three 0.25-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Pond Berms (Dikes)	Settlements	Any part of berm that has settled 4 inches lower than the design elevation. If settlement is apparent, measure berm to determine amount of settlement. Settling can be an indication of more severe problems with the berm or outlet works. A licensed engineer in the state of Washington should be consulted to determine the source of the settlement.	Dike is built back to the design elevation.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a licensed engineer in the state of Washington with geotechnical expertise be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms Over 4 Feet in Height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms > 4 feet in height may lead to piping through the berm, which could lead to failure of the berm.	Trees should be removed. If root system is small (base < 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed engineer in the state of Washington should be consulted for proper berm/spillway restoration.
	Piping	Discernible water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a licensed engineer in the state of Washington with geotechnical expertise be called in to inspect and evaluate condition and recommend repair of condition.)	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway	Emergency Overflow/ Spillway	Only one layer of rock exists above native soil in area ≥ 5 sf, or any exposure of native soil at the top of outflow path of spillway. (Riprap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.

V-A.14 Maintenance Standards - Wetvaults

Table V-A.13: Maintenance Standards - Wetvaults

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6 inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Cover repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified percentage of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

V-A.15 Maintenance Standards - Sand Filters (Aboveground/Open)

Table V-A.14: Maintenance Standards - Sand Filters (Aboveground/Open)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Above Ground (open sand filter)	Sediment Accumulation on top layer	Sediment depth exceeds 1/2-inch.	No sediment deposit on grass layer of sand filter that would impede permeability of the filter section.
	Trash and Debris Accumulations	Trash and debris accumulated on sand filter bed.	Trash and debris removed from sand filter bed.
	Sediment/ Debris in Clean-Outs	When the clean-outs become full or partially plugged with sediment and/or debris.	Sediment removed from clean-outs.
	Sand Filter Media	Drawdown of water through the sand filter media takes longer than 24-hours, and/or flow through the overflow pipes occurs frequently.	Top several inches of sand are scraped. May require replacement of entire sand filter depth depending on extent of plugging (a sieve analysis is helpful to determine if the lower sand has too high a proportion of fine material).
	Prolonged Flows	Sand is saturated for prolonged periods of time (several weeks) and does not dry out between storms due to continuous base flow or prolonged flows from detention BMPs.	Low, continuous flows are limited to a small portion of the facility by using a low wooden divider or slightly depressed sand surface.
	Short Circuiting	When flows become concentrated over one section of the sand filter rather than dis-	Flow and percolation of water through sand filter is uniform and dispersed across the entire filter area.

Table V-A.14: Maintenance Standards - Sand Filters (Aboveground/Open) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		persed.	
	Erosion Damage to Slopes	Erosion over 2-inches deep where cause of damage is prevalent or potential for continued erosion is evident.	Slopes stabilized using proper erosion control measures.
	Rock Pad Missing or Out of Place	Soil beneath the rock is visible.	Rock pad replaced or rebuilt to design specifications.
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

V-A.16 Maintenance Standards - Sand Filters (Belowground/Enclosed)

Table V-A.15: Maintenance Standards - Sand Filters (Belowground/Enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 0.5 inch.	No sediment deposits on sand filter section that would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	Ventilation	Ventilation area blocked or plugged	Blocking material removed or cleared from ventilation area. A specified percentage of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damaged; Includes Cracks in Walls, Cracks in Bottom, or Damage to Frame and/or Top Slab.	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/out-

Table V-A.15: Maintenance Standards - Sand Filters (Belowground/Enclosed) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	let pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and/or misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

V-A.17 Maintenance Standards - Manufactured Media Filters

Table V-A.16: Maintenance Standards - Manufactured Media Filters

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault	Sediment Accumulation on Media	Sediment depth exceeds 0.25 inches.	No sediment deposits that would impede permeability of the media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6 inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on filter bed.	Trash and debris removed from the filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping, and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and/or misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Filter Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

V-A.18 Maintenance Standards - API (Baffle Type) Oil/Water Separators

Table V-A.17: Maintenance Standards - API (Baffle Type) Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with out thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6-inches in depth.	No sediment deposits on vault bottom that would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulation in vault, or pipe inlet/outlet, floatables and non-float-ables.	Trash and debris removed from vault, and inlet/outlet piping.
	Oil Accumulation	Oil accumulations that exceed 1-inch, at the surface of the water.	Extract oil from vault by vactoring. Disposal in accordance with state and local rules and regulations.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to Frame and/or Top Slab	See V-A.7 Maintenance Standards - Catch Basins Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

V-A.19 Maintenance Standards - Coalescing Plate (CP) Oil/Water Separators

Table V-A.18: Maintenance Standards - Coalescing Plate (CP) Oil/Water Separators

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Monitoring	Inspection of discharge water for obvious signs of poor water quality.	Effluent discharge from vault should be clear with no thick visible sheen.
	Sediment Accumulation	Sediment depth in bottom of vault exceeds 6 inches in depth and/or visible signs of sediment on plates.	No sediment deposits on vault bottom and plate media, which would impede flow through the vault and reduce separation efficiency.
	Trash and Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Oil Accumulation	Oil accumulation that exceeds 1 inch at the water surface.	Oil is extracted from vault using vactoring methods. Coalescing plates are cleaned by thoroughly rinsing and flushing. Should be no visible oil depth on water.
	Damaged Coalescing Plates	Plate media broken, deformed, cracked and/or showing signs of failure.	A portion of the media pack or the entire plate pack is replaced depending on severity of failure.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and or replaced.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Vault Structure Damage - Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 0.5 inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 0.5 inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 0.25 inch at the joint of the inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

V-A.20 Maintenance Standards - Catch Basin Inserts

Table V-A.19: Maintenance Standards - Catch Basin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

V-A.21 Maintenance Standards - Media Filter Drains

Table V-A.20: Maintenance Standards - Media Filter Drains

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment accumulation on grass filter strip	Sediment depth exceeds 2 inches or creates uneven grading that interferes with sheet flow.	Remove sediment deposits on grass treatment area of the embankment. When finished, embankment should be level from side to side and drain freely toward the toe of the embankment slope. There should be no areas of standing water once inflow has ceased.
	No-vegetation zone/flow spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire embankment width.	Level the spreader and clean to spread flows evenly over entire embankment width.
	Poor vegetation coverage	Grass is sparse or bare, or eroded patches are observed in more than 10% of the grass strip surface area.	Determine why grass growth is poor and correct the offending condition. Reseed into loosened, fertile soil or compost; or, replant with plugs of grass from the upper slope.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow vegetation or remove nuisance vegetation to not impede flow. Mow grass to a height of 6 inches.
	Media filter drain mix replacement	Water is seen on the surface of the media filter drain mix long after the storms have ceased. Typically, the 6-month, 24-hour precipitation event should drain within 48 hours. More common storms should drain within 24 hours. Maintenance also needed on a 10-year cycle and during a preservation project.	Excavate and replace all of the media filter drain mix contained within the media filter drain.
	Excessive shading	Grass growth is poor because sunlight does not reach embankment.	If possible, trim back overhanging limbs and remove brushy vegetation on adjacent slopes.
	Trash and debris	Trash and debris have accumulated on embankment.	Remove trash and debris from embankment.
	Flooding of Media filter drain	When media filter drain is inundated by flood water	Evaluate media filter drain material for acceptable infiltration rate and replace if media filter drain does not meet long-term infiltration rate standards.

V-A.22 Maintenance Standards - Compost-Amended Vegetated Filter Strips (CAVFS)

Table V-A.21: Maintenance Standards - Compost-Amended Vegetated Filter Strips (CAVFS)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits. Relevel so slope is even and flows pass evenly through strip.
	Vegetation	Grass becomes excessively tall (greater than 10 inches); nuisance weeds and other vegetation start to take over.	Mow grass and control nuisance vegetation so that flow is not impeded. Grass should be mowed to a height of 6 inches.
	Trash and debris	Trash and debris have accumulated on the vegetated filter strip.	Remove trash and debris from filter.
	Erosion/Scouring	Areas have eroded or scoured due to flow channelization or high flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with a 50/50 mixture of crushed gravel and compost. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the vegetated filter strip should be regraded and reseeded. For smaller bare areas, overseed when bare spots are evident.

Table V-A.21: Maintenance Standards - Compost-Amended Vegetated Filter Strips (CAVFS) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Flow Spreader	Flow spreader is uneven or clogged so that flows are not uniformly distributed over entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

V-A.23 Maintenance Standards - Bioretention

Table V-A.22: Maintenance Standards - Bioretention

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Facility Footprint				
Earthen side slopes and berms	B, S		Erosion (gullies/ rills) greater than 2 inches deep around inlets, outlet, and alongside slopes	<ul style="list-style-type: none"> Eliminate cause of erosion and stabilize damaged area (regrade, rock, vegetation, erosion control matting) For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made. Properly designed, constructed and established facilities with appropriate flow velocities should not have erosion problems except perhaps in extreme events. If erosion problems persist, the following should be reassessed: (1) flow volumes from contributing areas and bioretention facility sizing; (2) flow velocities and gradients within the facility; and (3) flow dissipation and erosion protection strategies at the facility inlet.
	A		Erosion of sides causes slope to become a hazard	Take actions to eliminate the hazard and stabilize slopes
	A, S		Settlement greater than 3 inches (relative to undisturbed sections of berm)	Restore to design height
	A, S		Downstream face of berm wet, seeps or leaks evident	Plug any holes and compact berm (may require consultation with engineer, particularly for larger berms)
	A		Any evidence of rodent holes or water piping in berm	<ul style="list-style-type: none"> Eradicate rodents (see "Pest control") Fill holes and compact (may require consultation with engineer, particularly for larger berms)
Concrete sidewalls	A		Cracks or failure of concrete sidewalls	<ul style="list-style-type: none"> Repair/ seal cracks Replace if repair is insufficient
Rockery sidewalls	A		Rockery side walls are insecure	Stabilize rockery sidewalls (may require consultation with engineer, particularly for walls 4 feet or greater in height)
Facility area		All maintenance visits (at least biannually)	Trash and debris present	Clean out trash and debris
Facility bottom area	A, S		Accumulated sediment to extent that infiltration rate is reduced (see "Ponded water") or surface storage capacity significantly impacted	<ul style="list-style-type: none"> Remove excess sediment Replace any vegetation damaged or destroyed by sediment accumulation and removal Mulch newly planted vegetation Identify and control the sediment source (if feasible)

Table V-A.22: Maintenance Standards - Bioretention (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> If accumulated sediment is recurrent, consider adding presettlement or installing berms to create a forebay at the inlet
		During/after fall leaf drop	Accumulated leaves in facility	Remove leaves if there is a risk to clogging outlet structure or water flow is impeded
Low permeability check dams and weirs	A, S		Sediment, vegetation, or debris accumulated at or blocking (or having the potential to block) check dam, flow control weir or orifice	Clear the blockage
	A, S		Erosion and/or undercutting present	Repair and take preventative measures to prevent future erosion and/or undercutting
	A		Grade board or top of weir damaged or not level	Restore to level position
Ponded water	B, S		Excessive ponding water: Water overflows during storms smaller than the design event or ponded water remains in the basin 48 hours or longer after the end of a storm.	Determine cause and resolve in the following order: <ol style="list-style-type: none"> 1. Confirm leaf or debris buildup in the bottom of the facility is not impeding infiltration. If necessary, remove leaf litter/debris. 2. Ensure that underdrain (if present) is not clogged. If necessary, clear underdrain. 3. Check for other water inputs (e.g., groundwater, illicit connections). 4. Verify that the facility is sized appropriately for the contributing area. Confirm that the contributing area has not increased. If steps #1-4 do not solve the problem, the bioretention soil is likely clogged by sediment accumulation at the surface or has become overly compacted. Dig a small hole to observe soil profile and identify compaction depth or clogging front to help determine the soil depth to be removed or otherwise rehabilitated (e.g., tilled). Consultation with an engineer is recommended.
Bioretention soil mix	As needed		Bioretention soil mix protection is needed when performing maintenance requiring entrance into the facility footprint	<ul style="list-style-type: none"> Minimize all loading in the facility footprint (foot traffic and other loads) to the degree feasible in order to prevent compaction of bioretention soils. Never drive equipment or apply heavy loads in facility footprint. Because the risk of compaction is higher during saturated soil conditions, any type of loading in the cell (including foot traffic) should be minimized during wet conditions. Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility. As an example, boards may be placed across soil to distribute loads and minimize compaction. If compaction occurs, soil must be loosened or otherwise rehabilitated to original design state.
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet	M during the wet season and before severe storm is forecasted	Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)

Table V-A.22: Maintenance Standards - Bioretention (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, trash, or mulch reducing capacity of inlet/outlet	<ul style="list-style-type: none"> • Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	<ul style="list-style-type: none"> • Clear vegetation (transplant vegetation when possible) within 1 foot of inlets and outlets, maintain access pathways • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Erosion control at inlet	A		Concentrated flows are causing erosion	Maintain a cover of rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)
Trash rack	S		Trash or other debris present on trash rack	Remove/dispose
	A		Bar screen damaged or missing	Repair/replace
Overflow	A, S		Capacity reduced by sediment or debris	Remove sediment or debris/dispose
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	<ul style="list-style-type: none"> • Plant roots, sediment or debris reducing capacity of underdrain • Prolonged surface ponding (see "Ponded water") 	<ul style="list-style-type: none"> • Jet clean or rotary cut debris/roots from underdrain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly.
Vegetation				
Facility bottom area and upland slope vegetation	Fall and Spring		Vegetation survival rate falls below 75% within first two years of establishment (unless project O&M manual or record drawing stipulates more or less than 75% survival rate).	<ul style="list-style-type: none"> • Determine cause of poor vegetation growth and correct condition • Replant as necessary to obtain 75% survival rate or greater. Refer to original planting plan, or approved jurisdictional species list for appropriate plant replacements (See Appendix 3 - Bioretention Plant List, in the <i>LID Technical Guidance Manual for Puget Sound</i>, (Hinman and Wulkan, 2012)). • Confirm that plant selection is appropriate for site growing conditions • Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Vegetation (general)	As needed		Presence of diseased plants and plant material	<ul style="list-style-type: none"> • Remove any diseased plants or plant parts and dispose of in an approved location (e.g., commercial landfill) to avoid risk of spreading the disease to other plants • Disinfect gardening tools after pruning to prevent the spread of disease • See the <i>Pacific Northwest Plant Disease Management Handbook</i> (Pscheidt and Ocamb, 2016) for information on disease recognition and for additional resources • Replant as necessary according to recommendations provided for "facility bottom area and upland slope vegetation".
Trees and shrubs		All pruning seasons (timing varies by)	Pruning as needed	<ul style="list-style-type: none"> • Prune trees and shrubs in a manner appropriate for each species. Pruning should be performed by landscape professionals familiar with proper pruning techniques

Table V-A.22: Maintenance Standards - Bioretention (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
		species)		<ul style="list-style-type: none"> All pruning of mature trees should be performed by or under the direct guidance of an ISA certified arborist
	A		Large trees and shrubs interfere with operation of the facility or access for maintenance	<ul style="list-style-type: none"> Prune trees and shrubs using most current ANSI A300 standards and ISA BMPs. Remove trees and shrubs, if necessary.
	Fall and Spring		Standing dead vegetation is present	<ul style="list-style-type: none"> Remove standing dead vegetation Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather-/planting season) If vegetation replacement is not feasible within 30 days, and absence of vegetation may result in erosion problems, temporary erosion control measures should be put in place immediately. Determine cause of dead vegetation and address issue, if possible If specific plants have a high mortality rate, assess the cause and replace with appropriate species. Consultation with a landscape architect is recommended.
	Fall and Spring		Planting beneath mature trees	<ul style="list-style-type: none"> When working around and below mature trees, follow the most current ANSI A300 standards and ISA BMPs to the extent practicable (e.g., take care to minimize any damage to tree roots and avoid compaction of soil). Planting of small shrubs or groundcovers beneath mature trees may be desirable in some cases; such plantings should use mainly plants that come as bulbs, bare root or in 4-inch pots; plants should be in no larger than 1-gallon containers.
	Fall and Spring		Presence of or need for stakes and guys (tree growth, maturation, and support needs)	<ul style="list-style-type: none"> Verify location of facility liners and underdrain (if any) prior to stake installation in order to prevent liner puncture or pipe damage Monitor tree support systems: Repair and adjust as needed to provide support and prevent damage to tree. Remove tree supports (stakes, guys, etc.) after one growing season or maximum of 1 year. Backfill stake holes after removal.
Trees and shrubs adjacent to vehicle travel areas (or areas where visibility needs to be maintained)	A		Vegetation causes some visibility (line of sight) or driver safety issues	<ul style="list-style-type: none"> Maintain appropriate height for sight clearance When continued, regular pruning (more than one time/ growing season) is required to maintain visual sight lines for safety or clearance along a walk or drive, consider relocating the plant to a more appropriate location. Remove or transplant if continual safety hazard Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
Flowering plants		A	Dead or spent flowers present	Remove spent flowers (deadhead)
Perennials		Fall	Spent plants	Cut back dying or dead and fallen foliage and stems
Emergent vegetation		Spring	Vegetation compromises conveyance	Hand rake sedges and rushes with a small rake or fingers to remove dead foliage before new growth emerges in spring or earlier only if the foliage is blocking water flow (sedges and rushes do not respond well to pruning)
Ornamental grasses (perennial)		Winter and Spring	Dead material from previous year's growing cycle or dead collapsed foliage	<ul style="list-style-type: none"> Leave dry foliage for winter interest Hand rake with a small rake or fingers to remove dead foliage back to within several inches from the soil before new growth emerges in spring or earlier if the foliage collapses and is blocking water flow

Table V-A.22: Maintenance Standards - Bioretention (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Ornamental grasses (evergreen)		Fall and Spring	Dead growth present in spring	<ul style="list-style-type: none"> Hand rake with a small rake or fingers to remove dead growth before new growth emerges in spring Clean, rake, and comb grasses when they become too tall Cut back to ground or thin every 2-3 years as needed
Noxious weeds		M (March - October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	<ul style="list-style-type: none"> By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately Reasonable attempts must be made to remove and dispose of class C noxious weeds It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions Apply mulch after weed removal (see "Mulch")
Weeds		M (March - October, preceding seed dispersal)	Weeds are present	<ul style="list-style-type: none"> Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate Follow IPM protocols for weed management (see "Additional Maintenance Resources" section for more information on IPM protocols)
Excessive vegetation		Once in early to mid- May and once in early- to mid-September	Low-lying vegetation growing beyond facility edge onto sidewalks, paths, or street edge poses pedestrian safety hazard or may clog adjacent permeable pavement surfaces due to associated leaf litter, mulch, and soil	<ul style="list-style-type: none"> Edge or trim groundcovers and shrubs at facility edge Avoid mechanical blade-type edger and do not use edger or trimmer within 2 feet of tree trunks While some clippings can be left in the facility to replenish organic material in the soil, excessive leaf litter can cause surface soil clogging
	As needed		Excessive vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety	<ul style="list-style-type: none"> Determine whether pruning or other routine maintenance is adequate to maintain proper plant density and aesthetics Determine if planting type should be replaced to avoid ongoing maintenance issues (an aggressive grower under perfect growing conditions should be transplanted to a location where it will not impact flow) Remove plants that are weak, broken or not true to form; replace in-kind Thin grass or plants impacting facility function without leaving visual holes or bare soil areas Consultation with a landscape architect is recommended for removal, transplant, or substitution of plants
	As needed		Vegetation blocking curb cuts, causing excessive sediment buildup and flow bypass	Remove vegetation and sediment buildup
Mulch				
Mulch		Following weeding	Bare spots (without mulch cover) are present or mulch depth less than 2 inches	<ul style="list-style-type: none"> Supplement mulch with hand tools to a depth of 2 to 3 inches Replenish mulch per O&M manual. Often coarse compost is used in the bottom of the facility and arborist wood chips are used on side slopes and rim (above typical water levels) Keep all mulch away from woody stems
Watering				
Irrigation system (if any)		Based on manufacturer's instructions	Irrigation system present	Follow manufacturer's instructions for O&M

Table V-A.22: Maintenance Standards - Bioretention (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
		tions		
	A		Sprinklers or drip irrigation not directed/located to properly water plants	Redirect sprinklers or move drip irrigation to desired areas
Summer watering (first year)		Once every 1-2 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in first year of establishment period	<ul style="list-style-type: none"> • 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present <ul style="list-style-type: none"> ◦ Pulse water to enhance soil absorption, when feasible ◦ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff • Add a tree bag or slow-release watering device (e.g., bucket with a perforated bottom) for watering newly installed trees when irrigation system is not present
Summer watering (second and third years)		Once every 2-4 weeks or as needed during prolonged dry periods	Trees, shrubs and groundcovers in second or third year of establishment period	<ul style="list-style-type: none"> • 10 to 15 gallons per tree • 3 to 5 gallons per shrub • 2 gallons water per square foot for groundcover areas • Water deeply, but infrequently, so that the top 6 to 12 inches of the root zone is moist • Use soaker hoses or spot water with a shower type wand when irrigation system is not present <ul style="list-style-type: none"> ◦ Pulse water to enhance soil absorption, when feasible ◦ Pre-moisten soil to break surface tension of dry or hydrophobic soils/mulch, followed by several more passes. With this method , each pass increases soil absorption and allows more water to infiltrate prior to runoff
Summer watering (after establishment)		As needed	Established vegetation (after 3 years)	<ul style="list-style-type: none"> • Plants are typically selected to be drought tolerant and not require regular watering after establishment; however, trees may take up to 5 years of watering to become fully established • Identify trigger mechanisms for drought-stress (e.g., leaf wilt, leaf senescence, etc.) of different species and water immediately after initial signs of stress appear • Water during drought conditions or more often if necessary to maintain plant cover
Pest Control				
Mosquitoes	B, S		Standing water remains for more than 3 days after the end of a storm	<ul style="list-style-type: none"> • Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • To facilitate maintenance, manually remove standing water and direct to the storm drainage system (if runoff is from non pollution-generating surfaces) or sanitary sewer system (if runoff is from pollution-generating surfaces) after getting approval from sanitary sewer authority. • Use of pesticides or <i>Bacillus thuringiensis israelensis</i> (Bti) may be considered only as a temporary measure while

Table V-A.22: Maintenance Standards - Bioretention (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				addressing the standing water cause. If overflow to a surface water will occur within 2 weeks after pesticide use, apply for coverage under the Aquatic Mosquito Control NPDES General Permit.
Nuisance animals	As needed		Nuisance animals causing erosion, damaging plants, or depositing large volumes of feces	<ul style="list-style-type: none"> Reduce site conditions that attract nuisance species where possible (e.g., plant shrubs and tall grasses to reduce open areas for geese, etc.) Place predator decoys Follow IPM protocols for specific nuisance animal issues (see "Additional Maintenance Resources" section for more information on IPM protocols) Remove pet waste regularly For public and right-of-way sites consider adding garbage cans with dog bags for picking up pet waste.
Insect pests	Every site visit associated with vegetation management		Signs of pests, such as wilting leaves, chewed leaves and bark, spotting or other indicators	<ul style="list-style-type: none"> Reduce hiding places for pests by removing diseased and dead plants For infestations, follow IPM protocols (see "Additional Maintenance Resources" section for more information on IPM protocols)

Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".

^a Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

IPM - Integrated Pest Management
ISA - International Society of Arboriculture

V-A.24 Maintenance Standards - Permeable Pavement

Table V-A.23: Maintenance Standards - Permeable Pavement

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Surface/Wearing Course				
Permeable Pavements, all	A, S		Runoff from adjacent pervious areas deposits soil, mulch or sediment on paving	<ul style="list-style-type: none"> Clean deposited soil or other materials from permeable pavement or other adjacent surfacing Check if surface elevation of planted area is too high, or slopes towards pavement, and can be regraded (prior to regrading, protect permeable pavement by covering with temporary plastic and secure covering in place) Mulch and/or plant all exposed soils that may erode to pavement surface
Porous asphalt or pervious concrete		A or B	None (routine maintenance)	<p>Clean surface debris from pavement surface using one or a combination of the following methods:</p> <ul style="list-style-type: none"> Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves)

Table V-A.23: Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> • Vacuum/sweep permeable paving installation using: <ul style="list-style-type: none"> ◦ Walk-behind vacuum (sidewalks) ◦ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ◦ ShopVac or brush brooms (small areas) • Hand held pressure washer or power washer with rotating brushes Follow equipment manufacturer guidelines for when equipment is most effective for cleaning permeable pavement. Dry weather is more effective for some equipment.
	A _b		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	<ul style="list-style-type: none"> • Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) • Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. • If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. To clean clogged pavement surfaces, use one or combination of the following methods: <ul style="list-style-type: none"> ◦ Combined pressure wash and vacuum system calibrated to not dislodge wearing course aggregate. ◦ Hand held pressure washer or power washer with rotating brushes ◦ Pure vacuum sweepers <p>Note: If the annual/biannual routine maintenance standard to clean the pavement surface is conducted using equipment from the list above, corrective maintenance may not be needed.</p>
	A		Sediment present at the surface of the pavement	<ul style="list-style-type: none"> • Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding then see above. • Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	<ul style="list-style-type: none"> • Sidewalks: Use a stiff broom to remove moss in the summer when it is dry • Parking lots and roadways: Pressure wash, vacuum sweep, or use a combination of the two for cleaning moss from pavement surface. May require stiff broom or power brush in areas of heavy moss.
	A		Major cracks or trip hazards and concrete spalling and raveling	<ul style="list-style-type: none"> • Fill potholes or small cracks with patching mixes • Large cracks and settlement may require cutting and replacing the pavement section. Replace in-kind where feasible. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function. • Take appropriate precautions during pavement repair and replacement efforts to prevent clogging of adjacent porous materials
Interlocking concrete paver blocks and		A or B	None (routine maintenance)	<p>Clean pavement surface using one or a combination of the following methods:</p> <ul style="list-style-type: none"> • Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf

Table V-A.23: Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
aggregate pavers				<ul style="list-style-type: none"> blowers can be used for removing leaves) Vacuum/sweep permeable paving installation using: <ul style="list-style-type: none"> Walk-behind vacuum (sidewalks) High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ShopVac or brush brooms (small areas) <p>Note: Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.</p>
	A _b		Surface is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	<ul style="list-style-type: none"> Review the overall performance of the facility (note that small clogged areas may not reduce overall performance of facility) Test the surface infiltration rate using ASTM C1701 as a corrective maintenance indicator. Perform one test per installation, up to 2,500 square feet. Perform an additional test for each additional 2,500 square feet up to 15,000 square feet total. Above 15,000 square feet, add one test for every 10,000 square feet. If the results indicate an infiltration rate of 10 inches per hour or less, then perform corrective maintenance to restore permeability. Clogging is usually an issue in the upper 2 to 3 centimeters of aggregate. Remove the upper layer of encrusted sediment, and fines, and/or vegetation from openings and joints between the pavers by mechanical means and/or suction equipment (e.g., pure vacuum sweeper). Replace aggregate in paver cells, joints, or openings per manufacturer's recommendations
	A		Sediment present at the surface of the pavement	<ul style="list-style-type: none"> Assess the overall performance of the pavement system during a rain event. If water runs off the pavement and/or there is ponding, then see above. Determine source of sediment loading and evaluate whether or not the source can be reduced/eliminated. If the source cannot be addressed, consider increasing frequency of routine cleaning (e.g., twice per year instead of once per year).
	Summer		Moss growth inhibits infiltration or poses slip safety hazard	<ul style="list-style-type: none"> Sidewalks: Use a stiff broom to remove moss in the summer when it is dry Parking lots and roadways: Vacuum sweep or stiff broom/power brush for cleaning moss from pavement surface
	A		Paver block missing or damaged	Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations
	A		Loss of aggregate material between paver blocks	Refill per manufacturer's recommendations for interlocking paver sections
	A		Settlement of surface	May require resetting
Open-celled paving grid with gravel		A or B	None (routine maintenance)	<ul style="list-style-type: none"> Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) Follow equipment manufacturer guidelines for cleaning surface.
	A _b		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	<ul style="list-style-type: none"> Use vacuum truck to remove and replace top course aggregate Replace aggregate in paving grid per manufacturer's recommendations

Table V-A.23: Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A		Paving grid missing or damaged	<ul style="list-style-type: none"> Remove pins, pry up grid segments, and replace gravel Replace grid segments where three or more adjacent rings are broken or damaged Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Loss of aggregate material in paving grid	Replenish aggregate material by spreading gravel with a rake (gravel level should be maintained at the same level as the plastic rings or no more than 1/4 inch above the top of rings). See manufacturer's recommendations.
		A	Weeds present	<ul style="list-style-type: none"> Manually remove weeds Presence of weeds may indicate that too many fines are present (refer to Actions Needed under "Aggregate is clogged" to address this issue)
Open-celled paving grid with grass		A or B	None (routine maintenance)	<ul style="list-style-type: none"> Remove sediment, debris, trash, vegetation, and other debris deposited onto pavement (rakes and leaf blowers can be used for removing leaves) Follow equipment manufacturer guidelines for cleaning surface.
	A _b		Aggregate is clogged: Ponding on surface or water flows off the permeable pavement surface during a rain event (does not infiltrate)	Rehabilitate per manufacturer's recommendations.
	A		Paving grid missing or damaged	<ul style="list-style-type: none"> Remove pins, pry up grid segments, and replace grass Replace grid segments where three or more adjacent rings are broken or damaged Follow manufacturer guidelines for repairing surface.
	A		Settlement of surface	May require resetting
	A		Poor grass coverage in paving grid	<ul style="list-style-type: none"> Restore growing medium, reseed or plant, aerate, and/or amend vegetated area as needed Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible
		As needed	None (routine maintenance)	Use a mulch mower to mow grass
		A	None (routine maintenance)	<ul style="list-style-type: none"> Sprinkle a thin layer of compost on top of grass surface (1/2" top dressing) and sweep it in Do not use fertilizer
		A	Weeds present	<ul style="list-style-type: none"> Manually remove weeds Mow, torch, or inoculate and replace with preferred vegetation
Inlets/Outlets/Pipes				
Inlet/outlet pipe	A		Pipe is damaged	Repair/replace
	A		Pipe is clogged	Remove roots or debris
Underdrain pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain (may cause prolonged draw-down period)	<ul style="list-style-type: none"> Jet clean or rotary cut debris/roots from underdrain(s) If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly

Table V-A.23: Maintenance Standards - Permeable Pavement (continued)

Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Raised subsurface overflow pipe	Clean pipe as needed	Clean orifice at least biannually (may need more frequent cleaning during wet season)	Plant roots, sediment or debris reducing capacity of underdrain	<ul style="list-style-type: none"> • Jet clean or rotary cut debris/roots from under-drain(s) • If underdrains are equipped with a flow restrictor (e.g., orifice) to attenuate flows, the orifice must be cleaned regularly
Outlet structure	A, S		Sediment, vegetation, or debris reducing capacity of outlet structure	<ul style="list-style-type: none"> • Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
Overflow	B		Native soil is exposed or other signs of erosion damage are present at discharge point	Repair erosion and stabilize surface
Aggregate Storage Reservoir				
Observation port	A, S		Water remains in the storage aggregate longer than anticipated by design after the end of a storm	If immediate cause of extended ponding is not identified, schedule investigation of subsurface materials or other potential causes of system failure.
Vegetation				
Adjacent large shrubs or trees		As needed	Vegetation related fallout clogs or will potentially clog voids	<ul style="list-style-type: none"> • Sweep leaf litter and sediment to prevent surface clogging and ponding • Prevent large root systems from damaging subsurface structural components
		Once in May and Once in September	Vegetation growing beyond facility edge onto sidewalks, paths, and street edge	Edging and trimming of planted areas to control groundcovers and shrubs from overreaching the sidewalks, paths and street edge improves appearance and reduces clogging of permeable pavements by leaf litter, mulch and soil.
Leaves, needles, and organic debris		In fall (October to December) after leaf drop (1-3 times, depending on canopy cover)	Accumulation of organic debris and leaf litter	Use leaf blower or vacuum to blow or remove leaves, evergreen needles, and debris (i.e., flowers, blossoms) off of and away from permeable pavement
<p>Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".</p> <p>a Frequency: A= Annually; B= Biannually (twice per year); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).</p> <p>b Inspection should occur during storm event.</p>				

V-A.25 Maintenance Standards - Vegetated Roofs

Table V-A.24: Maintenance Standards - Vegetated Roofs

Activity	Objective	Schedule	Notes
Structural and Drainage Components			
Clear inlet pipes: Remove soil substrate, vegetation or other debris.	Maintain free drainage of inlet pipes.	Twice annually.	
Inspect drain pipe: Check for cracks settling and proper alignment, and correct and re-compact soils or fill material surrounding pipe, if necessary.	Maintain free drainage of inlet pipes.	Twice annually.	

Table V-A.24: Maintenance Standards - Vegetated Roofs (continued)

Activity	Objective	Schedule	Notes
Inspect fire ventilation points for proper operation	Fire and safety.	Twice annually.	
Maintain egress and ingress: Clear routes of obstructions and maintained to design standards.	Fire and safety.	Twice annually.	
Insects: See Notes			Vegetated roof design should provide drainage rates that do not allow pooling of water for periods that promote insect larvae development. If standing water is present for extended periods correct drainage problem. Chemical sprays should not be used.
Prevent release of contaminants: Identify activities (mechanical systems maintenance, pet access, etc.) that can potentially release pollutants to the vegetated roof and establish agreements to prevent release.	Water quality protection.	During construction of roof and then as determined by inspection.	Any cause of pollutant release should be corrected as soon as identified and the pollutant removed.
Vegetation and Growth Medium			
Invasive or nuisance plants: Remove manually and without herbicide applications.	Promote selected plant growth and survival, maintain aesthetics.	Twice annually.	At a minimum, schedule weeding with inspections to coincide with important horticultural cycles (e.g., prior to major weed varieties dispersing seeds).
Removing and replacing dead material: See Notes	See Notes.	Once annually.	Normally, dead plant material will be recycled on the roof; however specific plants or aesthetic considerations may warrant removing and replacing dead material (see manufacturer's recommendations).
Fertilization: If necessary apply by hand. See Notes	Plant growth and survival.	Determined by inspection.	Extensive vegetated roofs should be designed to not require fertilization after plant establishment. If fertilization is necessary during plant establishment or for plant health and survivability after establishment, use an encapsulated, slow release fertilizer (excessive fertilization can contribute to increased nutrient loads in the stormwater system and receiving waters).
Mulching: See Notes			Avoid application of mulch on extensive vegetated roofs. Mulch should be used only in unusual situations and according to the vegetated roof provider guidelines. In conventional landscaping, mulch enhances moisture retention; however, moisture on a vegetated roof should be controlled by proper design of the soil/growth medium. Mulch will also increase establishment of weeds.
Irrigate: Use subsurface or drip irrigation.		Determined by inspection and only when necessary for plant survival.	Surface irrigation systems on extensive vegetated roofs can promote weed establishment, root development near the drier surface layer of the soil substrate, and increase plant dependence on irrigation. Accordingly, subsurface irrigation methods are preferred. If surface irrigation is the only method available, use drip irrigation to deliver water to the base of the plant.
<i>Source: Eastern Washington LID Guidance Manual (June 2013)</i>			

V-A.26 Maintenance Standards - Rainwater Harvesting

Table V-A.25: Maintenance Standards - Rainwater Harvesting

Activity	Objective	Schedule
Remove debris from roof: Sweep, rake or use leaf blower.	Prevent debris from entering collection and filter system	Determined by inspection
Clean gutters: By hand or use leaf blower.	Prevent debris from entering collection and filter system	Determined by inspection (generally September, November, January, and April). The most critical cleaning is in mid-spring to late spring to flush the pollen deposits from surrounding trees. ^a

Table V-A.25: Maintenance Standards - Rainwater Harvesting (continued)

Activity	Objective	Schedule
Clean downspout basket screens: Remove debris from screens at top of downspout.	Prevent debris from entering collection and filter system, and clogging of system	Same as gutters
Clean prefilters	Prevent debris from entering collection and filter system, and clogging of system	Monthly
Clean storage tanks of debris: Drain tank and remove debris from bottom of tank.	Prevent contamination	Determined by inspection
Clean particle filters	Prevent contamination	6 months or determined by pressure drop in system.
Clean and replace ultraviolet (UV) filters	Prevent contamination	Clean every 6 months and replace bulb every 12 months or according to manufacturer's recommendation.
Chlorinate storage tank: Chlorinate to 0.2 to 0.5 parts per million (ppm) (0.25 cup of household bleach [5.25%] at the rate of 1 cup of bleach to 1,000 gallons of stored water)	Prevent contamination	Quarterly
Flush household taps: Remove carbon filter and flush until chlorine odor is noticed at taps. Chlorinated water should be left standing in the piping for 30 minutes. Replace the carbon filter.	Prevent contamination	When storage tanks are cleaned
^a Covers for gutters may be appropriate for specific locations, but can make regular cleaning more difficult and will not prevent pollen from entering filter system.		

V-A.27 Maintenance Standards - Downspout, Sheet Flow, and Concentrated Dispersion Systems

Table V-A.26: Maintenance Standards - Downspout, Sheet Flow, and Concentrated Dispersion Systems

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Splash Block (Downspout Dispersion)				
Splash block	B		Water is being directed towards building structure	Reconfigure/ repair blocks to direct water away from building structure
	B		Water disrupts soil media	Reconfigure/ repair blocks
Transition Zone (Sheet Flow Dispersion)				
Transition zone	A		Adjacent soil erosion; uneven surface creating concentrated flow discharge; or less than 2 foot of width	Repair/replace transition zone to meet design criteria and eliminate concentrated flows
Dispersion Trench (Downspout Dispersion)				
Dispersion trench	A		Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" from edge of trench; intent is to prevent erosion damage)	<ul style="list-style-type: none"> Remove debris from trench surface, if necessary Realign notched grade board or other distributor type, if possible Rebuild trench to standards, if necessary
Surface of trench	Fall and Spring		Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow from facility	Remove/dispose in accordance with local solid waste requirements

Table V-A.26: Maintenance Standards - Downspout, Sheet Flow, and Concentrated Dispersion Systems (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
	A, W		Vegetation/moss present on drain rock surface impedes sheet flow from facility	Maintain open, freely draining drain rock surface
Pipe(s) to trench	A, W		Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc.	Remove/ dispose
	A, W		Pipe from sump to trench or drywell has accumulated sediment or is plugged	Clear sediment from inlet/outlet pipe screen and inlet/outlet pipe
	A, W		Cracked, collapsed, broken, or misaligned drain pipes	<ul style="list-style-type: none"> • Repair/seal cracks • Replace when repair is insufficient
Sump	A		Sediment in the sump	<ul style="list-style-type: none"> • Remove/ dispose in accordance with local solid waste requirements • Clear sediment from inlet/outlet pipe screen and/or inlet/outlet pipe
Access lid	A		Cannot be easily opened	Repair/ replace
	A		Buried	Refer to record drawings for design intent. If the access lid was designed to be exposed, expose and restore to surface grade
	A		Cover missing	Replace
Rock Pad (Concentrated Flow Dispersion)				
Rock pad	A		Only one layer of rock exists above native soil in area 6 square feet or larger, or any exposure of native soil	<ul style="list-style-type: none"> • Replace/ repair rock pad to meet design standards • Enlarge pad size or add additional courses of rock, if necessary
	A		Soil erosion in or adjacent to rock pad	Repair/replace rock pad to meet design standards
Dispersal Area				
Dispersal area (general)	B, S		Erosion (gullies/ rills) greater than 2 inches deep in dispersal area	Eliminate cause of erosion and stabilize damaged area (regrade, rock, revegetate)
	B, S		Accumulated sediment or debris to extent that blocks or channelizes flow path	<ul style="list-style-type: none"> • Remove excess sediment or debris • Identify and control the sediment source (if feasible)
Ponded water	B, S		Standing surface water in dispersion area remains for more than 3 days after the end of a storm event	Identify the cause of the standing water (e.g. grade depressions, compacted soil) and take appropriate actions to address the problem (e.g. regrade to eliminate depressions or aerate/ amend soils)
Plant establishment	B	Once every 1-2 weeks or as needed during prolonged dry periods ^b	Dispersal area vegetation in establishment period (1-2 years, or additional 3rd year during extreme dry weather)	Water weekly during periods of no rain to ensure plant establishment
Vegetation	As needed		Poor vegetation cover such that erosion is occurring	<ul style="list-style-type: none"> • Ensure proper care (e.g. watering) • Assess for nutrient deficiencies

Table V-A.26: Maintenance Standards - Downspout, Sheet Flow, and Concentrated Dispersion Systems (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
				<ul style="list-style-type: none"> • Replant as needed with appropriate plant species for the soil and moisture conditions • Consider amending soils to promote plant health
	B, S		Vegetation inhibits dispersed flow along flow path	Trim, weed or replant to restore dispersed flow path
Storage Sump				
Sump	A		Accumulated sediment in the sump	<ul style="list-style-type: none"> • Remove/ dispose in accordance with local solid waste requirements • Clear sediment from inlet/outlet pipe screen and/or inlet/outlet pipe
Access lid	A		Cannot be easily opened	Repair/ replace
	A		Buried	Expose and restore to surface grade
	A		Cover missing	Replace
Pest Control				
General Pests	As needed		Signs of pest infestations (IPM protocol threshold(s) are exceeded)	Follow IPM protocols for weed and pest management
Mosquitoes	B, S		Standing surface water in dispersion area remains for more than 3 days after the end of a storm	<ul style="list-style-type: none"> • Identify the cause of the standing water and take appropriate actions to address the problem (see "Ponded water") • Do not use pesticides or <i>Bacillus thuringiensis israelensis</i> (Bti)
Rodents	As needed		Rodent holes or mounds disturb dispersion flow paths	Fill and compact soil around the holes and vegetate to restore flow path
<p>Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".</p> <p>a) Frequency: A = Annually; B = Biannually (twice per year); W = At least once during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).</p> <p>b) Inspection should occur during plant establishment period (1-2 years, or additional 3rd year during extreme dry weather).</p> <p>IPM - Integrated Pest Management</p> <p>Source: (Herrera and WSC, 2013)</p>				

V-A.28 Maintenance Standards - Downspout Full Infiltration

Table V-A.27: Maintenance Standards - Downspout Full Infiltration

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Rock Trench / Well				
Surface of trench/well (i.e. water enters through exposed aggregate)	Fall and Spring		Accumulated trash, debris, or sediment on drain rock surface impedes sheet flow into facility	Remove/dispose in accordance with local solid waste requirements
	A, W		Vegetation/moss present on drain rock surface impedes sheet flow into facility	Maintain open, freely draining drain rock surface
Drain rock	Fall and Spring		<ul style="list-style-type: none"> If water enters the facility from the surface, inspect to see if water is ponding at the surface during storm events If buried drain rock, observe drawdown through observation port or cleanout 	<ul style="list-style-type: none"> Clear piping through facility when ponding occurs Replace rock/sand reservoirs as necessary Tilling of subgrade below reservoir may be necessary (for trenches) prior to backfill
Inlet / Outlet Pipe Conveyance				
Pipe(s)	A, W		Accumulation of trash, debris, or sediment in roof drains, gutters, driveway drains, area drains, etc.	Remove / dispose
	A, W		Pipe from sump to trench or drywell has accumulated sediment or is plugged	Clear sediment from inlet/outlet pipe screen and inlet/outlet pipe
	A, W		Cracked, collapsed, broken, or misaligned drain pipes	<ul style="list-style-type: none"> Repair/seal cracks Replace when repair is insufficient
Roof downspout	B, W		Splash pad missing or damaged	Repair / replace
	A, W		Leaves or other debris plugging downspout	Remove / dispose
Storage Sump				
Sump	A		Sediment in the sump	Remove/dispose in accordance with local solid waste requirements
Access lid	A		Cannot be easily opened	Repair/replace
	A		Buried	Refer to record drawings for design intent. If the access lid was designed to be exposed, expose and restore to surface grade
	A		Cover missing	Replace
<p>Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".</p> <p>a) Frequency: A = Annually; B = Biannually (twice per year); W = At least one visit should occur during the wet season (for debris/clog related maintenance, this inspection/maintenance visit should occur in the early fall, after deciduous trees have lost their leaves).</p>				

Table V-A.27: Maintenance Standards - Downspout Full Infiltration (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Source: (Herrera and WSC, 2013)				

V-A.29 Maintenance Standards - Post-Construction Soil Quality and Depth

Table V-A.28: Maintenance Standards - Post-Construction Soil Quality and Depth

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Soil media (maintain high organic soil content)	A		Vegetation not fully covering ground surface or vegetation health is poor	<ul style="list-style-type: none"> Maintain 2 to 3 inches of mulch over bare areas in landscape beds Add plants if sufficient space Re-seed bare turf areas until the vegetation fully covers ground surface
		Ongoing	None (routine maintenance)	Return leaf fall and shredded woody materials from the landscape to the site when possible in order to replenish soil nutrients and structure
		Ongoing	None (routine maintenance)	On turf areas, "grasscycle" (mulch-mow or leave the clippings) to build turf health
		Ongoing	None (routine maintenance)	Avoiding use of pesticides (bug and weed killers), like "weed & feed", which damage the soil
		A	None (routine maintenance)	<ul style="list-style-type: none"> Where fertilization is needed (mainly turf and annual flower beds), a moderate fertilization program should be used which relies on compost, natural fertilizers or slow-release synthetic balanced fertilizers Follow IPM protocols for fertilization procedures
Soil media (maintain infiltration)	A ^b		Soils become waterlogged, do not appear to be infiltrating	<ul style="list-style-type: none"> To remediate compaction, aerate soil, till to at least 8-inch depth, or further amend soil with compost and re-till If areas are turf, aerate compacted areas and topdress them with 1/4 to 1/2 inch of compost to renovate them If drainage is still slow, consider investigating alternative causes (e.g. high wet season groundwater levels, low permeability soils) Also consider site use and protection from compacting activities
Erosion / Scouring	A, W, S		Areas of potential erosion are visible	<ul style="list-style-type: none"> Identify and address cause of erosion (e.g. concentrate flow entering area, channelization of runoff) and stabilize damaged area (regrade, rock, vegetation, erosion control matting) For deep channels or cuts (over 3 inches in ponding depth), temporary erosion control measures should be put in place until permanent repairs can be made.
Grass / Vegetation		A	Less than 75% of planted vegetation is healthy with a generally	<ul style="list-style-type: none"> Take appropriate maintenance actions (e.g. remove/ replace plants)

Table V-A.28: Maintenance Standards - Post-Construction Soil Quality and Depth (continued)

Maintenance Component	Recommended Frequency ^a		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
			good appearance	<ul style="list-style-type: none"> If problem persists, evaluate if vegetation is appropriate for the location (e.g. exposure, soil, soil moisture)
Noxious weeds		M (March – October, preceding seed dispersal)	Listed noxious vegetation is present (refer to current county noxious weed list)	<ul style="list-style-type: none"> By law, class A & B noxious weeds must be removed, bagged and disposed as garbage immediately Reasonable attempts must be made to remove and dispose of class C noxious weeds Watch for and respond to new occurrences of especially aggressive weeds such as Himalayan blackberry, Japanese knotweed, morning glory, English ivy, and reed canary grass to avoid invasions It is strongly encouraged that herbicides and pesticides not be used in order to protect water quality; use of herbicides and pesticides may be prohibited in some jurisdictions
Weeds		M (March – October, preceding seed dispersal)	Weeds are present	<ul style="list-style-type: none"> Remove weeds with their roots manually with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate Follow IPM protocols for weed management

Note that the inspection and routine maintenance frequencies listed above are recommended by Ecology. They do not supersede or replace the municipal stormwater permit requirements for inspection frequency required of municipal stormwater permittees for "stormwater treatment and flow control BMPs/facilities".

a) Frequency: A = Annually; B = Biannually (twice per year); M = Monthly; W = At least one visit should occur during the wet season (for debris/clog related maintenance, this visit should occur in the early fall, after deciduous trees have lost their leaves); S = Perform inspections after major storm events (24-hour storm event with a 10-year or greater recurrence interval).

b) Inspection should occur during a storm event.

IPM - Integrated Pest Management

Source: [\(Herrera and WSC, 2013\)](#)