

Technical Memorandum

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| To: | City of Olympia | Principal in Charge: | Jennfier H. Saltonstall, L.G., L.Hg. |
| | | Project Name: | Long Term Bioretention Monitoring Study, Phase III |
| Attn: | Mr. Jesse Barham | Project No: | 20150387H008 |
| Subject: | Task 3.2 Geotechnical and Hydrogeologic Data/Report, City of Olympia Contract Agreement Number: C2300003 | | |

1.0 INTRODUCTION

This technical memorandum documents existing shallow soil and groundwater conditions in 50 bioretention facilities greater than 10 years in operation throughout Western Washington and the Puget Sound area (Figure 1). This technical memorandum was prepared in accordance with Task 3 of the contract scope of work. Associated Earth Sciences, Inc. (AESI) documented the current condition of each facility relative to the as-built drawings and available background geotechnical information, collected shallow soil and groundwater conditions data related to bioretention cell function, and performed infiltration testing.

This technical memorandum has been prepared for the exclusive use of the City of Olympia and their agents for specific application to this project. Within the limitations of scope, schedule, and budget, our services have been performed in accordance with generally accepted hydrogeologic and geotechnical practices in effect in this area at the time our document was prepared. No other warranty, express or implied, is made.

2.0 PURPOSE AND SCOPE

The purpose of our work was to provide in-field documentation data to assess effectiveness of bioretention hydrologic performance and maintenance, to evaluate shallow soil and groundwater conditions, and perform infiltration testing on 50 bioretention facilities.

Specifically, our scope included the following activities:

- Review of project documents.
- Review of site plans relative to the constructed facility, in particular, the number and location of inlets, energy dissipation devices, outlets, and other flow-related details.
- Site reconnaissance.
- Visual condition assessment of erosion and deposition features near inlet and outlet.
- Excavate shallow hand augers through the bioretention soil.

- Classify sediment according to the Unified Soil Classification System (USCS) and American Society for Testing and Materials (ASTM) D2488, “Standard Recommended Practice for Description of Soils.”
- Collect samples for laboratory testing of (1) particle size distribution in accordance with ASTM D422-63, “Standard Test Method for Particle-Size Analysis of Soils”; (2) organic matter content per ASTM D2974.
- Conduct qualitative assessment of soil compaction via T-probe.
- Conduct facility scale infiltration testing.
- Preparation of descriptive exploration logs for each exploration.
- Preparation of this summary document.

Appendix A to this report includes individual Site Assessment Forms for each site. The Site Assessment Forms include a detailed description of site features, a map of existing facility features and the locations of hand-auger boreholes completed for each site, exploration logs and laboratory testing data, soil probe summary, and field infiltration testing data. Several site photos are included.

3.0 METHODS

Site information was collected in accordance with the project Quality Assurance Project Plan (June 1, 2023). Site information consisted of document review, field observations, shallow soil and groundwater data, infiltration measurements and geotechnical laboratory testing. These are described in more detail below.

3.1 Document Review

We reviewed available civil drainage plans and drainage reports for construction date, construction details (number and locations of inlets, energy dissipation devices, outlets and other flow-related details), soil specification information, and design infiltration rate information. We reviewed topographic, geologic, and hydrogeologic setting of each site both from regional studies and where available, background site-specific geotechnical and groundwater studies.

3.2 Cell Construction Information

General site information was documented for each cell including drone imagery (if allowed by local regulation), cell base area, inflow, energy dissipation elements, overflow, presence of an underdrain, condition of the inlets and overflow, and approximate construction date. The cell base area was sketched onto the base aerial image and then the area was estimated. The diameter or width of each element was measured with a tape incremented in hundredths of feet.

3.3 Cell Substrate and Condition

The mulch presence, type and approximate extent coverage was visually estimated. Erosion and deposition were documented for each inlet, and the presence of scour or other flow paths through the cell were documented. Observations were made of animal or insect burrows and feces, and trash. The thickness of loose bioretention soil as a qualitative indicator of compaction was estimated through use of a geotechnical soils T-probe. This qualitative data was used in conjunction with the hand-auger

observations to understand loose soil thickness and relative potential compactness of the bioretention soils at depth. General vegetation observations were included.

3.4 Subsurface exploration

Limited information on subsurface conditions was obtained from hand-auger samples and soil probe penetration measurements at about 2-foot increments in each hand-augered borehole. For most cells, one hand boring was performed in the facility bottom and advanced to a depth of 8 to 10 feet or refusal to document bioretention soil thickness and underlying sediments and to allow for temporary well point installation. Two additional hand borings were completed to depths of 2 to 4 feet to document the bioretention soil section. Representative samples were collected, visually classified in the field, stored in water-tight containers, and transported to AESI's offices for additional classification, geotechnical testing and study. The sediments were described by visual and textural examination using the soil classification in general accordance with ASTM D-2488, Standard Recommended Practice for Description of Soils. Hydrogeologic analysis and geologic unit assignment were conducted to estimate infiltration capacity of the native subgrade sediments. At the conclusion of the excavation, each borehole was immediately backfilled with the excavated material or completed as a temporary monitoring wellpoint for use during the infiltration test and the bioretention soil replaced.

The various types of sediments, as well as the depths where characteristics of the sediments changed, are indicated on the exploration logs presented in Appendix A. A detailed record of the observed bioretention soil, subsurface soil, geology, and groundwater conditions was made. The depths indicated on the logs where conditions changed may represent gradational variations between sediment types in the field. The exploration logs in Appendix A are based on field observations, inspection of the samples, and where applicable, laboratory grain-size analysis. Our explorations were approximately located in the field relative to known site features, and are shown on each site map included in Appendix A.

3.5 Geotechnical Laboratory Testing

The bioretention soil and native subgrade sediments were further classified using geotechnical laboratory testing procedures. Three samples from each facility will be tested for particle size distribution and percent organic matter, two from the bioretention media and one from the native subgrade, reported individually and in aggregate. The bioretention soil was tested for organic matter content using the Ash Content and Organic Material test method (ASTM D-2974) to estimate the percent organic matter, and the burned material will then be washed and sieved in accordance with ASTM D-1140 and ASTM D-6913 testing procedures. The native subgrade sediments were washed and sieved in accordance with ASTM D-1140 and ASTM D-6913 testing procedures.

3.6 Infiltration Rate Testing

Infiltration rate testing involves estimates of the ponded surface area, flow rate and volume of pumped water, and depth of water. Flow rate and volume were measured to the nearest 0.1 gallon per minute (gpm) and gallon. Water depths were measured in feet to the nearest 0.01 feet. The ponded surface dimensions were typically irregular and were measured using hand tapes to the nearest 0.1 feet. The ponded area will then be estimated by solving for trapezoidal areas. The accuracy of the resultant area measurement is approximately 5 to 10 percent, and is dependent on the area size, shape irregularity and obstructions (e.g., large vegetation).

Infiltration rates were measured in one of two ways:

- Full-scale testing: where adequate water supply was available and the facility base area was relatively small, field infiltration rates were measured by full-scale testing (maintaining a constant level of water across the facility at a constant flow rate, and accurately measuring the wetted pool); or
- Pilot infiltration test: when full-scale testing was not practical either due to high infiltration rates or lack of water supply, infiltration rates will be measured using the Pilot Infiltration Test (PIT) procedure. The PIT is not a standard test but rather a practical field procedure recommended by Ecology. For sites with rapid infiltration rates and corresponding small wetted areas, a second PIT was conducted in another portion of the cell base to obtain additional infiltration rate information across the cell.

Each test was conducted by discharging water into the facility for a “soaking period,” to allow the receptor soils to become saturated. After completion of the soaking period, water was discharged into the cell at a rate sufficient to maintain a relatively constant head. This constitutes the “constant-head” phase of infiltration testing. Immediately following the constant-head phase of infiltration testing, flow into the facilities was discontinued, and the water level was monitored as it dropped. This constitutes the “falling-head” portion of the infiltration testing. Total inflow or discharge time ranged from 6 to 8 hours. Falling head data were collected for one hour. If water remained in the wellpoint after one hour, the datalogger was left overnight to collect additional data.

The water for testing was obtained from hydrants, onsite hose bibs, or from a subcontracted water truck. Hydrant permits were obtained, as applicable. During infiltration testing, the water was conveyed into the bioretention cell via a digital flow meter with gallons per minute (gpm) and total gallon readouts and discharged through a flow diffuser. Ponded water levels within the cell were monitored using a temporary staff gauge marked in 0.01-foot increments typically installed in the low point of the cell, and within the wellpoints or other subsurface observation ports with an electronic water level tape, and with digital pressure transducers for the duration of the test. Data from the digital pressure transducers were compensated for barometric response using a separate digital barometer. The test wetted area was measured periodically during testing.

3.7 Groundwater and Ponding Depth Measurements.

During infiltration testing, surface ponding depth was measured with a staff gauge(s) and subsurface ponding or groundwater was measured with a temporary monitoring wellpoint. For a subset of cells, additional information on subsurface ponding was collected from existing monitoring or observation ports, underdrain cleanouts, and/or catch basin structures. The temporary wellpoint and other monitoring station(s) were equipped with a data logger during infiltration rate testing to compare with staff gauge water level data within the facility.

4.0 DATA ANALYSIS AND RESULTS

The geotechnical and hydrogeologic assessment for the bioretention cells focused on:

- Comparison with As-builts – inlets, outlets, underdrains, overflow, base area
- Geologic/hydrogeologic setting

- Infiltration Performance – bioretention soil and subgrade infiltration rates and shallow groundwater considerations
- Bioretention surface conditions and soil
- Other observations that affect performance

Summary data tables are included in Appendix A. Details for each site are included in Appendix B. Summary findings and graphics are presented below.

4.1 Cell Condition Relative to Plans

Key physical parameters are how the built system compares to design, the presence of an underdrain, and condition of inflow and overflow points. Thirty-eight cells were consistent with the as-built plans for physical drainage elements: inlets, overflow, underdrain, cell size and other structures. Three sites did not have plans available for our review. Nine sites had a variety of differences from plans including non-engineered overflow or bypass and landscaping modifications. Separately, ten cells had leakage occurring through joints in the overflow catch basins. Information on predominant land use surrounding the cells and presence of irrigation is summarized in Table 1.

Facility Types:

- 28 cells were typical bioretention cells, with no underdrain. Of these, 3 had an added dispersion pipe bedded in gravel beneath the bioretention soil to manage larger stormwater events that would exceed the bioretention soil infiltration rate.
- 19 cells had underdrains;
- 3 cells did not fit either the typical or underdrain cell design. A thick gravel sump without underdrain pipes was installed for underground storage. The infiltration rate through the bioretention cell was unrestricted by the native subgrade due to the large storage reservoir, like an underdrained cell. The large storage reservoir mitigated for low infiltration rates in the native soils.

Inlet Condition:

- 27 cells had only piped inflow, no sheet flow
- 23 cells had either a combination of piped inlets and sheet flow or only sheet flow
- 17 cells had at least one inlet with erosion
- 32 cells had at least one inlet with blockage

Overflow:

- 41 cells had a clearly engineered overflow structure
- 11 overflow structures had some debris buildup

Table 1. Predominant Land Use and Irrigation Installation

| Land Use | Total | Irrigation | |
|--------------------------|-----------|------------|-----------|
| | | Yes | No |
| Arterial Road | 11 | 6 | 5 |
| Commercial | 9 | 7 | 2 |
| Parkland | 4 | | 4 |
| Residential Neighborhood | 15 | 3 | 12 |
| School | 11 | 10 | 1 |
| Grand Total | 50 | 26 | 24 |

4.2 Hydrogeologic Setting

The 50 bioretention cells cover a range of hydrogeologic settings. In this study, hydrogeologic setting includes general geomorphic position, geologic unit and groundwater condition. Geomorphic setting, geologic unit, and facility type (typical infiltration, underdrain, and a subset) are summarized in Table 2.

Geomorphic position includes valley, terrace or upland. Geologic units from youngest to older include: Fill, Recent alluvium, Everson glaciomarine drift, Vashon recessional outwash, till and advance outwash, and pre-Fraser fine-grained deposits. For this study, Everson glaciomarine drift, Vashon glacial till, and Vashon advance outwash are situated on glaciated uplands. Recent alluvium and Vashon recessional outwash are located in valleys or on terrace or plains. Groundwater conditions include perched/intermittent, shallow, moderate and deep. A few sites are designated as "Fill/Unknown," because the hand auger explorations terminated in an underdrain gravel layer, or the sediment beneath the bioretention soil was interpreted to consist of imported or reworked fill sediment.

Shallow groundwater was present at three sites at the time of infiltration testing. The remaining sites did not have groundwater present. Most typical infiltrating facilities are interpreted to have shallow to moderate depth to groundwater. Most underdrained sites are underlain by hydraulically restrictive layers which will form a perched condition during the wetter winter months.

Table 2. Geologic Unit and Geomorphic Setting Compared to Facility Type

| Geomorphic and Geologic Setting | Total | Facility Type | | |
|---------------------------------|-----------|----------------------|------------|--------------------|
| | | Typical Infiltrating | Underdrain | Large Storage Sump |
| Glaciated Upland | 33 | 15 | 16 | 2 |
| Fill/Unknown | 2 | 1 | | 1 |
| Glaciomarine Drift | 3 | | 2 | 1 |
| Till | 15 | 3 | 12 | |
| Advance Outwash | 12 | 10 | 2 | |
| Fill/Pre-Fraser Silt | 1 | 1 | | |
| Outwash Delta | 1 | | 1 | |
| Recessional Outwash | 1 | | 1 | |
| Outwash Plain | 10 | 10 | | |
| Recessional Outwash | 10 | 8 | | |
| Valley | 6 | 3 | 2 | 1 |
| Recent Alluvium | 6 | 3 | 2 | 1 |
| Grand Total | 50 | 28 | 19 | 3 |

4.3 Infiltration Performance

Controlled facility scale infiltration testing was used to estimate facility performance, and the results ranged from less than 0.1 to greater than 100 inches per hour. Field-based infiltration rates are a function of estimated surface and subsurface ponding areas, water depth and flow rate measurements. A boxplot of facility infiltration rates is presented in Chart 1. Table 3 summarizes facility type, geologic unit and facility infiltration rate minimum, average and maximum.

In the underdrained cells, the bioretention soil is placed over a pipe bedded in a gravel layer situated on either a fine-grained native soil with low infiltration rates, or on an impermeable liner. The bioretention soil is the limiting layer, so the field-based infiltration rate represents the bioretention soil.

For typical infiltrating non-underdrained sites, the field-based infiltration rate can include two components. The initial portion of the infiltration test can be used to estimate the bioretention soil infiltration when there is significant storage beneath the soil. Once the storage is filled, the infiltration rate decreases, and the final portion of the infiltration test reflects the subgrade infiltration rate. However, if the native subgrade soil has a higher infiltration rate than the bioretention soil, then the bioretention soil is the limiting layer, and field rate represents the bioretention soil.

For this study, the native soil was the limiting layer for most of the typical infiltrating sites.

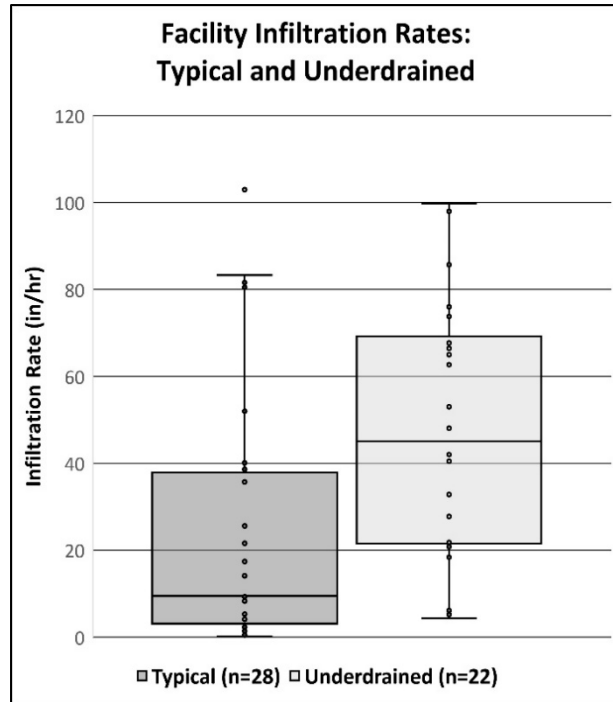


Chart 1. Boxplot of Facility infiltration rates for typical and underdrained facilities. For this plot, facilities with a large storage sump were grouped with underdrained. The plot used an exclusive median.

Table 3. Facility Type, Geologic Unit and Facility Infiltration Rate

| Facility Type and Geologic Unit | Total | Facility Infiltration Rate* | | |
|---|-----------|-----------------------------|-----------------|--------------|
| | | Min (in/hr) | Average (in/hr) | Max (in/hr) |
| Typical Infiltrating (no underdrain) | 26 | 0.1 | 20.0 | 103.0 |
| Advance Outwash | 10 | 1.4 | 11.3 | 40.1 |
| Fill/Unknown | 1 | 17.6 | 17.6 | 17.6 |
| Pre-Fraser Silt | 1 | 5.3 | 5.3 | 5.3 |
| Recent Alluvium | 3 | 8.3 | 21.9 | 35.7 |
| Recessional Outwash | 8 | 2.7 | 39.5 | 103.0 |
| Till | 3 | 0.1 | 0.6 | 1.1 |
| Underdrain | 21 | 4.3 | 48.2 | 99.8 |
| Advance Outwash | 2 | 32.8 | 36.7 | 40.5 |
| Glaciomarine Drift | 2 | 6.1 | 41.1 | 76.0 |
| Recent Alluvium | 2 | 5.2 | 39.5 | 73.8 |
| Recessional Outwash | 3 | 66.5 | 76.2 | 81.6 |
| Till | 12 | 4.3 | 45.8 | 99.8 |
| Large Storage Sump (no underdrain) | 3 | 27.8 | 64.5 | 98.0 |
| Fill/Unknown | 1 | - | 27.8 | - |
| Glaciomarine Drift | 1 | - | 67.7 | - |
| Recent Alluvium | 1 | - | 98.0 | - |
| Grand Total | 50 | 0.1 | 34.5 | 103.0 |

*For underdrained sites and sites with a large storage sump, the facility infiltration rate is controlled by the bioretention soil, not the underlying geologic unit. For typical infiltrating sites, the infiltration rate can be controlled by the underlying geologic unit or the bioretention soil, whichever is the slower draining material.

4.4 Bioretention Cell Surface and Bioretention Soil

4.4.1 Bioretention Cell Surface Condition

Most cells had a layer of either natural mulch or imported mulch across the soil surface. Details on mulch coverage and type are summarized in Table 4. There is some overlap in the percent coverages where both designed (imported) mulch and natural mulch were mixed. Together, the leaf litter and organic material, where present, and mulch, form a layer on the top of the bioretention soil which could potentially influence the behavior of the bioretention cell.

Animal presence indicators (either feces or burrows) were observed in 16 cells, and stinging insects were observed in two cells. Trash was observed in 14 cells.

Table 4. Summary of Mulch and Bare Ground Percent Coverage

| Cell Base Coverage | Designed Mulch | Bare Ground | Natural Mulch |
|--------------------|----------------|-------------|---------------|
| Not Present | 27 | 16 | 27 |
| < 25% | 6 | 14 | 6 |
| 25 - 50% | 4 | 11 | 8 |
| 50 - 75% | 2 | 7 | 15 |
| 75 - 100% | 11 | 2 | 11 |
| Grand Total | 50 | 50 | 50 |

4.4.2 Bioretention Soil

We tested mechanical grain-size distribution and percent organic matter by weight on samples of bioretention soil mix from each site. We also conducted a geotechnical T-probe survey of the facility base to qualitatively assess soil thickness and compaction. Six cells had areas of moderate soil compaction.

Organic matter content and grain size data from laboratory testing data were compared to the Ecology SWMMWW-recommended specifications for 60:40 bioretention soil mix. A summary of averaged organic matter relative to the recommended specification is included in Chart 2.

The gradation or grain size distribution was variable. For infiltration performance, the key gradations are the finer grain sizes represented by the #200, #100 and the #40 sieve sizes and summarized in Table 5. The #200 was within the recommend range for 16 sites. The #100 was within the recommend range for 22 sites. The #40 sieve results were within the recommended range for 18 sites but were the most variable with exceedances on both ends of the range.

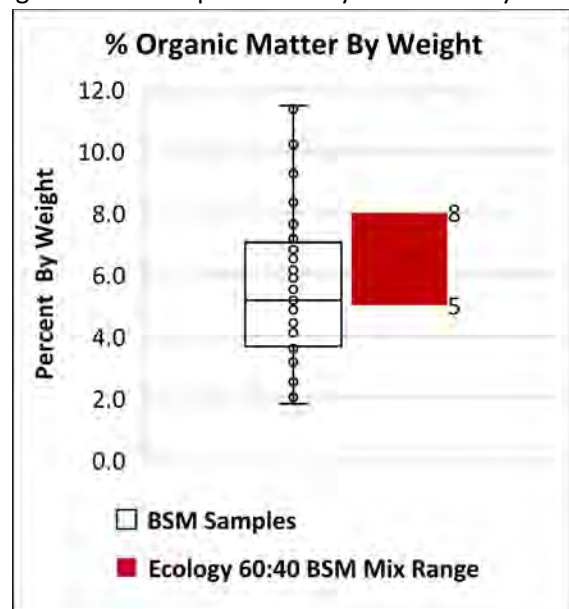


Chart 2: Boxplot of bioretention soil % organic matter by weight. Excludes site ST174 outlier (10.0%)

The uniformity coefficient (Cu) is a numerical expression of the variety in particle sizes in mixed soils. A value of Cu greater than 4 to 6 classifies the soil as well graded. When Cu is less than 4, it is classified as poorly graded or uniformly graded soil. The curvature coefficient (Cc) is estimated using the gradation curve through sieve analysis. When the value Cc is between 1 and 3, the soil is said to be well graded. Most sites had well-graded sands based on Cu. Nearly all sites were at the low-end of the Cc range, near 1, consistent with the mostly sand fraction of the bioretention soil.

Table 5. Summary of Bioretention Soil Gradation Relative to Current Recommended Range

| Bioretention Soil Gradation, Recommended Range | Sites Within Spec | Finer | Coarser | Total |
|--|-------------------|-------|---------|-------|
| #200, 2 to 5% | 16 | 33 | 1 | 50 |
| #100, 4 to 10% | 22 | 28 | 0 | 50 |
| #40, 25-40% | 18 | 25 | 7 | 50 |

Chart 3 illustrates the bioretention soil gradation and Ecology's recommend grain size envelope. Of note, the recommended organic matter content and grain size for the bioretention soil mix has been unchanged since at least 2009 (Washington State University, 2009) but wasn't clearly specified in the Ecology manual at the time of construction for the selected sites. Soil specifications on plans ranged from loose guidelines such as "compost/soil mix" to prescriptive guideline consistent with the current Ecology manual.

The amount of silt/clay-sized particles and fine sand are important for permeability. Too much fine material can slow drainage, too little results in very high infiltration rates. High infiltration rates affect flow control and water quality treatment assumptions and can stress vegetation. Organic matter can increase the water holding capacity of the soil and provides nutrients to aid plant growth. Chart 4 illustrates facility infiltration rate relative to bioretention silt/clay (fines) content. There is a wide band of infiltration rates when fines are low. However, as the fines content increases, there is a clear drop in the infiltration rate.

Summary findings on bioretention soil characteristics:

- Most soil was finer than the current gradation on the silt, fine sand and medium sand fractions.
- Most sites contained more gravel than the current gradation
- 9 sites had 15+% silt/clay
- Wide range of organic matter content, 2 to 29% by weight

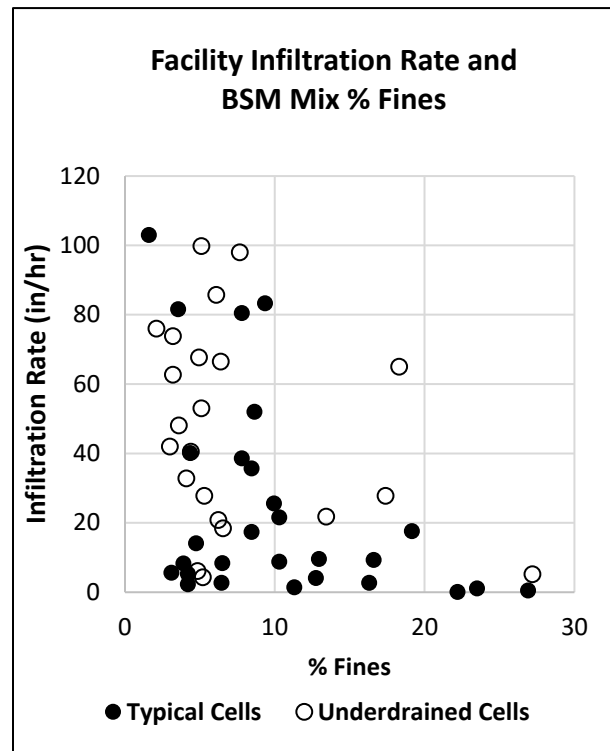
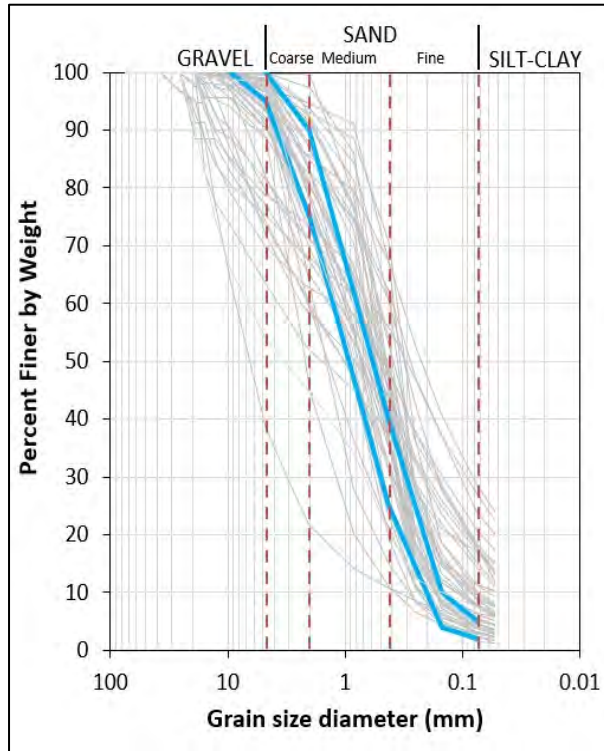


Chart 3 (left). Bioretention soil grain size distribution curve. The light blue lines illustrate the current specification guidelines for the 60:40 bioretention soil mix.

Chart 4 (right). Facility infiltration rate (y-axis) compared to percent fines content (x-axis). Fines content refers to sediment finer than the #200 sieve and consists of silt and clay particles.

5.0 CLOSURE

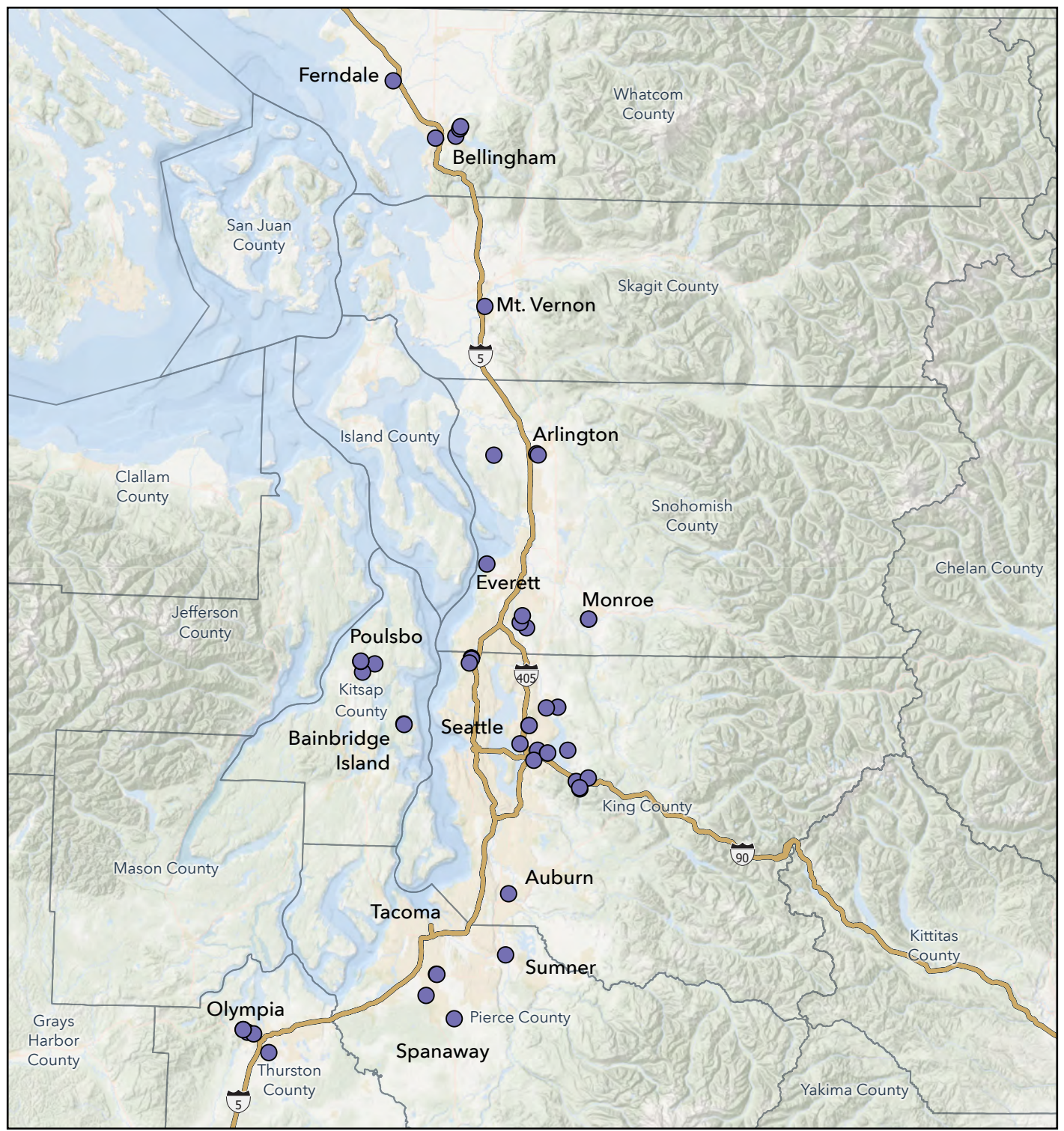
This document provides physical site parameters, and geotechnical and hydrogeologic data that will be combined with other information on vegetation, maintenance and hydrologic design in a future summary report.

We appreciate the opportunity to be of service on this project and hope that this technical memorandum meets your present needs. If you should have any questions, or require further assistance, please do not hesitate to call.

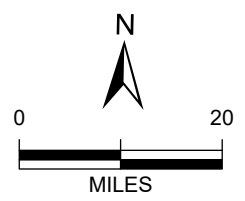
- Attachments:
- Figure 1. Site Locations
 - Appendix A. Summary Tables
 - Appendix B. Site Assessment Forms

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LEGEND
 SITE



SITE LOCATIONS

**LONG-TERM BIORETENTION
PERFORMANCE STUDY**

| | | |
|-----------------------------|--------------|-------------|
| PROJECT NO. 20150387H008 | DATE 4/24 | FIGURE 1 |
|-----------------------------|--------------|-------------|

DATA SOURCES/REFERENCES:
 WADOT STATE ROUTES 24K (12/20). ARCGIS ONLINE BASEMAP:
 ESRI, USGS, NATIONAL GEOGRAPHIC, DELORME, NATURALVUE, I-
 CUBED, GEBCO.

LOCATION AND DISTANCES
SHOWN ARE APPROXIMATE.
 BLACK AND WHITE REPRODUCTION OF
THIS COLOR ORIGINAL MAY REDUCE
ITS EFFECTIVENESS AND LEAD TO
INCORRECT INTERPRETATION.

Appendix A

Summary Tables

APPENDIX A: SUMMARY TABLES

Summary site information is presented in Table 1 to Table 8. Descriptions for each table are included below.

Table 1: Site Information

This table records basic site information such as each site's name, abbreviated site identification code, Jurisdiction, and navigable address. Additional information includes the site land use, assessment date, and construction date which are further explained below.

- Site ID: The abbreviated code used to identify each site.
- Site Land Use: The land use classification for each site. Five land use classifications were included for this study: arterial road, commercial, parkland, residential, school.
- Site Assessment Date: The date of each site's field assessment. The field assessment includes hand auger explorations completed in the cell, one wellpoint installation, infiltration testing, and documentation of cell conditions. When appropriate, hand auger excavation and wellpoint installation were completed prior to the infiltration test. The presented date represents the day of the infiltration test and cell assessment.
- Year Constructed: The year of each site's construction. These dates were recovered from the design plans or private correspondence with the owner.

Table 2: Summary of Infiltration Test Results

This table records the results of infiltration testing from 50 bioretention sites in the Puget Sound region. Infiltration rates are presented in inches per hour and each site's results are interpreted as being representative of either the bioretention or subgrade soil based on the test data. Additional information for individual columns is below.

- Infiltration Test Number: In some cases, multiple infiltration tests were performed within the same cell. Typically, this effort was taken to document infiltration rates at more than one location in the cell if the water source was not strong enough to flood the entire cell. If only one infiltration test was performed in a given cell, the test number is IT-1. At sites where multiple infiltration tests were performed the first test was titled IT-1 and following tests were titled IT-2, IT-3, etc.
- Final Poned Area: The field measured final ponded (wetted) area which is used to calculate the test infiltration rate.
- Total Gallons: Total number of gallons used for each infiltration test.
- Approximate Percent of Cell Area Poned: A visual estimate of the percent of the cell base wetted during infiltration testing.
- Poning Comment: Provides an explanation for sites in which the entire cell base was not filled by the infiltration test.
- Field Based Infiltration Rate: The field-based rate for each infiltration test. Unless otherwise noted, this is the constant head rate for the final hour of inflow.

- **Bioretention Soil Infiltration Rate:** The bioretention soil rate could be calculated for sites where the bioretention soil was the material which controlled vertical infiltration. This was the case for all underdrained sites. For typical sites, this was the case when the subgrade material beneath the cell had a higher hydraulic conductivity than the bioretention soil. This phenomenon was observed when there was a vertical gradient between the relative elevation of the water level measured by the staff gauge on the cell's surface and the water level measured by the wellpoint screened in the subgrade. For typical sites with a slower infiltrating subgrade, the bioretention soil rate was calculated from the initial wetted area.
- **Subgrade Soil Infiltration Rate:** The subgrade soil infiltration rate could be calculated for sites where the subgrade material had a lower hydraulic conductivity and the overlying bioretention soil. This phenomenon was observed when the water level measured by the staff gauge and the water level measured by the wellpoint had the same relative elevation. The subgrade soil infiltration rate could not be calculated for underdrained sites.
- **Facility Performance Rate:** This represents the infiltration rate of the facility, measured by the constant head rate for the final hour of testing, unless otherwise noted.

Table 3: Design Infiltration Rates

This table compares each cell's tested infiltration rate with their designed infiltration rates. Design rates were received for 22/50 sites. Additional information for individual columns is below.

- **Drainage Report Available:** A yes/no designation for whether the drainage report for the site was received.
- **Plans Available:** A yes/no designation for whether the design plans for the site were received.
- **Exceed Design Rate:** A yes/no designation for whether the tested infiltration rate exceeds the designed rate.
- **Basis for design rate:** This column describes where the design rate was located from the design documents received from the site owner.

Table 4: Bioretention Soil

This table records measured parameters of the tested bioretention soil. The presented values are representative of the bioretention soil and exclude outlier samples which may have been collected in the field to document site specific observations such as siltation or scouring. Additional information for individual columns is explained below.

- **Average Bioretention Soil Thickness:** The average measured thickness of the bioretention soil. This number integrates both geotechnical probe depth observations and hand augers completed in the bioretention soil.
- **Organic Matter Content:** The percent by weight organic matter of the bioretention soil using the Ash Content and Organic Material test method (ASTM D-2974).
- **Percent Passing #200 Sieve:** The percent by weight of burned and washed material passing the #200 sieve in accordance with ASTM D-1140 and ASTM D-6913.
- **Percent Passing #100 Sieve:** The percent by weight of burned and washed material passing the #100 sieve in accordance with ASTM D-1140 and ASTM D-6913.

- Percent Passing #40 Sieve: The percent by weight of burned and washed material passing the #40 sieve in accordance with ASTM D-1140 and ASTM D-6913.
- Cc: The coefficient of curvature defined as the ratio of $(D_{30})^2 / (D_{10} \times D_{60})$, where D_{60} , D_{30} , D_{10} are the particle sizes corresponding to the 60, 30, and 10% finer on the cumulative particle-size distribution curve, respectively.
- Cu: The coefficient of uniformity defined as the ratio of D_{60} / D_{10} , where D_{60} and D_{10} are the particle diameters corresponding to 60 and 10% finer on the cumulative particle-size distribution curve, respectively.

Table 5: Bioretention Soil Specifications

This table records the received soil specifications from the owners of each cell and relates the tested material to the design information. Design soil specifications were received from 20/50 sites. For sites where soil specifications were received, the tested material was compared to the specifications. Additional information for individual columns is below.

- Soil Specification Received: This yes/no column references whether design soil specifications were received in the design plans from the site owner. Though design plans were received for almost all sites in the study, the soil specifications were not always included in the delivered plan set.
- Organic Matter Content in Relation to Plans: This column compares each site's organic matter content to the organic matter content specified by the plans. "Exceeds" indicates the site's tested soils contained more organic matter than the plans specified. "Below" indicates the site's tested soils contained less organic matter content than the plans specified. "Meets" indicates the site's tested soils met the organic matter content specified by the plans.
- Sand Gradation in Relation to Plans: This column compares each site's tested sand gradation in relation to the gradation specified by the plans. "Finer" indicates the tested soil gradation was generally finer than the planned gradation. "Coarser" indicates the tested soil gradation was generally coarser than the planned gradation. "Meets" indicates that the tested soil gradation generally met the planned gradation.
- Fines Content in Relation to Plans: This column compares each site's tested fines content (% passing the #200 sieve) in relation to the fines content specified by the plans. "Exceeds" indicates that the soil's tested fines content exceeded the amount specified by the plans. "Below" indicates that the soil's tested fines content is less than the amount specified by the plans. "Meets" indicates that the soil's tested fines content meets the amount specified by the plans.
- Soil Guidance: The description of the soil guidance received in the design plans.
- Consistency Column: This column relates the soil guidance provided in the plans to existing soil standards such as the Ecology Stormwater Manual, Hinman's 2009 technical report, or known aggregate gradations.

Table 6: Geology, Geomorphology and Groundwater Setting

This table summarized the subgrade geologic and groundwater conditions for each site. These conditions were evaluated from hand augers completed in the cell base, accompanying geotechnical reports, regional geologic and soils mapping, regional groundwater publications, and our experience in the site vicinity. Additional information for individual columns is below.

- **Geologic Setting:** The geologic setting for each site either encountered in hand augers or interpreted from geologic maps.
- **Geomorphic Position:** The relative geomorphic position of each site in relation to its glacial setting.
- **Observed Groundwater during Testing:** The presence or absence of groundwater encountered in hand auger completions within the cell.
- **Groundwater Setting:** The groundwater setting for each site, classified as either shallow, moderate, or perched.

Table 7: Built Conditions

This table records field observations of built conditions for each site. Additional information for individual columns is below.

- **Underdrain:** A yes/no designation for whether the bioretention cell is constructed above an underdrain. An underdrain is generally understood to be a perforated pipe set in imported clean, loose, gravels which conveys water out of the cell. Several sites are designated “sump” which is the presence of a thick gravel layer underneath the bioretention soil but without the perforated pipe.
- **Built Per Plan:** A yes/no designation for whether the cell was observed to be constructed in general accordance with the plans. Variations from the plans include non-design overflows, lateral seepages, incorrect bioretention soil placement or soil modifications, incorrect underdrain structure, leaky catch basins, and obvious elevation variations (no level survey performed). “N/A” is noted for cells with design plans we did not receive.
- **Leaky Catch Basin:** A yes/no designation for sites whose catch basins were observed to leak below the overflow grate. N/A indicates no catch basin present.
- **Sheet Flow:** A yes/no designation for whether or not sheet flow was observed as a type of inlet at site. Sheet flow is understood to be uncontrolled runoff into the cell not confined by a curb cut or pipe.
- **Number of Inlets:** The total number of inlets observed at each site.
- **Number of Inlets with Erosion:** The total number of inlets at each site that were observed to be causing erosion within the bioretention soil.
- **Number of Inlets with Blockages:** The total number of inlets at each site that were observed to contain blockages.
- **Only Sheet Inflow:** A yes/no designation for whether the site only received stormwater from sheet flow.
- **Only Piped Inflow:** A yes/no designation for whether the site only received stormwater from a pipe(s).
- **Number of Overflow Structures:** The total number of overflow structures at each site.
- **Non-Engineered Overflows:** A yes/no designation for whether a non-engineered overflow is present at the site. Non-Engineered overflows are understood to be water which exits the bioretention facility through a non-design method and does not infiltrate into the ground.

Table 8: Cell Surface Coverage and Miscellaneous Field Observations

This table documents the surface cover of each cell and additional miscellaneous field observations. Additional information for individual columns is below.

- Percent of Cell Coverage Design Mulch: A visually observed estimate of the percent of the cell base which is covered in designed mulch. Designed mulch is understood to be woody bark or other surface cover which was installed as an intentional mulch layer and is not developed naturally from twig droppings or other coarse organic debris falling into the cell.
- Percent of Cell Coverage Bare Ground: A visually observed estimate of the percent of the cell base which is exposed bare ground. Bare ground is understood to be exposed bioretention soil with no mulch, natural or designed, covering it.
- Percent of Cell Coverage Natural Mulch: A visually observed estimate of the percent of the cell base which is covered in natural mulch. Natural mulch is understood to be a mulch layer not intentionally placed and which has developed over time due to twig droppings, leaf decay, or other coarse organic debris falling into the cell.
- Animal Presence (Feces, Burrows, Stinging Insects): A yes/no designation for whether the presence of animals through feces, burrows, or stinging insects was observed at the site.
- Trash Observed: A yes/no designation for whether trash or litter was observed within the bioretention facility.
- Irrigation: A yes/no designation for whether irrigation was observed at the site. Irrigation did not have to be active while field representatives were onsite for its existence to be documented. Sprinklers and exposed water lines are understood to be evidence of onsite irrigation.
- Irrigation Status: The status of each cell's irrigation lines. N/A indicates that no irrigation was observed at the site. Active indicates that irrigation was observed to be operational. Abandoned indicates that the irrigation was observed to not be operational. Unknown indicates that field representatives were unable to discern the current status of the irrigation.

| Site ID | Site Name | Jurisdiction | Address | Site Land Use | Site Assessment Date | Date Constructed |
|---------|---|-------------------|---|---------------|----------------------|------------------|
| AR51-N | Airport Boulevard (51st Avenue) Cell 2 (North) {Lot 10} | Arlington | 4701 Airport Blvd, Arlington, WA 98223 | Arterial Road | 9/19/2023 | 2009 |
| AR51-S | Airport Boulevard (51st Avenue) Cell 1 (South) {Lot 2} | Arlington | 17713 48th Dr NE, Arlington, WA 98223 | Arterial Road | 10/9/2023 | 2009 |
| AUPQ | Pick Quick (Basin C) | Auburn | 1132 Auburn Way N, Auburn, WA 98002 | Commercial | 8/10/2023 | 2011 |
| BHBD | Bloedel Donovan Park | Bellingham | 2144 Electric Ave, Bellingham, WA 98229 | Parkland | 7/5/2023 | 2003 |
| BHCH | Bellingham City Hall | Bellingham | 210 Lottie St., Bellingham, WA 98225 | Commercial | 6/29/2023 | 2003 |
| BHLA | Lahti Drive (Bioinfiltration Swale) | Whatcom County | 1495 Lahti Dr., Bellingham, WA 98226 | Arterial Road | 10/3/2023 | 2011 |
| BHWT | West Tributary (Brownsville Drive) | Whatcom County | 3797 Brownsville Dr., Bellingham, WA 98226 | Residential | 10/4/2023 | 2013 |
| BIHS-2 | Bainbridge Island High School-Type 2 (Roof Cell) | Bainbridge Island | 9330 High School Rd NE, Bainbridge Island, WA 98110 | School | 8/15/2023 | 2009 |
| BIHS-5 | Bainbridge Island High School-Type 5 (Tennis Cell) | Bainbridge Island | 9330 High School Rd NE, Bainbridge Island, WA 98110 | School | 8/16/2023 | 2009 |
| BO25 | 25th Avenue (Site 7A) | Snohomish County | 16403 25th Ave SE, Bothell, WA 98012 | Residential | 9/14/2023 | 2011 |
| BO35G | 35th and Grannis (Raingarden #2) | Snohomish County | 18901 34th Dr SE, Bothell, WA 98012 | Residential | 9/15/2023 | 2012 |
| BOBB | Brook Boulevard (Site 2E) | Snohomish County | 17813 Brook Blvd, Bothell, WA 98012 | Residential | 9/18/2023 | 2012 |
| BV145 | 145th Pl (Raingarden #2) | Bellevue | 1880 145th Pl SE, Bellevue, WA 98007 | Arterial Road | 6/28/2023 | 2011 |
| BVCC-1 | Cherry Crest Elementary-Rain Garden #1 | Bellevue | 12400 NE 32nd st, Bellevue, WA 98005 | School | 8/1/2023 | 2012 |
| BVCC-2 | Cherry Crest Elementary-Rain Garden #2 | Bellevue | 12400 NE 32nd st, Bellevue, WA 98005 | School | 8/17/2023 | 2012 |
| BVHS | Bellevue High School | Bellevue | 10416 SE Wolverine Way, Bellevue, WA 98004 | School | 7/27/2023 | 2013 |
| BVSE-1 | Spiritridge Elementary-Raingarden #1 | Bellevue | 16401 SE 24th St, Bellevue, WA 98008 | School | 7/28/2023 | 2011 |
| BVSE-2 | Spiritridge Elementary-Raingarden #2 | Bellevue | 16401 SE 24th St, Bellevue, WA 98008 | School | 8/14/2023 | 2011 |
| BVTM | Tyee Middle School (Bioretention Pond A) | Bellevue | 13630 SE Allen Rd, Bellevue, WA 98006 | School | 8/8/2023 | 2012 |
| FDTM | Thornton and Maureen | Ferndale | 2268 Thornton St, Ferndale, WA 98248 | Residential | 7/25/2023 | 2013 |
| ISCP | Central Park Pad 3 (Raingarden) | Issaquah | 1907 NE Park Dr, Issaquah, WA 98029 | School | 9/11/2023 | 2011 |

| | | | | | | |
|---------|--|--------------|--|---------------|------------|------|
| ISHS-1 | Issaquah High School-Cell #1 | Issaquah | 700 2nd Ave SE, Issaquah, WA 98027 | School | 9/12/2023 | 2010 |
| ISHS-24 | Issaquah High School-Cell #24 | Issaquah | 700 2nd Ave SE, Issaquah, WA 98027 | Parkland | 9/6/2023 | 2010 |
| ISRB | Rainier Boulevard | Issaquah | 545 Rainier Blvd N, Issaquah, WA 98027 | Arterial Road | 9/5/2023 | 2007 |
| MKRH | Rosehill Community Center (North Rain Garden) | Mukilteo | 304 Lincoln Ave, Mukilteo, WA 98275 | Commercial | 5/26/2023 | 2009 |
| MOBR | Baron Residence (Plat 2) | Monroe | 16875 Tester Rd., Monroe, WA 98272 | Residential | 8/29/2023 | 2005 |
| MOMR | Manry Residence (Plat 3) | Monroe | 16863 Tester Road, Monroe, WA 98272 | Residential | 8/30/2023 | 2005 |
| MVDB | David Brookings Rain Garden (1800 Continental Pl.) | Mount Vernon | 1800 Continental Place, Mount Vernon, WA 98273 | Commercial | 5/23/2023 | 2009 |
| OL420 | 420 McPhee | Olympia | 420 McPhee Rd SW, Olympia, WA 98502 | Commercial | 9/20/2023 | 2013 |
| OL436 | 436 McPhee | Olympia | 420 McPhee Rd SW, Olympia, WA 98502 | Commercial | 9/21/2023 | 2005 |
| OLDE | Decatur (Rain Garden) | Olympia | 1015 Decatur St SW, Olympia, WA 98502 | Residential | 6/5/2023 | 2008 |
| OLYA | Yauger Park | Olympia | 3100 Capital Mall Dr. SW, Olympia, WA 98502 | Parkland | 6/1/2023 | 2009 |
| OLYE | Yelm Highway | Olympia | 4520 Henderson Blvd SE, Olympia, WA 98501 | Arterial Road | 6/14/2023 | 2010 |
| PUNR | Noll Road Roundabout (Bioretention Cell) | Poulsbo | 204060 Noll Rd NE, Poulsbo, WA 98370 | Arterial Road | 6/20/2023 | 2012 |
| PUVI-4 | Viking Avenue BioCell 4 (Lower) | Poulsbo | 21056 Viking Ave NW, Poulsbo, WA 98370 | Arterial Road | 6/23/2023 | 2009 |
| PUVI-1 | Viking Avenue BioCell 1 (Upper) | Poulsbo | 21056 Viking Ave NW, Poulsbo, WA 98370 | Arterial Road | 6/22/2023 | 2009 |
| PUWA | Waterfront Park (Anderson Parkway) | Poulsbo | 18809 Anderson Pkwy NE, Poulsbo, WA 98370 | Commercial | 6/21/2023 | 2012 |
| RD185 | 185th (Bioretention Swale #3) | Redmond | 18500 185th Ave NE, Redmond, WA 98952 | Arterial Road | 7/13/2023 | 2010 |
| RDDP | Downtown Park | Redmond | 16101 NE Redmond Way, Redmond, WA 98952 | Commercial | 7/20/2023 | 2013 |
| SACR | Creekside Elementary {Rain Garden} | Sammamish | 20777 SE 16th St, Sammamish, WA 98075 | School | 9/7/2023 | 2010 |
| SHAS-1 | Ashworth Avenue-Cell 1 (18824) | Shoreline | 18824 Ashworth Ave N, Shoreline, WA 98133 | Residential | 9/27/2023 | 2011 |
| SHAS-2 | Ashworth Avenue-Cell 2 (18834) | Shoreline | 18834 Ashworth Ave N, Shoreline, WA 98133 | Residential | 9/27/2023 | 2011 |
| SHAS-3 | Ashworth Avenue-Cell 3 (18538) | Shoreline | 18538 Ashworth Ave N, Shoreline, WA 98133 | Residential | 10/10/2023 | 2011 |

| | | | | | | |
|--------|--|------------------|--|---------------|-----------|------|
| SHAU | Aurora Avenue (Rain Garden Swale DR10-9) | Shoreline | 17525 Aurora Ave N, Shoreline, WA, 98133 | Arterial Road | 9/29/2023 | 2009 |
| SMDR | Sumner Neighborhood (Dunn Residence) | Sumner | 6022 153rd Ave Ct E, Sumner, WA 98390 | Residential | 9/25/2023 | 2004 |
| SPCM | Central Maintenance Facility | Pierce County | 4812 196th St E, Spanaway , WA 98387 | Commercial | 7/18/2023 | 2008 |
| SPSP | Spanaway Park (Bioretention Area B) | Pierce County | 14905 Bresemann Blvd S, Spanaway, WA 98387 | Parkland | 8/24/2023 | 2013 |
| ST174 | 174th Cul de Sac | Snohomish County | 4216 174th Pl NW, Stanwood, WA 98292 | Residential | 10/5/2023 | 2012 |
| TAWG-1 | Woods at Golden Given (Cell 1) | Pierce County | 10506 10th Ave E, Tacoma, WA 98445 | Residential | 8/22/2023 | 2012 |
| TAWG-7 | Woods at Golden Given (Cell 7) | Pierce County | 10506 10th Ave E, Tacoma, WA 98445 | Residential | 8/22/2023 | 2012 |

| Site ID | Infiltration Test Number | Final Poned Area (ft^2) | Total Gallons | Approximate Percent of Cell Area Poned | Ponding Comment | Field Based Infiltration Rate (in/hr) | Bioretention Soil Infiltration Rate (in/hr) | Subgrade Soil Infiltration Rate (in/hr) | Facility Performance Rate (in/hr) |
|---------|--------------------------|-------------------------|---------------|--|---------------------------------------|---------------------------------------|---|---|-----------------------------------|
| AR51-N | IT-1 | 88 | 18,464 | Full | | 52 | 52 | 111 | 52 |
| AR51-S | IT-1 | 116 | 41,531 | 25-50% | High infiltration rate soils | 83.3 | 83.3 | 104 | 83.3 |
| AUPQ | IT-1 | 210 | 28,088 | 50-75% | Sloped Facility | 35.7 | 35.7 | - | 35.7 |
| BHBD | IT-1 | 5 | 725 | <10% | Limited obtainable flow | 94.1 | 98 | - | 98 |
| BHBD | IT-2 | 5 | 588 | <10% | Limited obtainable flow | 101.6 | | | |
| BHBD | IT-3 | 3 | 581 | <10% | Limited obtainable flow | 162.6 | | | |
| BHCH | IT-1 | 38 | 1,436 | 10-25% | Limited obtainable flow | 22 | 67.7 | - | 67.7 |
| BHCH | IT-2 | 12 | 1,762 | 10-25% | Limited obtainable flow | 67.7 | | | |
| BHLA | IT-1 | 66 | 3,089 | <10% | Limited obtainable flow | 43.2 | 42 | - | 42 |
| BHLA | IT-2 | 75 | 3,839 | <10% | Limited obtainable flow | 38.6 | | | |
| BHLA | IT-3 | 63 | 3,883 | <10% | Limited obtainable flow | 46.3 | | | |
| BHWT | IT-1 | 31 | 3,896 | <10% | Limited obtainable flow | 76 | 76 | - | 76 |
| BHWT | IT-2 | 106 | 3,813 | <10% | Limited obtainable flow | 22.3 | | | |
| BIHS-2 | IT-1 | 19 | 1,937 | <10% | Limited obtainable flow | 27.8 | 27.8 | - | 27.8 |
| BIHS-5 | IT-1 | 36 | 1,158 | <10% | Limited obtainable flow | 17.4 | | | 85.7 |
| BIHS-5 | IT-2 | 7 | 1,122 | <10% | Limited obtainable flow | 85.7 | 85.7 | - | |
| BO25 | IT-1 | 50 | 10,766 | Full | | 40.1 | >40.1 | 40.1 | 40.1 |
| BO35G | IT-1 | 369 | 9,091 | Full | | 2.7 | 27.7 | 2.7 | 2.7 |
| BOBB | IT-1 | 205 | 24,214 | Full | | 32.8 | 32.8 | - | 32.8 |
| BV145 | IT-1 | 294 | 46,948 | Full | | 40.5 | 40.5 | - | 40.5 |
| BVCC-1 | IT-1 | 751 | 24,477 | Full | | 5.6 | >5.6 | 5.6 | 5.6 |
| BVCC-2 | IT-1 | 119 | 16,855 | 25-50% | Lateral flow | 14.1 | >14.1 | 14.1 | 14.1 |
| BVHS | IT-1 | 175 | 17,654 | <10% | High infiltration rate soils | 53.6 | 53 | - | 53 |
| BVHS | IT-2 | 176 | 15,938 | <10% | High infiltration rate soils | 52.1 | | | |
| BVSE-1 | IT-1 | 1905 | 37,017 | Full | | 2.3 | 28.9 | 2.3 | 2.3 |
| BVSE-2 | IT-1 | 1014 | 19,413 | Full | | 1.4 | >1.4 | 1.4 | 1.4 |
| BVTM | IT-1 | 153 | 40,194 | <10% | High infiltration rate soils | 62.7 | 62.7 | - | 62.7 |
| FDTM | IT-1 | 905 | 22,512 | Full | | 6.1 | 6.1 | - | 6.1 |
| ISCP | IT-1 | 129 | 60,333 | <10% | Limited obtainable flow | 18.4 | 18.4 | - | 18.4 |
| ISHS-1 | IT-1 | 127 | 39,052 | 10-25% | High infiltration rate soils | 81.6 | 81.6 | >81.6 | 81.6 |
| ISHS-24 | IT-1 | 188 | 7,589 | 10-25% | High infiltration rate soils | 80.5 | 80.5 | 67 | 80.5 |
| ISRB | IT-1 | 33 | 6,701 | 10-25% | Lateral flow | 21.6 | 21.6 | - | 21.6 |
| MKRH | IT-1 | 979 | 35,524 | Full | | 5.3 | >1000 | - | 5.3 |
| MOBR | IT-1 | 281 | 3,621 | Full | | 1.1 | - | 1.1 | 1.1 |
| MOMR | IT-1 | 193 | 6,275 | 25-50% | Lateral flow | 0.5 | - | 0.5 | 0.5 |
| MVDB | IT-1 | 144 | 8,329 | 25-50% | Leaky catch basin | 8.3 | - | 8.3 | 8.3 |
| OL420 | IT-1 | 490 | 27,735 | Full | | 9.3 | 9.3 | >9.3 | 9.3 |
| OL436 | IT-1 | 245 | 14,403 | 50-75% | Sloped facility and equalization pond | 9.6 | 9.6 | >9.6 | 9.6 |
| OLDE | IT-1 | 14 | 3,300 | <10% | Limited obtainable flow | 65 | 65 | - | 65 |
| OLYA | IT-1 | 275 | 2,935 | Full | | 2.7 | >2.7 | 2.7 | 2.7 |
| OLYE | IT-1 | 402 | 29,512 | Full | | 17.4 | >17.4 | 17.4 | 17.4 |
| PUNR | IT-1 | 143 | 44,799 | 10-25% | High infiltration rate soils | 99.8 | 99.8 | - | 99.8 |
| PUVI-1 | IT-1 | 54 | 1,322 | 10-25% | Sloped facility | 4.3 | 4.3 | - | 4.3 |
| PUVI-4 | IT-1 | 91 | 6,954 | Full | | 20.8 | 20.8 | - | 20.8 |
| PUWA | IT-1 | 31 | 5,670 | <10% | Limited obtainable flow | 48.1 | 48.1 | - | 48.1 |
| RD185 | IT-1 | 213 | 53,706 | 10-25% | High infiltration rate soils | 66.5 | 66.5 | - | 66.5 |
| RDDP | IT-1 | 127 | 31,889 | Full | | 73.8 | 73.8 | - | 73.8 |
| SACR | IT-1 | 451 | 35,474 | 50-75% | High infiltration rate soils | 21.8 | 21.8 | - | 21.8 |
| SHAS-1 | IT-1 | 162 | 3,410 | Full | | 8.8 | 20.5 | 8.8 | 8.8 |
| SHAS-2 | IT-1 | 27 | 8,578 | Full | | 25.6 | >25.6 | 25.6 | 25.6 |
| SHAS-3 | IT-1 | 147 | 1,986 | 50-75% | Sloped facility | 6.3 | >4.1 | 4.1 | 4.1 |
| SHAS-3 | IT-2 | 157 | 1,918 | 50-75% | Sloped facility | 4.1 | | | |
| SHAU | IT-1 | 369 | 16,940 | 50-75% | Leaky catch basin | 8.4 | >8.4 | 8.4 | 8.4 |
| SMDR | IT-1 | 491 | 11,021 | 50-75% | Sloped facility | 5.2 | 5.2 | - | 5.2 |

| | | | | | | | | | |
|--------|------|-----|-----------|--------|-------------------------|------|------|-------|------|
| SPCM | IT-1 | 155 | 11,398 | Full | | 38.6 | 38.6 | >38.6 | 38.6 |
| SPCM | IT-2 | 229 | 11,048 | Full | | 25 | | | |
| SPSP | IT-1 | 6 | 2,397 | <10% | Limited obtainable flow | 103 | 103 | >103 | 103 |
| ST174 | IT-1 | 54 | 3,685 | 50-75% | Limited obtainable flow | 17.6 | 39 | 17.6 | 17.6 |
| TAWG-1 | IT-1 | 204 | 23,119 | Full | | 27.8 | 27.8 | 0.2 | 27.8 |
| TAWG-7 | IT-1 | 244 | Pond full | Full | | 0.1 | - | 0.1 | 0.1 |

*Field based infiltration rate is derived from the constant head rate except for: TAWG-7 IT-1, ISRB IT-1, MOMR-IT-1

**Sites which may have a lateral flow component: ST-174, MKRH, MOMR, ISRB

| Site ID | Bioretention Soil Infiltration Rate (in/hr) | Subgrade Soil Infiltration Rate (in/hr) | Facility Performance Rate (in/hr) | Drainage Report Available | Plans Available | Bioretention Soil Design Infiltration Rate (in/hr) | Native Soil Design Infiltration Rate (in/hr) | Exceed design rate? | Basis For Design Rate |
|---------|---|---|-----------------------------------|---------------------------|-----------------|--|--|---------------------|---|
| AR51-N | 52 | 111 | 52 | Yes | Yes | - | 2.5 | Yes | Conservative assignment |
| AR51-S | 83.3 | 104 | 83.3 | Yes | Yes | - | 2.5 | Yes | Conservative assignment |
| AUPQ | 35.7 | - | 35.7 | Yes | Yes | 2 | 1 | Yes | Native Soil: Geotechnical Report / Bioretention Soil: Assumed Rate |
| BHBD | 98 | - | 98 | No | Yes | - | 0.5 | Yes | Hand Auger borehole falling head |
| BHCH | 67.7 | - | 67.7 | No | Yes | - | - | - | |
| BHLA | 42 | - | 42 | Yes | Yes | 6 | 0 | Yes | Native Soil: Assumed Rate (no infiltration) / Bioretention Soil: Adjacent Bioretention Soil Infiltration Test |
| BHWT | 76 | - | 76 | Yes | Yes | 3.2 | 0 | Yes | Adjusted infiltration rate from Clear Creek Solutions based on 24" of bioretention soil with an assumed rate of 2.4 in/hr when 18" of biosoils placed per DOE 2005. |
| BIHS-2 | 27.8 | - | 27.8 | Yes | Yes | 1 | 0 | Yes | Native Soil: Assumed Rate (No infiltration) / Bioretention Soil: Assumed Rate |
| BIHS-5 | 85.7 | - | 85.7 | Yes | Yes | 1 | 0 | Yes | Native Soil: Assumed Rate (No infiltration) / Bioretention Soil: Assumed Rate |
| BO25 | >40.1 | 40.1 | 40.1 | No | Yes | - | - | - | |
| BO35G | 27.7 | 2.7 | 2.7 | No | Yes | - | - | - | |
| BOBB | 32.8 | - | 32.8 | No | Yes | - | - | - | |
| BV145 | 40.5 | - | 40.5 | Yes | Yes | - | 1.3 | Yes | Pit Test |
| BVCC-1 | >5.6 | 5.6 | 5.6 | No | Yes | - | 2 | Yes | Grain Size Distribution |
| BVCC-2 | >14.1 | 14.1 | 14.1 | No | Yes | - | 2 | Yes | Grain Size Distribution |
| BVHS | 53 | - | 53 | Yes | Yes | - | - | - | |
| BVSE-1 | 28.9 | 2.3 | 2.3 | Yes | Yes | 1 | 0.25 | Yes | Geotechnical Report |
| BVSE-2 | >1.4 | 1.4 | 1.4 | Yes | Yes | 1 | 0.25 | Yes | Geotechnical Report |
| BVTM | 62.7 | - | 62.7 | Yes | Yes | 1 | - | Yes | Assumed Rate |
| FDTM | 6.1 | - | 6.1 | No | Yes | - | - | - | |
| ISCP | 18.4 | - | 18.4 | No | Yes | - | - | - | |
| ISHS-1 | 81.6 | >81.6 | 81.6 | No | Yes | 1 | 13 | Yes | Geotechnical Report |
| ISHS-24 | 80.5 | 67 | 80.5 | No | Yes | 1 | 13 | Yes | Geotechnical Report |
| ISRB | 21.6 | - | 21.6 | No | Yes | - | - | - | |
| MKRH | >1000 | - | 5.3 | Yes | No | - | 0.8 | Yes | Grain Size Distribution |
| MOBR | - | 1.1 | 1.1 | Yes | Yes | - | - | - | |

| | | | | | | | | | |
|--------|-------|-------|------|-----|-----|---|------|-----|--|
| MOMR | - | 0.5 | 0.5 | Yes | Yes | - | - | - | |
| MVDB | - | 8.3 | 8.3 | No | Yes | - | - | - | |
| OL420 | 9.3 | >9.3 | 9.3 | No | Yes | - | - | - | |
| OL436 | 9.6 | >9.6 | 9.6 | No | Yes | - | - | - | |
| OLDE | 65 | - | 65 | No | Yes | - | - | - | |
| OLYA | >2.7 | 2.7 | 2.7 | No | Yes | - | - | - | |
| OLYE | >17.4 | 17.4 | 17.4 | No | Yes | - | - | - | |
| PUNR | 99.8 | - | 99.8 | Yes | Yes | 4 | 0.5 | Yes | Native Soil: Assumed Rate / Bioretention Soil: Assigned Rate |
| PUVI-1 | 4.3 | - | 4.3 | Yes | Yes | 2 | 0.5 | Yes | Native Soil: Grain Size / Bioretention Soil: Assigned Rate |
| PUVI-4 | 20.8 | - | 20.8 | Yes | Yes | 2 | 0.5 | Yes | Native Soil: Grain Size / Bioretention Soil: Assigned Rate |
| PUWA | 48.1 | - | 48.1 | No | Yes | - | - | - | |
| RD185 | 66.5 | - | 66.5 | No | Yes | - | - | - | |
| RDDP | 73.8 | - | 73.8 | No | Yes | - | - | - | |
| SACR | 21.8 | - | 21.8 | No | No | - | - | - | |
| SHAS-1 | 20.5 | 8.8 | 8.8 | No | Yes | - | - | - | |
| SHAS-2 | >25.6 | 25.6 | 25.6 | No | Yes | - | - | - | |
| SHAS-3 | >4.1 | 4.1 | 4.1 | No | Yes | - | - | - | |
| SHAU | >8.4 | 8.4 | 8.4 | No | Yes | - | - | - | |
| SMDR | 5.2 | - | 5.2 | No | Yes | - | - | - | |
| SPCM | 38.6 | >38.6 | 38.6 | No | Yes | - | - | - | |
| SPSP | 103 | >103 | 103 | Yes | Yes | 3 | - | Yes | Assigned Rate |
| ST174 | 39 | 17.6 | 17.6 | Yes | Yes | 2 | 0.13 | Yes | Native Soil: Soil Textural Triangle / Bioretention Soil: Assigned Rate |
| TAWG-1 | 27.8 | 0.2 | 27.8 | No | No | - | - | - | |
| TAWG-7 | - | 0.1 | 0.1 | No | No | - | - | - | |

| Site ID | Average Bioretention Soil Thickness | Organic Matter Content | Percent Passing #200 Sieve | Percent Passing #100 Sieve | Percent Passing #40 Sieve | Cc | Cu |
|---------|-------------------------------------|------------------------|----------------------------|----------------------------|---------------------------|-----|------|
| AR51-N | 1.8 | 6.5 | 8.7 | 17.7 | 52.4 | 1.2 | 6.1 |
| AR51-S | 1.8 | 6.8 | 9.4 | 17.5 | 47.7 | 1.2 | 8.2 |
| AUPQ | 0.7 | 11.5 | 8.5 | 13.3 | 26.9 | 2.1 | 11.2 |
| BHBD | 1.4 | 6.9 | 7.7 | 11.8 | 35.5 | 1.5 | 7.1 |
| BHCH | 2.5 | 4.1 | 5.0 | 8.0 | 28.0 | 1.3 | 5.1 |
| BHLA | 1.9 | 3.4 | 3.0 | 5.3 | 31.4 | 1.0 | 3.6 |
| BHWT | 2.1 | 1.8 | 2.1 | 4.2 | 36.5 | 0.9 | 2.7 |
| BIHS-2 | 1.5 | 3.2 | 5.3 | 8.2 | 31.7 | 0.8 | 5.5 |
| BIHS-5 | 1.8 | 3.7 | 6.1 | 9.5 | 35.4 | 0.9 | 6.2 |
| BO25 | 1.4 | 3.8 | 4.4 | 10.5 | 35.3 | 0.8 | 7.7 |
| BO35G | 1.2 | 6.1 | 6.5 | 11.1 | 46.4 | 1.3 | 4.0 |
| BOBB | 1.8 | 3.8 | 4.1 | 9.4 | 30.5 | 1.0 | 7.4 |
| BV145 | 2.1 | 3.3 | 4.4 | 8.3 | 31.0 | 1.0 | 5.6 |
| BVCC-1 | 1.3 | 5.4 | 3.1 | 6.5 | 48.0 | 1.0 | 2.6 |
| BVCC-2 | 1.3 | 5.1 | 4.8 | 9.0 | 47.5 | 1.0 | 3.5 |
| BVHS | 1.3 | 5.9 | 5.1 | 9.7 | 42.7 | 1.2 | 4.0 |
| BVSE-1 | 1.2 | 5.7 | 4.2 | 8.1 | 51.8 | 1.0 | 2.9 |
| BVSE-2 | 1.4 | 3.3 | 11.3 | 15.0 | 60.3 | 1.0 | 3.1 |
| BVTM | 1.4 | 4.4 | 3.2 | 5.7 | 35.8 | 1.0 | 3.0 |
| FDTM | 1.0 | 2.5 | 4.9 | 7.1 | 18.3 | 1.3 | 9.9 |
| ISCP | 2.2 | 7.2 | 6.6 | 11.1 | 36.1 | 0.8 | 8.7 |
| ISHS-1 | 1.5 | 3.6 | 3.6 | 6.4 | 22.2 | 1.0 | 5.6 |
| ISHS-24 | 1.4 | 8.5 | 7.8 | 12.4 | 40.7 | 1.2 | 7.2 |
| ISRB | 1.8 | 11.3 | 10.3 | 15.4 | 47.1 | 1.7 | 8.8 |
| MKRH | 3.5 | 2.6 | 4.2 | 6.0 | 9.3 | 3.5 | 19.6 |
| MOBR | 1.1 | 5.5 | 23.5 | 35.5 | 56.8 | 1.6 | 49.2 |
| MOMR | 1.6 | 9.4 | 26.9 | 40.4 | 69.0 | 1.4 | 16.7 |
| MVDB | 1.6 | 3.6 | 3.9 | 5.7 | 16.0 | 1.4 | 6.6 |
| OL420 | 1.2 | 11.5 | 16.6 | 25.4 | 44.1 | 0.5 | 43.5 |
| OL436 | 1.2 | 10.2 | 13.0 | 20.1 | 34.8 | 0.4 | 91.3 |
| OLDE | 0.6 | 7.4 | 18.3 | 29.4 | 49.8 | 0.8 | 29.4 |
| OLYA | 1.4 | 5.0 | 16.3 | 23.6 | 42.5 | 1.3 | 36.4 |
| OLYE | 1.5 | 7.6 | 8.5 | 13.7 | 68.1 | 1.8 | 3.9 |
| PUNR | 1.3 | 5.0 | 5.1 | 8.4 | 34.3 | 1.3 | 7.8 |
| PUVI-1 | 1.5 | 6.4 | 5.2 | 8.9 | 30.7 | 0.5 | 12.3 |
| PUVI-4 | 1.5 | 2.0 | 6.2 | 9.8 | 32.4 | 0.5 | 13.0 |
| PUWA | 1.5 | 6.7 | 3.6 | 6.2 | 15.4 | 1.4 | 20.0 |
| RD185 | 1.3 | 5.6 | 6.4 | 10.7 | 37.5 | 1.2 | 5.5 |
| RDDP | 1.4 | 3.7 | 3.2 | 5.4 | 20.0 | 1.0 | 4.7 |
| SACR | 1.3 | 3.8 | 13.4 | 24.4 | 71.1 | 1.6 | 6.1 |
| SHAS-1 | 1.8 | 7.3 | 10.3 | 16.7 | 42.5 | 1.5 | 10.8 |
| SHAS-2 | 1.7 | 4.9 | 10.0 | 16.3 | 42.7 | 1.5 | 9.9 |
| SHAS-3 | 1.3 | 8.3 | 12.8 | 19.4 | 41.5 | 2.4 | 16.4 |
| SHAU | 1.9 | 5.2 | 6.5 | 10.9 | 46.3 | 1.0 | 13.1 |
| SMDR | 0.8 | 4.6 | 27.2 | 40.2 | 57.5 | 1.0 | 15.3 |

| | | | | | | | |
|--------|-----|------|------|------|------|-----|------|
| SPCM | 1.3 | 5.2 | 7.8 | 10.3 | 20.9 | 0.6 | 37.8 |
| SPSP | 1.9 | 2.2 | 1.6 | 4.4 | 38.7 | 1.0 | 2.8 |
| ST174 | 1.7 | 29.3 | 19.2 | 30.3 | 61.4 | 1.3 | 10.2 |
| TAWG-1 | 1.1 | 6.5 | 17.4 | 25.0 | 45.8 | 1.2 | 18.5 |
| TAWG-7 | - | 9.3 | 22.2 | 32.1 | 52.5 | 1.3 | 31.2 |

*Soils which have a specified volume of 60% sand, 40% compost mix the assumed organic content by weight is 5-
For soils with a mix of 30-35% compost, 4-7% is assumed
For soils with 20-25% compost, 2-5% is assumed

| Site ID | Soil Specification Received | Organic Matter Content in Relation to Plans* | Sand Gradation in Relation to Plans | Fines Content in Relation to Plans | Soil Guidance | Consistency column (in relation to one another and DOE) |
|---------|-----------------------------|--|-------------------------------------|------------------------------------|--|---|
| AR51-N | No | N/A | N/A | N/A | Design Specification referenced but not available for review. Documents refer to 2005 LID Manual | N/A |
| AR51-S | No | N/A | N/A | N/A | Design Specification referenced but not available for review. Documents refer to 2005 LID Manual | N/A |
| AUPQ | Yes | Meets | Meets | Exceeds | By volume: 10% planting soil mix, 40% grade A compost, 50% C-33 sand | C33 |
| BHBD | Yes | Exceeds | Finer | Exceeds | By volume: 20-25% total organic matter, including 12-18% composted organics, 75-80% sand | 75-25 mix. Sand mix similar to DOE but different on the 200 and 100 and includes more compost |
| BHCH | Yes | Below | Finer | Exceeds | By volume: 20-25% total organic matter, including 12-18% composted organics, 75-80% sand | 75-25 mix. Sand mix similar to DOE but different on the 200 and 100 and includes more compost |
| BHLA | Yes | Below | Meets | Meets | Hinman, 2009; modified as 10% organic matter by weight, <2.5% fines | Hinman, 2009 |
| BHWT | Yes | Below | Meets | Meets | Refers to Lahti Drive specification; 10% organic matter by weight, <2.5% fines | Hinman, 2009 |
| BIHS-2 | No | N/A | N/A | N/A | Design Specification referenced but not available for review. | N/A |
| BIHS-5 | No | N/A | N/A | N/A | Design Specification referenced but not available for review. | N/A |
| BO25 | No | N/A | N/A | N/A | Special provisions referenced but not available for review. | N/A |
| BO35G | No | N/A | N/A | N/A | Planting soil mix (No spec reference) | N/A |
| BOBB | No | N/A | N/A | N/A | Bioretention Soil (No spec reference) | N/A |
| BV145 | Yes | Below | Meets | Meets | 2010 Surface Water Engineering Standards pg. 196 | Hinman, 2009 |
| BVCC-1 | Yes | Below | Finer | Meets | 2012 Surface Water Engineering Standards pg. 210 | Hinman, 2009 |
| BVCC-2 | Yes | Below | Finer | Meets | 2012 Surface Water Engineering Standards pg. 210 | Hinman, 2009 |
| BVHS | Yes | Below | Finer | Exceeds | 2013 Surface Water Engineering Standards pg. 215 | Hinman, 2009 |
| BVSE-1 | Yes | Below | Finer | Meets | 2011 Surface Water Engineering Standards pg. 210 | Hinman, 2009 |
| BVSE-2 | Yes | Below | Finer | Exceeds | 2011 Surface Water Engineering Standards pg. 210 | Hinman, 2009 |
| BVTM | Yes | Below | Meets | Meets | 2010 Surface Water Engineering Standards pg. 196 | Hinman, 2009 |
| FDTM | No | N/A | N/A | N/A | Planting soil mix (No spec reference) | N/A |
| ISCP | No | N/A | N/A | N/A | Rain Garden soil mix (No spec reference) | N/A |
| ISHS-1 | No | N/A | N/A | N/A | Rain garden amended soil (No spec reference) | N/A |
| ISHS-24 | No | N/A | N/A | N/A | Rain garden amended soil (No spec reference) | N/A |
| ISRB | No | N/A | N/A | N/A | Amended soil (vegetable garden mix supplied by Cedar Grove of WA) No Spec Reference | N/A |
| MKRH | No | N/A | N/A | N/A | N/A | N/A |

| | | | | | | |
|--------|-----|---------|---------|---------|---|--|
| MOBR | Yes | Below | Finer | Exceeds | 50-60% C-33 sand, 30% leaf compost, 20-30% topsoil, clay content <5%, minimum compost 10% by weight | C-33 |
| MOMR | Yes | Below | Finer | Exceeds | 50-60% C-33 sand, 30% leaf compost, 20-30% topsoil, clay content <5%, minimum compost 10% by weight | C-33 |
| MVDB | Yes | Below | Meets | Below | 65-70% gravelly sand, 30-35% compost. Fines content 5-15% | Similar to Hinman but with higher fines |
| OL420 | No | N/A | N/A | N/A | Plans state materials should be in accordance with City of Olympia Stormwater Manual which is no longer posted on their website | N/A |
| OL436 | No | N/A | N/A | N/A | Plans state materials should be in accordance with City of Olympia Stormwater Manual which is no longer posted on their website | N/A |
| OLDE | No | N/A | N/A | N/A | Compost Soil Mix (No spec reference) | N/A |
| OLYA | No | N/A | N/A | N/A | 2005 LID Manual used as guidelines, no specific specification reference. | N/A |
| OLYE | No | N/A | N/A | N/A | Amended soil (No specification reference) | N/A |
| PUNR | Yes | Meets | Meets | Meets | 2012 DOE SMWW | 2012 WWSM |
| PUVI-1 | Yes | Meets | Meets | Exceeds | 30-35% composted material, 65-70% gravelly sand | Similar to Hinman, but with a coarser sand mix |
| PUVI-4 | Yes | Below | Meets | Exceeds | 30-35% composted material, 65-70% gravelly sand | Similar to Hinman, but with a coarser sand mix |
| PUWA | Yes | Meets | Coarser | Meets | 2012 WWSM Vol 5 | 2012 WWSM |
| RD185 | No | N/A | N/A | N/A | No spec received | N/A |
| RDDP | No | N/A | N/A | N/A | No spec received | N/A |
| SACR | No | N/A | N/A | N/A | No spec received | N/A |
| SHAS-1 | No | N/A | N/A | N/A | Bioretention Soil (No spec reference) | N/A |
| SHAS-2 | No | N/A | N/A | N/A | Bioretention Soil (No spec reference) | N/A |
| SHAS-3 | No | N/A | N/A | N/A | Bioretention Soil (No spec reference) | N/A |
| SHAU | No | N/A | N/A | N/A | Compost Amended Soil (No spec reference) | N/A |
| SMDR | No | N/A | N/A | N/A | Hydrologic Group B Soil (No spec reference) | N/A |
| SPCM | No | N/A | N/A | N/A | Porous Soil Fill (No spec reference) | N/A |
| SPSP | No | N/A | N/A | N/A | Bioretention Soil (No special provisions provided) | N/A |
| ST174 | Yes | Exceeds | Finer | Exceeds | 2 parts compost, 3 parts mineral aggregate, 8-10% organic matter. Mineral aggregate consistent with 2012 WWSM Specifications. | Hinman, 2009 |
| TAWG-1 | No | N/A | N/A | N/A | No Spec Received | N/A |
| TAWG-7 | No | N/A | N/A | N/A | No Spec Received | N/A |

*Soils which have a specified volume of 60% sand, 40% compost mix the assumed organic content by weight is 5-8%

For soils with a mix of 30-35% compost, 4-7% is assumed

For soils with 20-25% compost, 2-5% is assumed

| Site ID | Geologic Setting | Geomorphic Position | Observed Groundwater During Testing | Groundwater Setting |
|----------------|-------------------------|----------------------------|--|----------------------------|
| AR51-N | Recessional Outwash | Outwash Plain | No | Moderate |
| AR51-S | Recessional Outwash | Outwash Plain | No | Moderate |
| AUPQ | Recent Alluvium | Valley | No | Shallow |
| BHBD | Recent Alluvium | Valley | Yes | Shallow |
| BHCH | Glaciomarine Drift | Glaciated Upland | No | Perched |
| BHLA | Till | Glaciated Upland | No | Perched |
| BHWT | Glaciomarine Drift | Glaciated Upland | No | Perched |
| BIHS-2 | Till | Glaciated Upland | No | Perched |
| BIHS-5 | Till | Glaciated Upland | No | Perched |
| BO25 | Advance Outwash | Glaciated Upland | No | Moderate |
| BO35G | Advance Outwash | Glaciated Upland | No | Moderate |
| BOBB | Advance Outwash | Glaciated Upland | No | Moderate |
| BV145 | Advance Outwash | Glaciated Upland | No | Moderate |
| BVCC-1 | Advance Outwash | Glaciated Upland | No | Moderate |
| BVCC-2 | Advance Outwash | Glaciated Upland | No | Moderate |
| BVHS | Till | Glaciated Upland | No | Perched |
| BVSE-1 | Advance Outwash | Glaciated Upland | No | Moderate |
| BVSE-2 | Advance Outwash | Glaciated Upland | No | Moderate |
| BVTM | Till | Glaciated Upland | No | Perched |
| FDTM | Glaciomarine Drift | Glaciated Upland | No | Perched |
| ISCP | Till | Glaciated Upland | No | Perched |
| ISHS-1 | Recessional Outwash | Outwash Plain | No | Moderate |
| ISHS-24 | Recessional Outwash | Outwash Plain | No | Shallow |
| ISRB | Recent Alluvium | Valley | No | Shallow |
| MKRH | Pre-Fraser Silt | Glaciated Upland | No | Perched |
| MOBR | Till | Glaciated Upland | No | Perched |
| MOMR | Till | Glaciated Upland | No | Perched |
| MVDB | Recent Alluvium | Valley | Yes | Shallow |
| OL420 | Recessional Outwash | Outwash Plain | No | Shallow |
| OL436 | Recessional Outwash | Outwash Plain | No | Shallow |
| OLDE | Till | Glaciated Upland | No | Perched |
| OLYA | Recessional Outwash | Outwash Plain | No | Shallow |
| OLYE | Recessional Outwash | Outwash Plain | No | Shallow |
| PUNR | Till | Glaciated Upland | No | Perched |
| PUVI-4 | Till | Glaciated Upland | No | Perched |
| PUVI-1 | Till | Glaciated Upland | No | Perched |
| PUWA | Till | Glaciated Upland | No | Perched |
| RD185 | Recessional Outwash | Outwash Delta | No | Shallow |
| RDDP | Recent Alluvium | Valley | No | Shallow |

| | | | | |
|--------|---------------------|------------------|-----|----------|
| SACR | Till | Glaciated Upland | No | Perched |
| SHAS-1 | Advance Outwash | Glaciated Upland | No | Moderate |
| SHAS-2 | Advance Outwash | Glaciated Upland | No | Moderate |
| SHAS-3 | Advance Outwash | Glaciated Upland | No | Moderate |
| SHAU | Advance Outwash | Glaciated Upland | No | Moderate |
| SMDR | Recent Alluvium | Valley | Yes | Shallow |
| SPCM | Recessional Outwash | Outwash Plain | No | Shallow |
| SPSP | Recessional Outwash | Outwash Plain | No | Shallow |
| ST174 | Fill/Unknown | Glaciated Upland | No | Perched |
| TAWG-1 | Fill/Unknown | Glaciated Upland | No | Perched |
| TAWG-7 | Till | Glaciated Upland | No | Perched |

| Site ID | Underdrain | Built Per Plan | Leaky Catch Basin | Sheet Flow | Number of Inlets | Number of Inlets with Erosion | Number of Inlets with Blockages | Only Sheet Inflow | Only Piped Inflow | Number of Overflow Structures | Number of Overflow Structures with Blockages |
|---------|------------|----------------|-------------------|------------|------------------|-------------------------------|---------------------------------|-------------------|-------------------|-------------------------------|--|
| AR51-N | No | Yes | N/A | Yes | 5 | 0 | 4 | No | No | 0 | 0 |
| AR51-S | No | Yes | N/A | Yes | 2 | 0 | 1 | No | No | 0 | 0 |
| AUPQ | No | No | No | No | 1 | 0 | 1 | No | Yes | 1 | 0 |
| BHBD | Sump | Yes | N/A | No | 2 | 0 | 2 | No | No | 2 | 0 |
| BHCH | Sump | Yes | N/A | No | 3 | 1 | 2 | No | No | 1 | 0 |
| BHLA | Yes | Yes | No | Yes | 4 | 0 | 4 | No | No | 2 | 0 |
| BHWT | Yes | Yes | No | No | 1 | 0 | 1 | No | Yes | 1 | 0 |
| BIHS-2 | Yes | Yes | No | Yes | 1 | 0 | 0 | No | No | 1 | 1 |
| BIHS-5 | Yes | No | No | Yes | 2 | 0 | 0 | Yes | No | 1 | 0 |
| BO25 | No | Yes | Yes | No | 3 | 0 | 2 | No | No | 1 | 1 |
| BO35G | No | Yes | N/A | No | 2 | 0 | 0 | No | Yes | 1 | 1 |
| BOBB | Yes | Yes | No | No | 2 | 2 | 1 | No | No | 1 | 1 |
| BV145 | Yes | Yes | Yes | No | 1 | 0 | 1 | No | Yes | 1 | 0 |
| BVCC-1 | No | No | No | Yes | 2 | 0 | 2 | No | No | 1 | 1 |
| BVCC-2 | No | No | No | No | 6 | 0 | 2 | No | Yes | 3 | 0 |
| BVHS | Yes | Yes | No | No | 4 | 0 | 1 | No | Yes | 1 | 0 |
| BVSE-1 | No | Yes | Yes | Yes | 5 | 0 | 1 | No | No | 2 | 1 |
| BVSE-2 | No | Yes | Yes | Yes | 3 | 3 | 0 | Yes | No | 1 | 0 |
| BVTM | Yes | Yes | N/A | No | 9 | 1 | 6 | No | No | 1 | 0 |
| FDTM | Yes | No | No | No | 2 | 0 | 2 | No | No | 1 | 0 |
| ISCP | Yes | Yes | No | Yes | 1 | 0 | 0 | Yes | No | 1 | 0 |
| ISHS-1 | No | Yes | No | Yes | 1 | 0 | 0 | Yes | No | 1 | 0 |
| ISHS-24 | No | Yes | No | No | 2 | 0 | 2 | No | Yes | 1 | 0 |
| ISRB | No | No | Yes | No | 2 | 0 | 2 | No | No | 2 | 1 |
| MKRH | No | N/A | Yes | No | 3 | 1 | 2 | No | Yes | 1 | 0 |
| MOBR | No | Yes | N/A | No | 2 | 0 | 0 | No | Yes | 1 | 1 |
| MOMR | No | No | N/A | No | 1 | 0 | 0 | No | Yes | 1 | 1 |
| MVDB | No | Yes | Yes | No | 2 | 0 | 0 | No | Yes | 1 | 0 |
| OL420 | No | Yes | No | Yes | 16 | 6 | 12 | No | No | 1 | 0 |
| OL436 | No | Yes | No | Yes | 2 | 1 | 1 | No | No | 0 | 0 |
| OLDE | Yes | Yes | No | No | 1 | 0 | 1 | No | No | 2 | 0 |
| OLYA | No | Yes | N/A | No | 4 | 4 | 0 | No | No | 0 | 0 |
| OLYE | No | Yes | N/A | No | 4 | 2 | 2 | No | No | 2 | 0 |
| PUNR | Yes | Yes | No | No | 1 | 1 | 1 | No | Yes | 1 | 0 |
| PUVI-1 | Yes | Yes | Yes | Yes | 2 | 1 | 1 | No | No | 1 | 1 |
| PUVI-4 | Yes | Yes | Yes | Yes | 2 | 1 | 1 | No | No | 1 | 0 |
| PUWA | Yes | Yes | No | Yes | 1 | 0 | 0 | Yes | No | 1 | 0 |
| RD185 | Yes | Yes | No | No | 1 | 0 | 1 | No | No | 1 | 0 |

| | | | | | | | | | | | |
|--------|------|-----|-----|-----|---|---|---|-----|-----|---|---|
| RDDP | Yes | Yes | N/A | No | 2 | 0 | 2 | No | No | 0 | 0 |
| SACR | Yes | Yes | No | No | 1 | 0 | 0 | No | Yes | 1 | 0 |
| SHAS-1 | No | Yes | N/A | Yes | 2 | 0 | 2 | No | No | 0 | 0 |
| SHAS-2 | No | Yes | N/A | Yes | 3 | 0 | 1 | No | No | 0 | 0 |
| SHAS-3 | No | No | N/A | Yes | 2 | 0 | 0 | Yes | No | 0 | 0 |
| SHAU | No | Yes | Yes | Yes | 2 | 1 | 0 | No | No | 1 | 0 |
| SMDR | Yes | No | No | Yes | 1 | 1 | 0 | Yes | No | 2 | 0 |
| SPCM | No | Yes | N/A | Yes | 2 | 1 | 1 | Yes | No | 1 | 0 |
| SPSP | No | Yes | N/A | No | 2 | 1 | 0 | No | No | 1 | 0 |
| ST174 | No | Yes | N/A | No | 1 | 0 | 1 | No | Yes | 1 | 1 |
| TAWG-1 | Sump | N/A | N/A | Yes | 1 | 1 | 0 | Yes | No | 2 | 0 |
| TAWG-7 | No | N/A | N/A | Yes | 1 | 0 | 0 | Yes | No | 0 | 0 |

| Site ID | Percent of Cell Coverage Designed Mulch | Percent of Cell Coverage Bare Ground | Percent of Cell Coverage Natural Mulch | Animal Presence (Feces, Burrows, Stinging Insects) | Trash Observed | Irrigation | Irritation Status |
|---------|---|--------------------------------------|--|--|----------------|------------|-------------------|
| AR51-N | None | None | 75 - 100% | No | Yes | No | N/A |
| AR51-S | None | 25 - 50% | 25 - 50% | No | No | No | N/A |
| AUPQ | 75 - 100% | None | None | No | Yes | Yes | Active |
| BHBD | None | < 25% | 75 - 100% | No | No | No | N/A |
| BHCH | 75 - 100% | None | 75 - 100% | No | Yes | No | N/A |
| BHLA | None | None | 75 - 100% | Yes | No | No | N/A |
| BHWT | None | 25 - 50% | 50 - 75% | Yes | No | No | N/A |
| BIHS-5 | None | 75 - 100% | 25 - 50% | No | No | No | N/A |
| BIHS-2 | None | 25 - 50% | 50 - 75% | Yes | Yes | Yes | Unknown |
| BO25 | 25 - 50% | < 25% | 50 - 75% | No | Yes | No | N/A |
| BO35G | < 25% | 25 - 50% | 25 - 50% | No | Yes | No | N/A |
| BOBB | < 25% | < 25% | 50 - 75% | No | No | No | N/A |
| BV145 | None | 25 - 50% | 25 - 50% | Yes | Yes | Yes | Active |
| BVCC-1 | None | 50 - 75% | 25 - 50% | Yes | Yes | Yes | Active |
| BVCC-2 | None | None | 75 - 100% | No | Yes | Yes | Active |
| BVHS | None | 50 - 75% | 50 - 75% | No | No | Yes | Active |
| BVSE-1 | < 25% | < 25% | 50 - 75% | Yes | No | Yes | Active |
| BVSE-2 | None | < 25% | 50 - 75% | Yes | No | Yes | Active |
| BVTM | None | 25 - 50% | 50 - 75% | No | No | Yes | Active |
| FDTM | None | 75 - 100% | < 25% | No | No | No | N/A |
| ISCP | 75 - 100% | None | 75 - 100% | Yes | Yes | No | N/A |
| ISHS-1 | 75 - 100% | None | None | Yes | No | Yes | Unknown |
| ISHS-24 | None | 25 - 50% | 50 - 75% | Yes | Yes | Yes | Unknown |
| ISRB | 75 - 100% | None | < 25% | No | Yes | No | N/A |
| MKRH | 75 - 100% | < 25% | None | No | No | Yes | Active |
| MOBR | None | None | 75 - 100% | No | No | No | N/A |
| MOMR | None | None | 75 - 100% | No | No | No | N/A |
| MVDB | 75 - 100% | < 25% | None | No | No | No | N/A |
| OL420 | None | 50 - 75% | 50 - 75% | No | No | Yes | Abandoned |
| OL436 | None | 50 - 75% | 25 - 50% | No | No | Yes | Active |
| OLDE | None | None | 75 - 100% | Yes | No | Yes | Active |
| OLYA | 25 - 50% | 25 - 50% | < 25% | Yes | No | No | N/A |
| OLYE | None | None | 75 - 100% | No | No | Yes | Active |
| PUNR | None | < 25% | 50 - 75% | Yes | No | Yes | Unknown* |
| PUVI-4 | None | 50 - 75% | 50 - 75% | Yes | No | Yes | Active |
| PUVI-1 | None | 25 - 50% | 50 - 75% | No | No | Yes | Active |
| PUWA | < 25% | < 25% | 50 - 75% | No | Yes | Yes | Active |
| RD185 | 75 - 100% | < 25% | < 25% | Yes | No | Yes | Active |

| | | | | | | | |
|--------|-----------|----------|-----------|-----|-----|-----|-----------|
| RDDP | 50 - 75% | 50 - 75% | None | No | Yes | Yes | Active |
| SACR | 25 - 50% | None | None | No | No | Yes | Active |
| SHAS-1 | 75 - 100% | None | None | No | No | No | N/A |
| SHAS-2 | 25 - 50% | 50 - 75% | None | No | No | No | N/A |
| SHAS-3 | None | 25 - 50% | 25 - 50% | No | Yes | No | N/A |
| SHAU | 50 - 75% | None | 25 - 50% | No | No | No | N/A |
| SMDR | None | None | 75 - 100% | No | No | Yes | Active |
| SPCM | < 25% | < 25% | 75 - 100% | No | No | Yes | Active |
| SPSP | < 25% | 25 - 50% | 75 - 100% | Yes | No | No | N/A |
| ST174 | 75 - 100% | < 25% | None | No | No | No | N/A |
| TAWG-1 | 75 - 100% | < 25% | None | Yes | Yes | Yes | Abandoned |
| TAWG-7 | None | < 25% | 50 - 75% | No | No | No | N/A |

APPENDIX B

Site Assessment Data

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
October 9, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This bioretention cell is one of dozens of bioretention cells, constructed in 2009, which collect stormwater runoff from the adjacent Airport Boulevard/51st Avenue roadway. The cell was designed to be constructed with 18" of bioretention soil above a geotextile filter fabric set above native soils. Water enters the cell through a series of curb cuts with quarry spalls used for energy dissipation. All water is designed to infiltrate into the ground and there are no emergency overflow bypass.

BIORETENTION SOIL:

Thickness: 1.4-2.0

The apparent thickness of bioretention soil based on probe data and hand augers ranged from 1.4-2.0' below the ground surface with an average thickness of 1.7'. Filter fabric was not encountered in any of the 3 hand augers despite being called for in the plans.

Composition: The plans called for the bioretention soil specification to follow the guidance of the 2005 LID manual. The 2005 LID manual provides several different soil mix specifications and therefore the tested material cannot be compared to a specific design mix. In comparison to the 2019 Ecology specification, the tested soil did not meet the recommended guidelines for organic content but had a sand gradation finer than the specified range and exceeded the recommended silt content.

Organic Matter Content (% by weight): 6.5

Percent passing #200 sieve: 8.7

Coefficient of Uniformity (Cu): 6.1

Coefficient of Curvature (Cc): 1.2

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash, Marysville Member

Soil Description: Medium dense, slightly moist, light brown, fine to medium SAND, trace silt, some gravel (SP).

BUILT PER PLAN:

The sides slopes of the cell were observed to be excessively steep causing the bioretention soil to slough off the sidewalls and expose the underlying filter fabric. The filter fabric was not encountered in hand augers conducted throughout the cell base. Otherwise, the cell was constructed to designed specifications.

GROUNDWATER CONDITIONS:

According to the geotechnical report, groundwater was observed to be approximately 10' below ground surface in test pits near the bioretention cell. The wellpoint we installed was screened 3.2-2.4' below ground surface and did not encounter groundwater. The wellpoint responded to infiltration testing and rose to a minimum depth of 1.8' below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 52

Subgrade Soil Rate (in/hr): 111

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
 October 9, 2023



The bioretention soil rate was calculated using constant head results from the final hour of inflow. The subgrade soil rate was calculated using the falling head results from the wellpoint. AESI conducted pit infiltration tests in 2009 within 500 feet of the tested cell and measured an infiltration rate of 99 in/hr. The drainage report states a long-term infiltration rate of the existing native soils as 2.5 in/hr.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Filter fabric placement is not consistent with the design plans and may be eligible for replacement.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------|
| Weather | Overcast 60's | | |
| Recent Rainfall | Today: 0.07" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Evan Paul |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20231009-192239.jpg



Site Photo: FA_SitePhotos-20231009-192308.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
October 9, 2023



Site Photo: FA_SitePhotos-20231009-212130.jpg

Cell Construction

| | |
|---|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | |
| Water is conveyed to the cell through one curb cut inlet and from runoff from the adjacent impervious sidewalk. All water is designed to infiltrate into the ground as there is no overflow structure or underdrain system. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
October 9, 2023



Inlets

IN-1

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Width: 2.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20231009-192612.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
 Trash Vegetation

Additional Details: Grass and soil built up around curb cut inlet. Evidence of ponding along curb due to fines deposition.



FA_INBLPhoto-20231009-192554.jpg

Additional Details: Quarry spalls noted in plans buried by sediment and organic debris.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
 October 9, 2023



| | |
|---|--|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 44.8' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20231009-193041.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Sheet flow from adjacent pedestrian walkway. | |

Cell Surface and Geotech Probe Observations

| | |
|--|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth (ft): |
| Cell Coverage | |
| Mulch | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Natural mulch consists of cut grass and maple leaves. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |
| Vegetation Description | |
| Grasses mown short (<3"), some native shrubs present, but appear regularly cut back, Vegetation does not hinder out work. | |
| Additional Details | |
| Geotech Probe Observations: Soil probes ranged in depth from 1.4' to 2' with an average thickness of 1.7'. Due to steep slopes on the street side of the cell, bioretention soil was observed sloughing into the bottom of the cell and exposing underlying filter fabric. This filter fabric was not observed in hand augers performed in distant areas of the cell and therefore is interpreted to be discontinuous. | |



BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
 October 9, 2023



Hand Auger

| | | |
|---|---|---|
| HA-1WP | |  <p>FA_FPhoto-20231009-210838.jpg</p>  <p>IMG_0724.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | 1.7 | |
| to Import/Underdrain: | | |
| Total Depth: | 2.5 | |
| Rain/Garden Mix Soil Texture: Slightly moist, loose, dark brown, fine to medium SAND, some gravel, some silt, abundant organics (SW-SM). Native Soil Texture: Slightly moist, medium dense, light brown fine to medium SAND, some gravel, trace silt. (SP) | | |
| Liner Present: | Filter Fabric Present: | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 1.8 | | |
| Additional Details | | |

| | |
|---|-----|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.7 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
 October 9, 2023



| | |
|--|---|
| HA-2 | |
| to Import/Underdrain: | |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Sl. Moist, loose, dark brown, f-m SAND, some gravel, some silt, abundant organics (SW-SM). Native Soil Texture: N/A | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |



IMG_0726.jpg

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 2 |
| to Import/Underdrain: | |
| Total Depth: | 2 |
| Rain/Garden Mix Soil Texture: Sl. Moist, loose, dark brown, gravelly f-m SAND, some silt, abundant organics (SP-SM) Native Soil Texture: N/A | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |



IMG_0730.jpg

Infiltration Test

| | |
|--|--|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
October 9, 2023



| | |
|------------------------------|--------|
| AESI Meter# FM-4 (3-50) | |
| Wetted Pond Area (sq. ft) | 83 |
| Ponded Depth (ft) | 0.6 |
| Total Gallons | 18,464 |
| Steady State Flow Rate (GPM) | 45 |

Additional Details:



IT_Photo-20231009-211346.jpg



IT_Photo-20231009-211359.jpg



IT_Photo-20231009-211414.jpg

Additional Comments

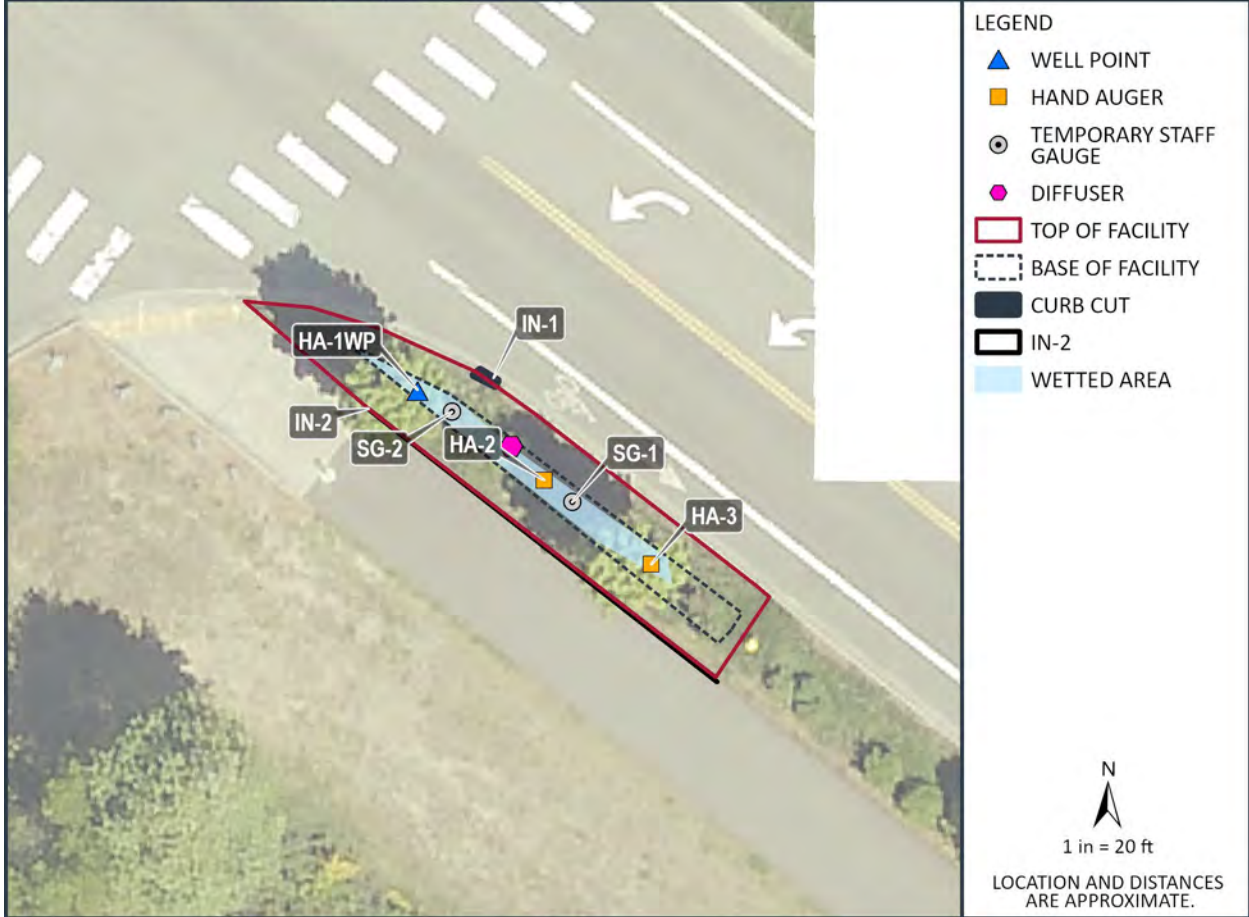
BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) North Cell (Lot 10)

Assessed On:
October 9, 2023



SITE: AIRPORT BOULEVARD (AR51) CELL: NORTH CELL





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Well Point

AR51N-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 10/9/23

Logged By: SNCF/EAP

20150387H008

Ending Date: 10/9/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 3.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.8

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.1

Water Level Elevation (ft): N/A

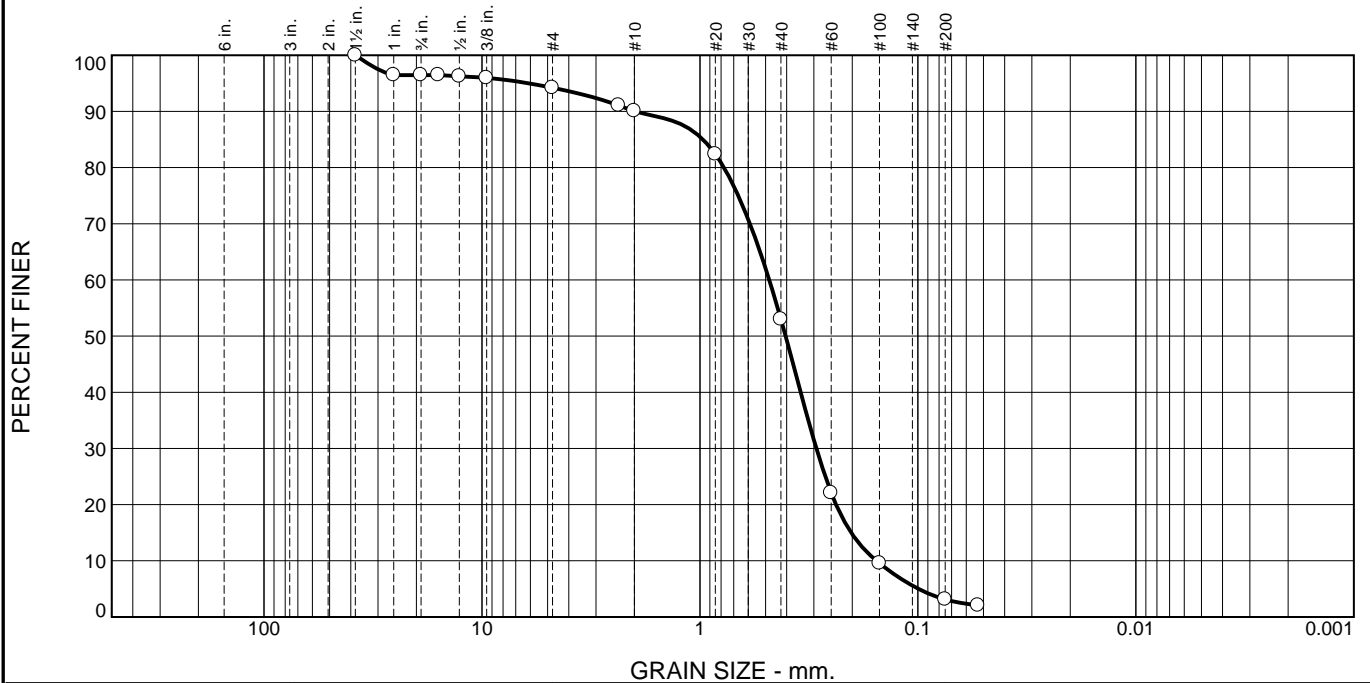
Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|---|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | Scattered grasses and organic debris. | Natural Mulch | | | | | | | Stick up -4.1 to 0.3 feet Existing bioretention soil 0 to 0.4 feet 3/8-inch bentonite chips 0.4 to 0.6 feet Medium grained silica sand 0.6 to 3.5 feet 1.25-inch I.D. threaded galvanized steel casing -4.1 to 0.4 feet; duct tape covers screen 0.4 to 2.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel gauze welded to perforated steel 2.4 to 3.2 feet Cast iron end cap 3.2 to 3.5 feet Cast iron drive point 3.5 to 3.8 feet |
| | Hand | 2 | Loose, slightly moist, dark brown, fine to medium SAND, some silt, some gravel; abundant organics (SW-SM). As above. | Bioretention Soil Mix | | | | | | | |
| 1 | Hand | 3 | As above; moist. | | | | | | | | |
| | Hand | 4 | | | | | | | | | |
| 2 | Hand | 5 | Medium dense, slightly moist, light brown, fine to medium SAND, trace silt, some gravel (SP). As above. | Vashon Recessional Outwash - Marysville Member | | | | | | | |
| 3 | Hand | 6 | | | | | | | | | |
| 4 | | | No seepage. Minimal caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

20150387H008 1/23/2024

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 3.5 | 2.3 | 4.1 | 37.1 | 49.9 | 3.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 96.5 | | |
| 3/4" | 96.5 | | |
| 5/8" | 96.5 | | |
| 1/2" | 96.3 | | |
| 3/8" | 96.0 | | |
| #4 | 94.2 | | |
| #8 | 91.1 | | |
| #10 | 90.1 | | |
| #20 | 82.4 | | |
| #40 | 53.0 | | |
| #60 | 22.1 | | |
| #100 | 9.6 | | |
| #200 | 3.1 | | |
| #270 | 2.1 | | |

* (no specification provided)

Material Description

SAND some gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

D₉₀= 1.9739 D₈₅= 0.9689 D₆₀= 0.4808
D₅₀= 0.4046 D₃₀= 0.2922 D₁₅= 0.2025
D₁₀= 0.1547 C_u= 3.11 C_c= 1.15

Remarks

Date Received: 10-09-2023 Date Tested: 11-28-2023

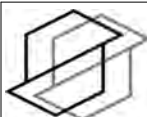
Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - Airport BLVD N
Sample Number: HA-1-WP **Depth:** 2.5-3.5'

Date Sampled: 10-09-2023



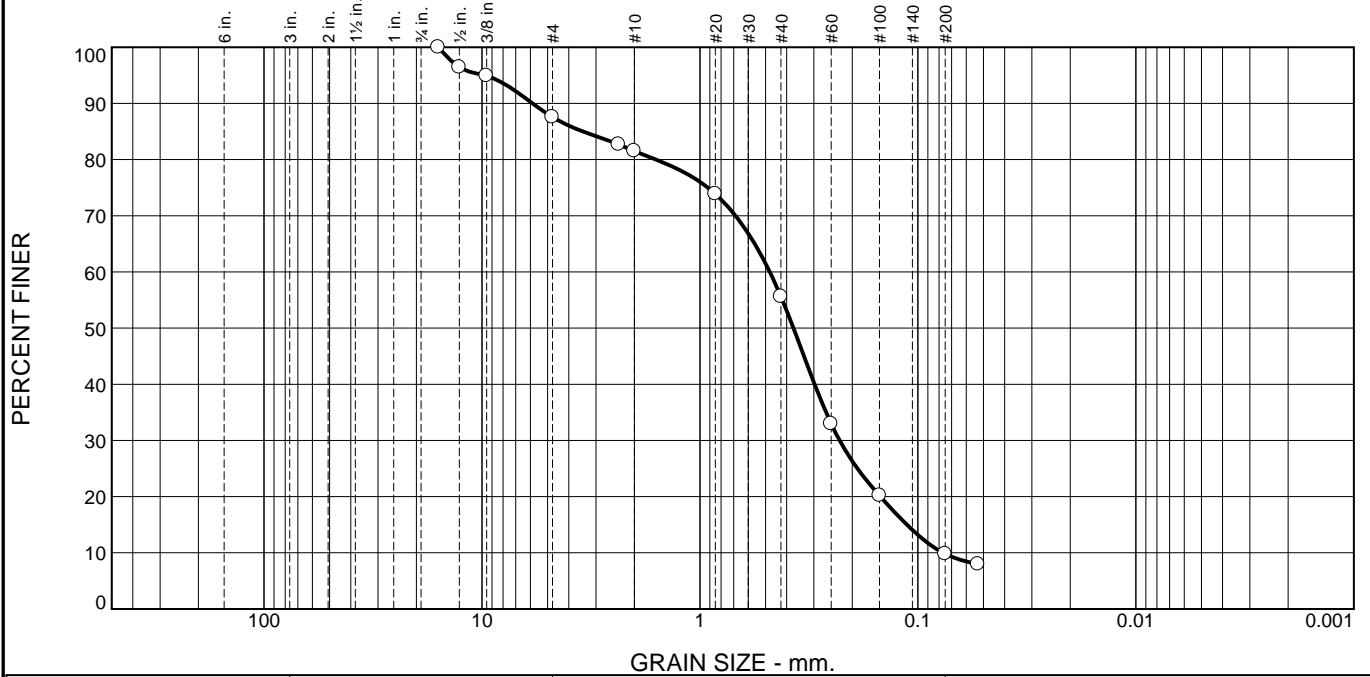
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 12.4 | 6.1 | 25.9 | 45.8 | 9.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 96.4 | | |
| 3/8" | 94.9 | | |
| #4 | 87.6 | | |
| #8 | 82.7 | | |
| #10 | 81.5 | | |
| #20 | 73.9 | | |
| #40 | 55.6 | | |
| #60 | 33.0 | | |
| #100 | 20.2 | | |
| #200 | 9.8 | | |
| #270 | 8.0 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-3

Coefficients

D₉₀= 5.8597 D₈₅= 3.4372 D₆₀= 0.4781
D₅₀= 0.3723 D₃₀= 0.2287 D₁₅= 0.1124
D₁₀= 0.0767 C_u= 6.23 C_c= 1.43

Remarks

Date Received: 10-09-2023 Date Tested: 11-27-2023

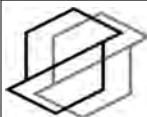
Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - BHPS-Airport BLVD. N
Sample Number: HA-1WP **Depth:** 0.1-0.5'

Date Sampled: 10-09-2023



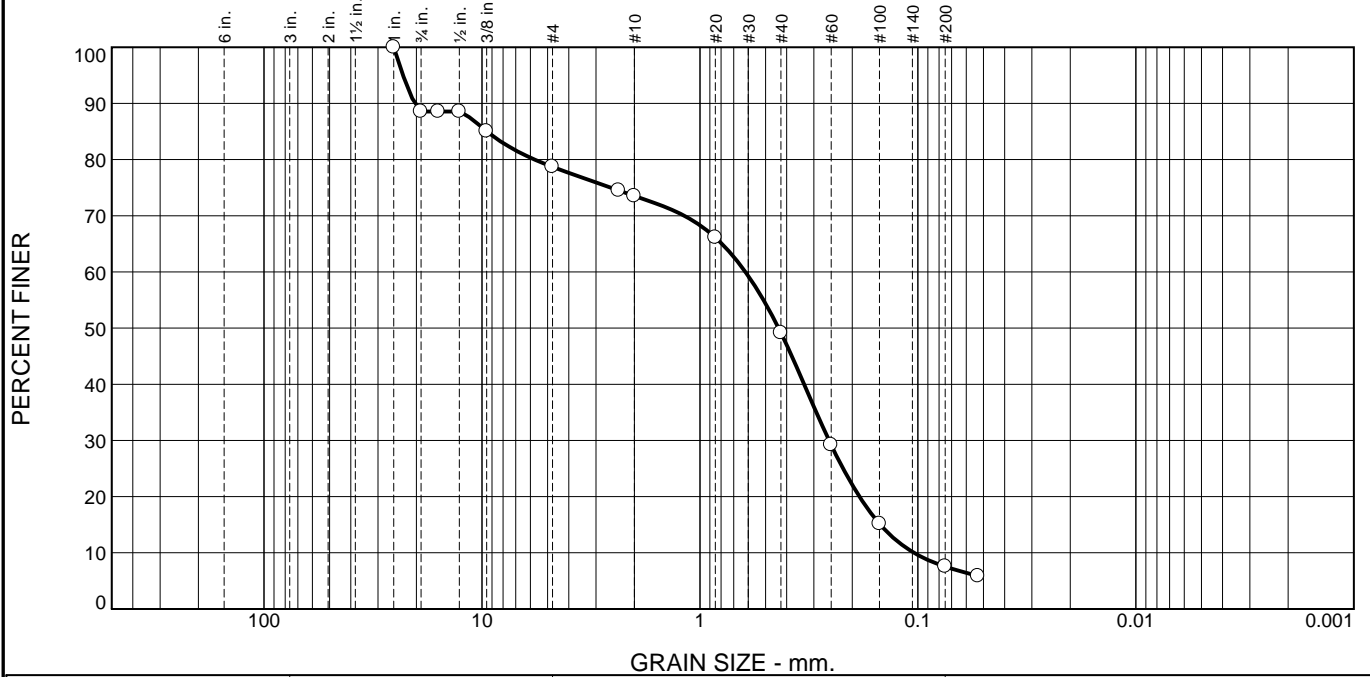
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 11.5 | 9.8 | 5.2 | 24.4 | 41.6 | 7.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 88.5 | | |
| 5/8" | 88.5 | | |
| 1/2" | 88.5 | | |
| 3/8" | 85.1 | | |
| #4 | 78.7 | | |
| #8 | 74.5 | | |
| #10 | 73.5 | | |
| #20 | 66.1 | | |
| #40 | 49.1 | | |
| #60 | 29.2 | | |
| #100 | 15.2 | | |
| #200 | 7.5 | | |
| #270 | 5.9 | | |

Material Description

gravelly SAND some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 20.3204 D₈₅= 9.4809 D₆₀= 0.6186
D₅₀= 0.4357 D₃₀= 0.2557 D₁₅= 0.1487
D₁₀= 0.1043 C_u= 5.93 C_c= 1.01

Remarks

Date Received: 10-09-2023 Date Tested: 11-27-2023

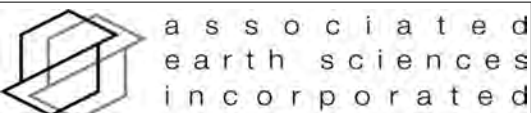
Tested By: FEW

Checked By: CSI/JHS

Title: _____

* (no specification provided)

Location: onsite - Airport BLVD. N Date Sampled: 10-09-2023
Sample Number: HA-3 Depth: 0.1-0.5'



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|-----------------------------------|---------------------------------------|-------------------------------------|--------------------------|--|
| Date Sampled 10/28/2023 | Project BHPS-AirportBLVD-N. | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Arlington, WA | EB/EP No. HA-3 | Depth 0.1-0.5' | |

Moisture Content

| | |
|--------------------|------------------------|
| Sample ID | HA-3 @ 0.1-0.5' |
| Wet Weight + Pan | 530.79 |
| Dry Weight + Pan | 508.22 |
| Weight of Pan | 262.00 |
| Weight of Moisture | 22.57 |
| Dry Weight of Soil | 246.22 |
| % Moisture | 9.17 |

Organic Matter and Ash Content

| | |
|-------------------------------|---------------|
| Dry Soil Before Burn + Pan | 508.22 |
| Dry Soil After Burn + Pan | 494.24 |
| Weight of Pan | 262.00 |
| Wt. Loss Due to Ignition | 13.98 |
| Actual Wt. Of Soil After Burn | 232.24 |
| % Organics | 5.68 |

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**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|-----------------------------------|---------------------------------------|-------------------------------------|--------------------------|--|
| Date Sampled 10/28/2023 | Project BHPS-AirportBLVD-N. | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Arlington, WA | EB/EP No. HA-1WP | Depth 0.1-0.5' | |

Moisture Content

| | |
|--------------------|--------------------------|
| Sample ID | HA-1WP @ 0.1-0.5' |
| Wet Weight + Pan | 500.61 |
| Dry Weight + Pan | 473.73 |
| Weight of Pan | 261.81 |
| Weight of Moisture | 26.88 |
| Dry Weight of Soil | 211.92 |
| % Moisture | 12.68 |

Organic Matter and Ash Content

| | |
|-------------------------------|---------------|
| Dry Soil Before Burn + Pan | 473.73 |
| Dry Soil After Burn + Pan | 458.22 |
| Weight of Pan | 261.81 |
| Wt. Loss Due to Ignition | 15.51 |
| Actual Wt. Of Soil After Burn | 196.41 |
| % Organics | 7.32 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|-----------------------------|--------------------------------|--|
| Project Name: | Airport Blvd North (Lot 10) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) |
| Date: | 10/9/2023 | Wetted Area (sq. feet): | 12:00 88 ft ² / 13:10: 83 ft ² |
| Weather: | Overcast, light showers | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.6 |
| Performed By: | SNCF/EAP | Receptor Soils: | Qvr |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|------------------------------------|
| 9:45 | | | | | | Water on |
| 9:47 | 30.02 | | | | 40 | Placed SG-2 |
| 9:50 | 30.5 | 0.18 | 0.52 | | 120 | |
| 9:55 | 29.7 | | | | 275 | Increase flow |
| 9:57 | 43.9 | 0.3 | 0.59 | | 385 | |
| 10:00 | 44.6 | 0.3 | 0.59 | | 488 | |
| 10:02 | | 0.31 | 0.59 | 6.77 | | Base of pond filled |
| 10:15 | 44.6 | 0.32 | 0.59 | 6.06 | 1,147 | |
| 10:31 | 44.7 | 0.31 | 0.59 | | 1,876 | |
| 10:37 | 44.7 | 0.45 | 0.59 | 5.95 | | SG-1 fell over - reset |
| 10:45 | 44.5 | 0.46 | 0.6 | 5.95 | 2,500 | Pond shrinking on south end |
| 11:00 | 44.6 | 0.46 | 0.6 | 5.95 | 3,160 | |
| 11:15 | 44.6 | 0.46 | 0.6 | 5.95 | 3,830 | |
| 11:30 | 44.9 | 0.46 | 0.6 | 5.93 | 4,527 | |
| 11:54 | 45 | 0.46 | 0.6 | 5.92 | 5,617 | |
| 12:00 | 44.9 | 0.46 | 0.6 | 5.92 | 5,894 | |
| 12:15 | 45 | 0.46 | 0.6 | 5.91 | 6,571 | |
| 12:34 | 44.8 | 0.46 | 0.6 | 5.9 | 7,419 | |
| 12:45 | 44.9 | 0.44 | 0.6 | 5.89 | 7,920 | |
| 13:00 | 45.1 | 0.44 | 0.6 | 5.9 | 8,559 | |
| 13:16 | 45.1 | 0.44 | 0.6 | 5.9 | 9,310 | |
| 13:30 | 44.8 | 0.44 | 0.6 | 5.9 | 9,903 | |
| 13:45 | 44.6 | 0.44 | 0.6 | 5.9 | 10,609 | |
| 14:00 | 44.8 | 0.44 | 0.6 | 5.89 | 11,259 | |
| 14:17 | 45.1 | 0.44 | 0.6 | 5.89 | 12,040 | |
| 14:30 | 45.2 | 0.44 | 0.6 | 5.89 | 12,604 | |
| 14:45 | 44.9 | 0.44 | 0.6 | 5.89 | 13,285 | Sheet flow into cell from sidewalk |
| 15:00 | 44.8 | 0.44 | 0.6 | 5.9 | 13,953 | |
| 15:15 | 44.9 | 0.44 | 0.6 | 5.9 | 14,628 | |
| 15:30 | 45 | 0.44 | 0.6 | 5.9 | 15,293 | |
| 15:45 | 44.8 | 0.44 | 0.6 | 5.89 | 15,962 | |
| 15:55 | 44.9 | 0.43 | 0.6 | 5.89 | 16,408 | |
| 16:05 | 44.8 | 0.43 | 0.6 | 5.89 | 16,857 | |
| 16:15 | 44.6 | 0.43 | 0.6 | 5.88 | 17,304 | |
| 16:25 | 44.8 | 0.43 | 0.6 | 5.89 | 17,752 | |

| | | | | | | |
|-------|------|------|------|------|--------|-----------|
| 16:35 | 44.7 | 0.43 | 0.6 | 5.89 | 18,210 | |
| 16:45 | | 0.43 | 0.6 | 5.89 | 18,646 | Water off |
| 16:46 | | 0.38 | 0.48 | 5.95 | | |
| 16:47 | | 0.3 | 0.36 | 6.06 | | |
| 16:48 | | 0 | 0 | | | |
| 16:50 | | | | 6.43 | | |
| 16:52 | | | | 6.83 | | |
| 16:54 | | | | 6.83 | | |
| 16:56 | | | | 6.83 | | |

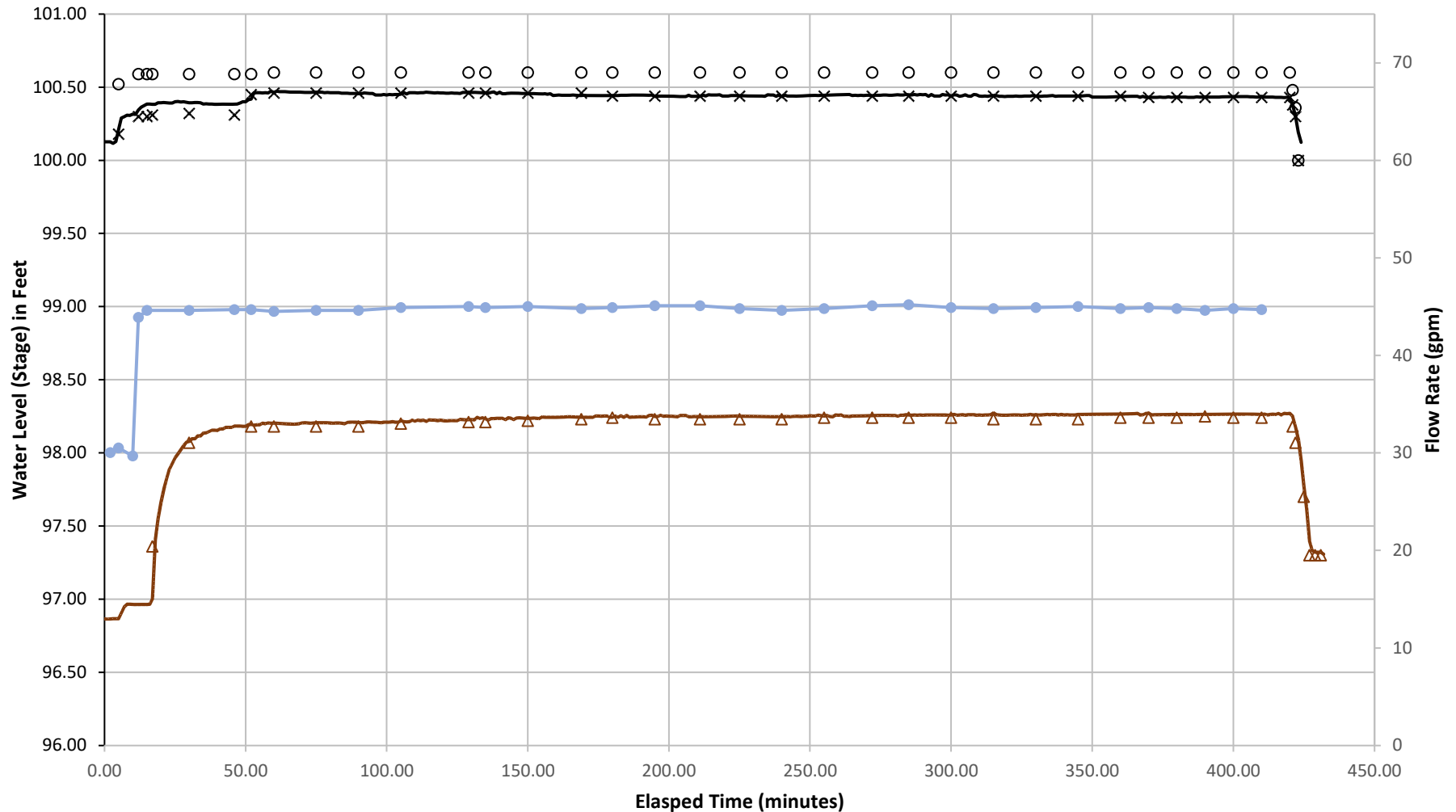
| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 52.0 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 46.8 |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 51.9 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 86.4 |

| | |
|--|-------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 51.9 |
| WP Average Infiltration Rate (in/hr) during falling head: | 110.9 |

Airport Boulevard North (Lot 10) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as relative reference. Elevation 100 represents ground surface.

x Staff Gauge #1 Hand Data

△ Wellpoint Hand Data

o Staff Gauge #2 Hand Data

— Staff Gauge #1 Logger Data

— Wellpoint Logger Data

—●— Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell is one of dozens of bioretention cells, constructed in 2009, which collect stormwater runoff from the adjacent Airport Boulevard/51st Avenue roadway. The cell was designed to be constructed with 18" of bioretention soil above a geotextile filter fabric set above native soils. Water enters the cell through a series of curb cuts with quarry spalls used for energy dissipation. All water is designed to infiltrate into the ground and there is no emergency overflow bypass.

BIORETENTION SOIL:

Thickness: 1.5-2.2

The apparent thickness of bioretention soil based on probe data and hand augers ranged from 1.5-2.2' below the ground surface with an average thickness of 1.8'.

Composition: The plans called for the bioretention soil specification to follow the guidance of the 2005 LID manual. The 2005 LID manual provides several different soil mix specifications and therefore the tested material cannot be compared to a specific design mix. In comparison to the 2019 Ecology specification, the tested soil did not meet the recommended guidelines for organic content but had a sand gradation finer than the specified range and exceeded the recommended silt content.

Organic Matter Content (% by weight): 6.8

Percent passing #200 sieve: 9.4

Coefficient of Uniformity (Cu): 8.2

Coefficient of Curvature (Cc): 1.2

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash, Marysville Member

Soil Description: Medium dense, slightly moist, brown, fine to medium SAND, some coarse sand, trace rounded fine gravel (SP).

BUILT PER PLAN:

The observed cell conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

According to the geotechnical report, groundwater was observed to be approximately 8' below ground surface in test pits near the bioretention cell. The wellpoint we installed was screened 2.2-2.7' below ground surface and did not encounter groundwater. The wellpoint responded to infiltration testing and rose to a minimum depth of 1' below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 83.3

Subgrade Soil Rate (in/hr): 104

The bioretention soil rate was calculated using constant head results from the final hour of inflow. The subgrade soil rate was calculated using the falling head results from the wellpoint.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
 September 19, 2023



AESI conducted pit infiltration tests in 2009 within 500 feet of the tested cell and measured an infiltration rate of 99 in/hr. The drainage report states a long-term infiltration rate of the existing native soils as 2.5 in/hr.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Other than sediment clogging of the inlets, the cell was generally found to be in working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|-------------------------|
| Weather | Overcast 60's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Brennan Nowak | | Half Day: Sarah Faubion |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 5 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230919-152459.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
 September 19, 2023



Site Photo: FA_SitePhotos-20230919-164555.jpg



Site Photo: FA_SitePhotos-20230919-164615.jpg



Site Photo: FA_SitePhotos-20230919-194313.jpg

Cell Construction

| | |
|-----------------------------|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Additional Comments

Water is conveyed to the cell through several curb cut inlets and from surface runoff from adjacent sidewalk. All water is designed to infiltrate into underlying native sediments.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.1'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230919-184357.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Some exposed angular cobble visible amongst thick mat of grass and weeds.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.1'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230919-173520.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 40% blocked

Types:

- Sediment
- Organic
- Rock
- Trash
- Vegetation

Additional Details: Grass and sand built up.



FA_INBLPhoto-20230919-184219.jpg

Additional Details: Some angular cobbles exposed beneath mat of grasses and vegetative debris.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.1'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230919-173854.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 70% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Large weed growth with organic material piled against it.



FA_INBLPhoto-20230919-173841.jpg

Additional Details: In comparison to adjacent inlets, more vegetative growth and taller grasses surrounds inlet 3.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



IN-4

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.1'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230919-183827.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 100% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Blockages fills entire inlet but not impervious.



FA_INBLPhoto-20230919-183546.jpg

Additional Details: Some angular cobbles exposed though most are buried under grass cuttings.

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



IN-5

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.1'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230919-183845.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
 September 19, 2023



Large Deposition of Feces Yes No

Additional Details:

Vegetation Description

Cell covered in grass. Bottom of cell consists of grass cuttings that are dried and dead.

Additional Details

Geotech Probe Observations: Soil probes depths in the cell base ranged from 1.5' to 2.2' with average depth of 1.8'. The bioretention soil was observed to be moderately compacted due to the resistance the soil presented to the geotechnical probe. Probes conducted near each inlet encountered gravels installed for energy dispersal which were buried in up to one foot of sediment.

Hand Auger

HA-1WP

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.3

to Native Soil: 1.6

to Import/Underdrain:

Total Depth: 3

Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some gravel, some silt, abundant organics (SW-SM).

Native Soil Texture: Medium dense, slightly moist, brown, fine to medium SAND, some coarse sand, some gravel rounded fine gravel, trace silt, sparse organics (one piece of charcoal) (SP)

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Black, geotextile filter fabric at 1.6'

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft): 1.06

Additional Details

Water in wellpoint never reached the surface of the bioretention cell.



IMG_0608.jpg

HA-2

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.2

to Native Soil: 1.7

to Import/Underdrain:


Total Depth: 1.7


BIORETENTION CELL FIELD ASSESSMENT

Site: Airport Boulevard (AR51)
 Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
 September 19, 2023



| | |
|---|--|
| HA-2 | |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, gravelly, fine to medium SAND, some silt, abundant organics (SW-SM). Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Filter fabric at 1.7' |
|  | |
| IMG_0610.jpg | |
| Additional Details | |

| | |
|---|--|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.8 |
| to Import/Underdrain: | |
| Total Depth: | 1.8 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, gravelly, fine to medium SAND, some silt, abundant organics (SW-SM). Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Filter fabric at 1.8' |
|  | |
| IMG_0617.jpg | |
| Additional Details | |

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# 6 | |
| Wetted Pond Area (sq. ft) | 116 |
| Ponded Depth (ft) | 0.63 |
| Total Gallons | 41,531 |
| Steady State Flow Rate (GPM) | 100.6 |
| Additional Details: | |

BIORETENTION CELL FIELD ASSESSMENT

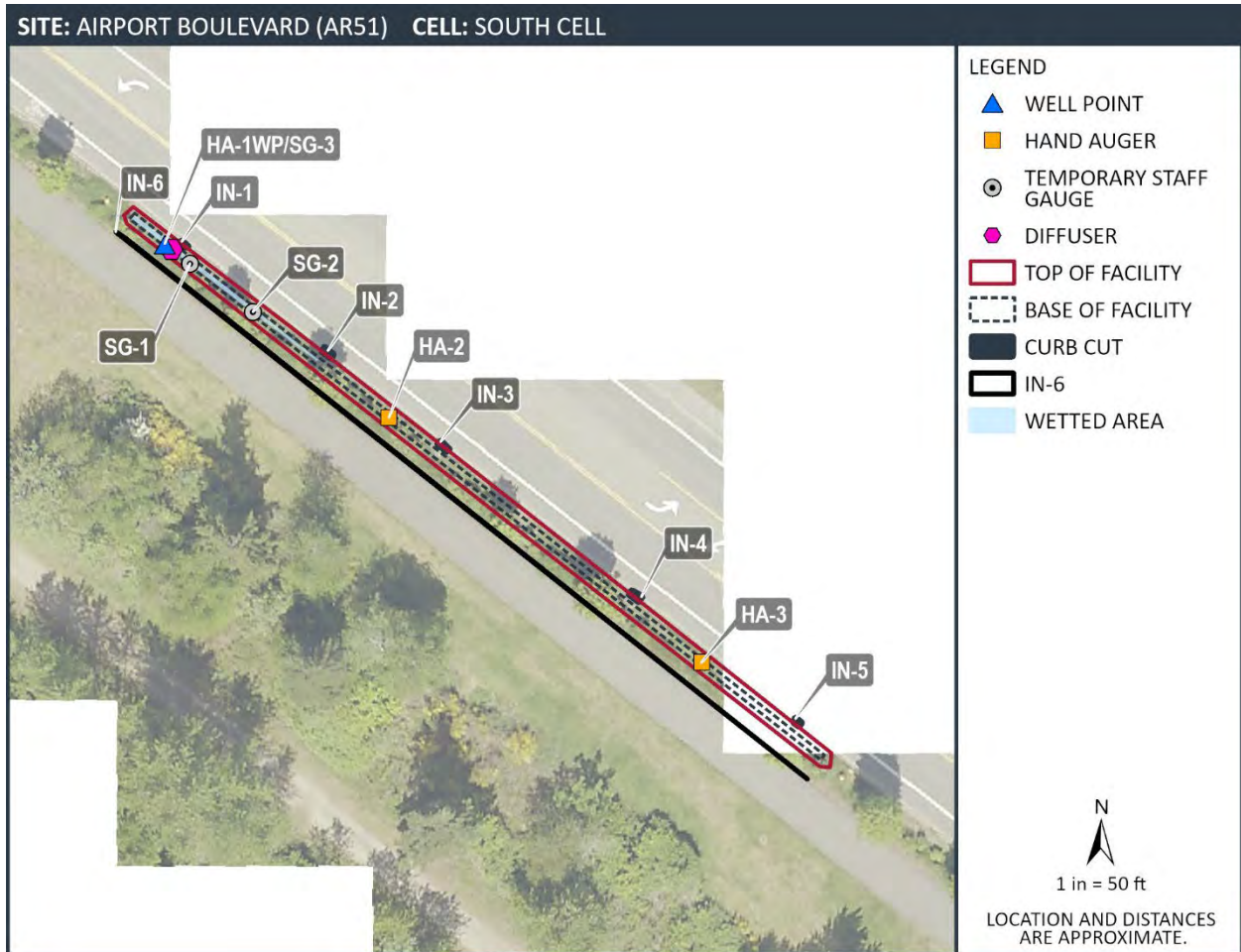
Site: Airport Boulevard (AR51)
Cell: (51st Avenue) South Cell (Lot 2)

Assessed On:
September 19, 2023



Flow rates fluctuated up and down as much as 3 gpm with flow rate control undisturbed. Water district mentioned there could be impacts tied to the water treatment plant with flows in the 100 gpm.

Additional Comments





associated
earth sciences
incorporated

Well Point

AR51S-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/18/23

Logged By: SNCF

20150387H008

Ending Date: 9/18/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.6

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

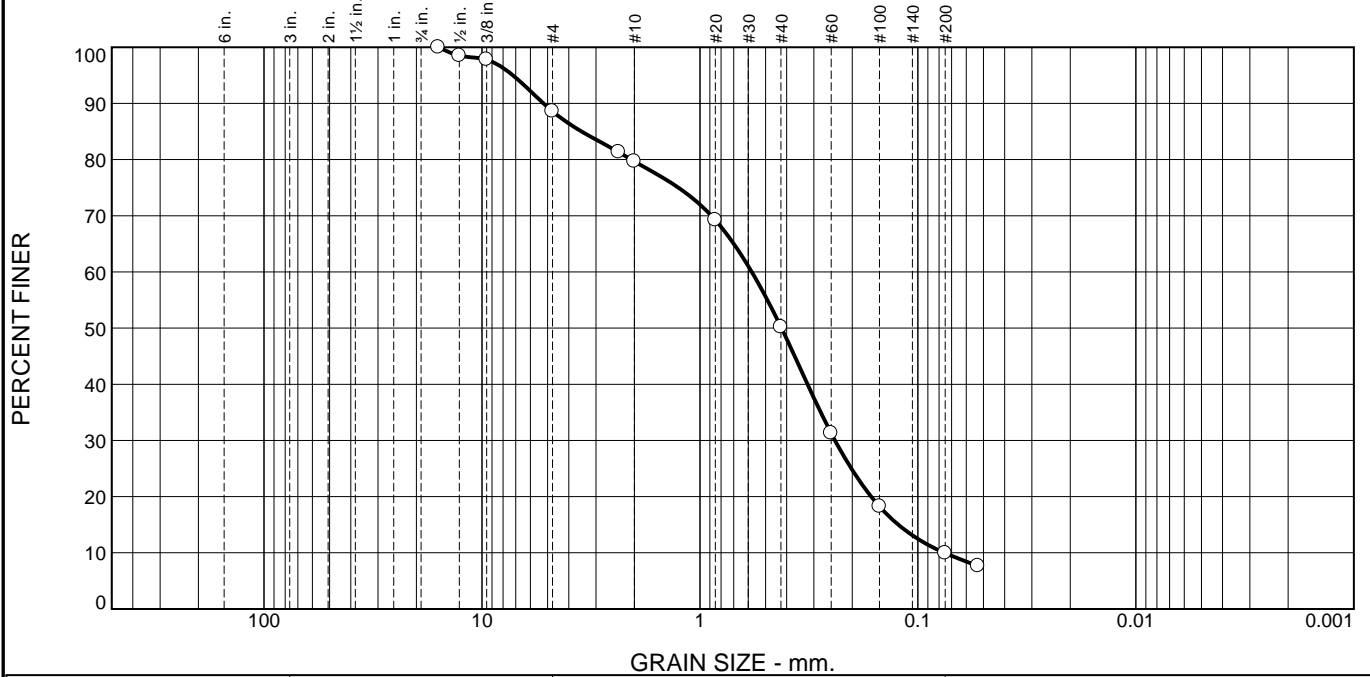
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | ↙ ↘ | Natural Mulch Natural mulch (leaf litter). | | | | | | | Stick up -4.6 to 0.1 feet Existing bioretention soil 0 to 1 feet 1.25-inch I.D. threaded galvanized steel casing -4.6 to 0.1 feet; duct tape covers screen 0.1 to 2.2 feet 3/8-inch bentonite chips 1 to 1.4 feet Medium grained silica sand 1.4 to 3 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 2.2 to 2.7 feet Cast iron end cap 2.7 to 3 feet Cast iron drive point 3 to 3.3 feet |
| 1 | Hand | 1 | ○ ○ ○ ○ | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some silt, some fine gravel; abundant organics (SW-SM). As above. | | | | | | | |
| 2 | Hand | 2 | ○ ○ ○ ○ | As above. | | | | | | | |
| 3 | Hand | 3 | ○ ○ ○ ○ | As above. | | | | | | | |
| 4 | Hand | 4 | ○ ○ ○ ○ | Filter fabric. | | | | | | | |
| 5 | Hand | 5 | ○ ○ ○ ○ | Vashon Recessional Outwash - Marysville Member Medium dense, slightly moist, brown, fine to medium SAND, some coarse sand, trace rounded fine gravel; sparse organics (charcoal wood) (SP). As above; no charcoal. | | | | | | | |
| 6 | Hand | 6 | ○ ○ ○ ○ | No seepage. No caving. Refusal at 3 feet (gravel). Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 7 | | | | | | | | | | | |

1/23/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 11.4 | 8.9 | 29.5 | 40.3 | 9.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 98.5 | | |
| 3/8" | 97.8 | | |
| #4 | 88.6 | | |
| #8 | 81.3 | | |
| #10 | 79.7 | | |
| #20 | 69.2 | | |
| #40 | 50.2 | | |
| #60 | 31.3 | | |
| #100 | 18.2 | | |
| #200 | 9.9 | | |
| #270 | 7.7 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 5.2236 | D ₈₅ = 3.4927 | D ₆₀ = 0.5784 |
| D ₅₀ = 0.4225 | D ₃₀ = 0.2401 | D ₁₅ = 0.1231 |
| D ₁₀ = 0.0756 | C _u = 7.65 | C _c = 1.32 |

Remarks

Date Received: 9-19-2023 Date Tested: 11-7-2023

Tested By: FEW

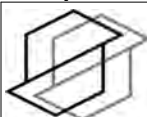
Checked By: SNCF/JS

Title: _____

Location: Onsite - BHPS-Airport Blvd-S
Sample Number: AR51S-HA-1WP

Depth: 0.3-0.8'

Date Sampled: 9-18-2023



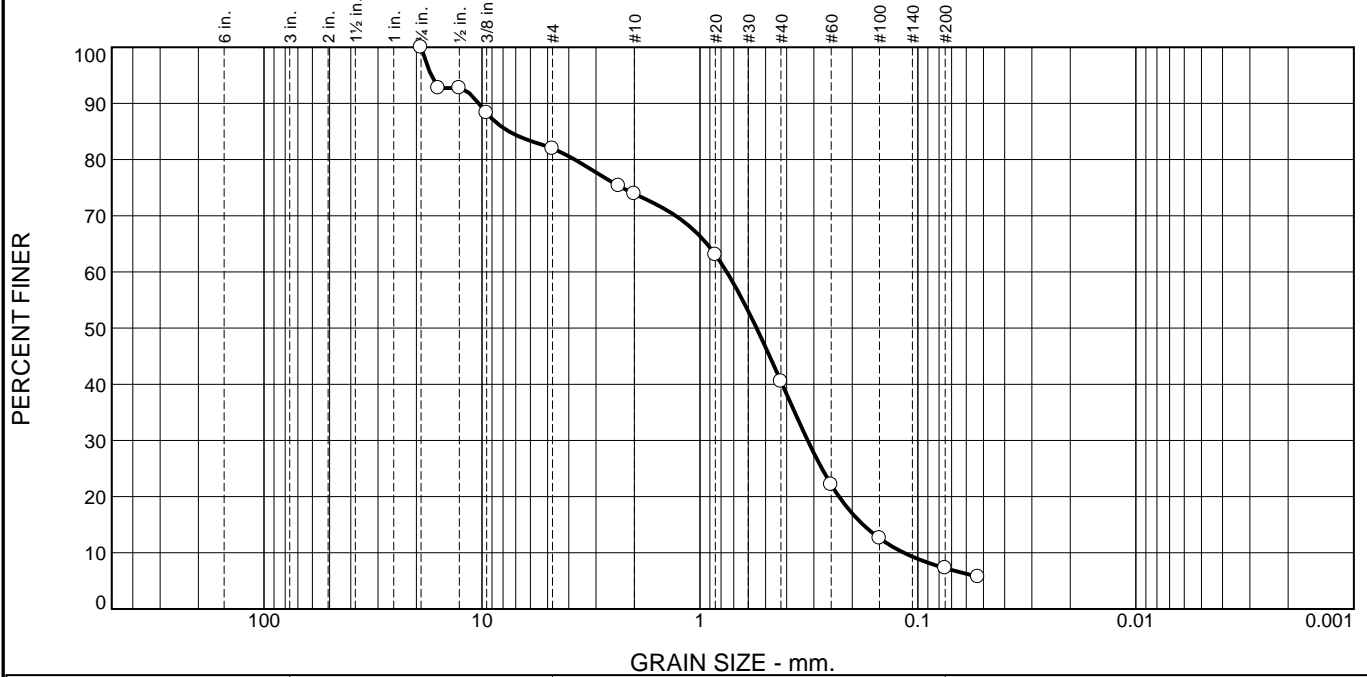
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 18.0 | 8.1 | 33.4 | 33.2 | 7.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 92.7 | | |
| 1/2" | 92.7 | | |
| 3/8" | 88.3 | | |
| #4 | 82.0 | | |
| #8 | 75.3 | | |
| #10 | 73.9 | | |
| #20 | 63.1 | | |
| #40 | 40.5 | | |
| #60 | 22.1 | | |
| #100 | 12.6 | | |
| #200 | 7.3 | | |
| #270 | 5.7 | | |

Material Description
gravelly SAND some silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 10.3530 D₈₅= 7.5240 D₆₀= 0.7530
 D₅₀= 0.5498 D₃₀= 0.3202 D₁₅= 0.1786
 D₁₀= 0.1160 C_u= 6.49 C_c= 1.17

Remarks

Date Received: 9-19-2023 Date Tested: 11-7-2023

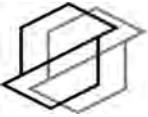
Tested By: FEW

Checked By: SNCF/JS

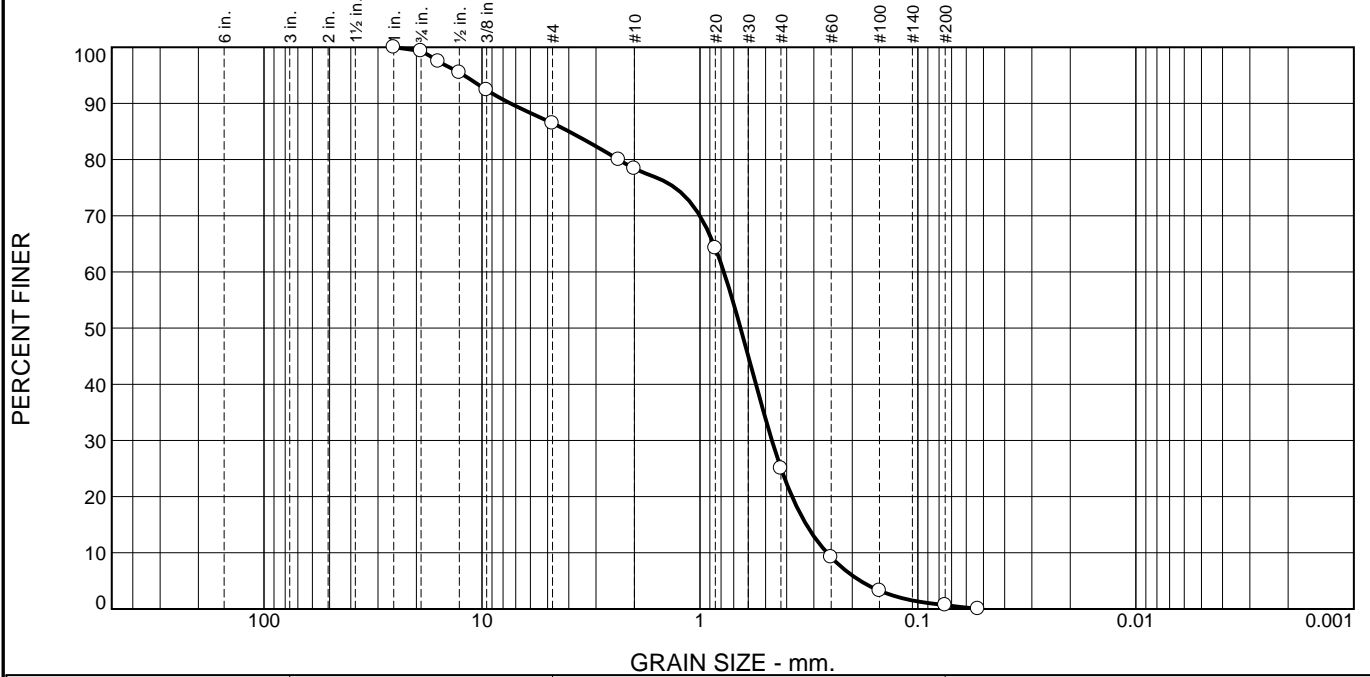
Title: _____

* (no specification provided)

Location: Onsite - BHPS-AR51S Date Sampled: 9-18-2023
 Sample Number: AR51S-HA-1WP Depth: 1.6-2.1'

| | | |
|---|---|--|
|  | <p>Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study</p> | <p>Project No: 20150387 H008 Figure</p> |
|---|---|--|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.7 | 12.8 | 8.1 | 53.4 | 24.3 | 0.7 | 0.0 |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 99.3 | | |
| 5/8" | 97.5 | | |
| 1/2" | 95.5 | | |
| 3/8" | 92.4 | | |
| #4 | 86.5 | | |
| #8 | 80.0 | | |
| #10 | 78.4 | | |
| #20 | 64.3 | | |
| #40 | 25.0 | | |
| #60 | 9.2 | | |
| #100 | 3.2 | | |
| #200 | 0.7 | | |
| #270 | 0.0 | | |

* (no specification provided)

Material Description

SAND some gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 7.4019 D₈₅= 3.9911 D₆₀= 0.7766
D₅₀= 0.6509 D₃₀= 0.4677 D₁₅= 0.3249
D₁₀= 0.2613 C_u= 2.97 C_c= 1.08

Remarks

Date Received: 9-19-2023 Date Tested: 10-26-2023

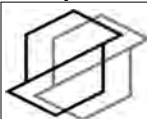
Tested By: FEW

Checked By: SNCF/JS

Title: _____

Location: Onsite - AR51S **Depth:** 2.1-2.5'

Date Sampled: 9-18-2023



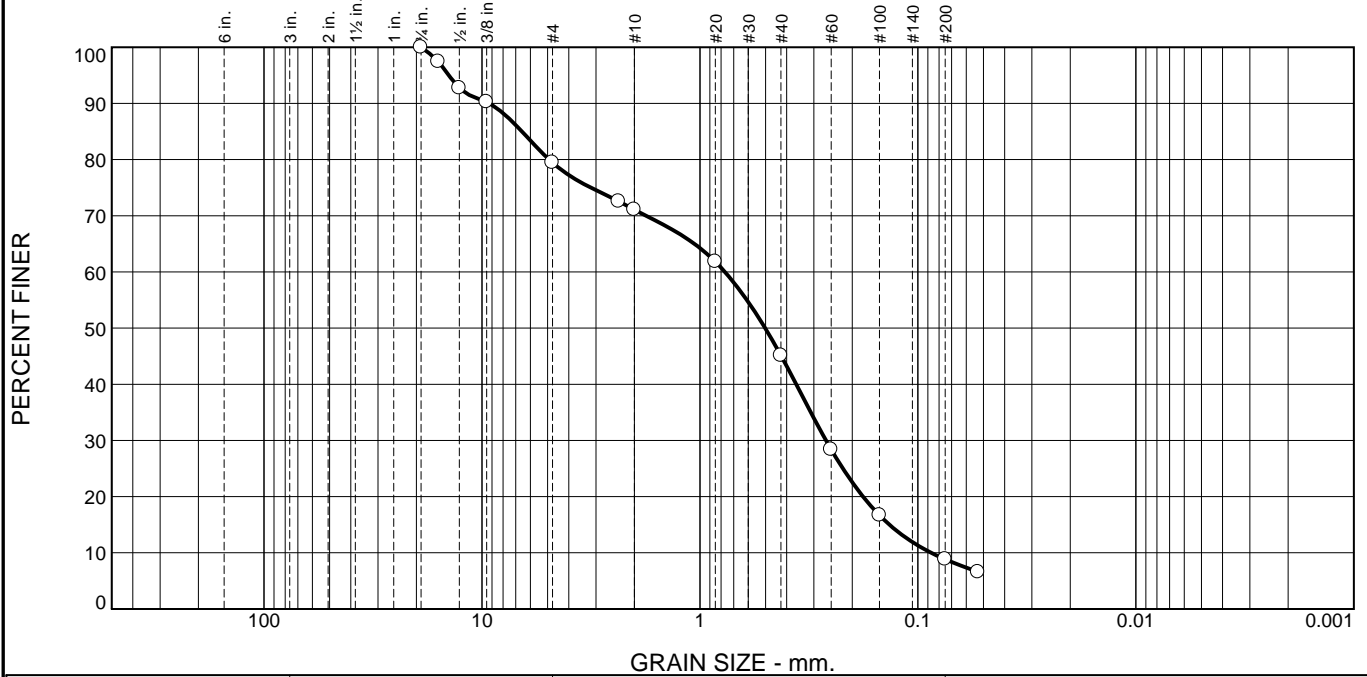
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 20.5 | 8.4 | 26.0 | 36.3 | 8.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 97.4 | | |
| 1/2" | 92.7 | | |
| 3/8" | 90.2 | | |
| #4 | 79.5 | | |
| #8 | 72.6 | | |
| #10 | 71.1 | | |
| #20 | 61.8 | | |
| #40 | 45.1 | | |
| #60 | 28.4 | | |
| #100 | 16.7 | | |
| #200 | 8.8 | | |
| #270 | 6.6 | | |

Material Description
gravelly SAND some silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 9.2554 D₈₅= 6.5574 D₆₀= 0.7682
 D₅₀= 0.5022 D₃₀= 0.2641 D₁₅= 0.1351
 D₁₀= 0.0870 C_u= 8.83 C_c= 1.04

Remarks

Date Received: 9-19-2023 Date Tested: 11-7-2023

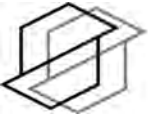
Tested By: FEW

Checked By: SNCF/JS

Title: _____

* (no specification provided)

Location: Onsite- BHPS-AR51S Date Sampled: 9-18-2023
 Sample Number: AR51S-HA-2 Depth: 0.2-0.8'

| | | |
|---|---|--------|
|  | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 | Figure |
|---|---|--------|



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/18/2023 | Project BHPS-AR51S | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Arlington, Wa. | EB/EP No. AR51S-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0.2-0.8' | HA-1WP @ 0.3-0.8' | HA-1 @ 1.6-2.1' |
|--------------------|-----------------|-------------------|-----------------|
| Wet Weight + Pan | 521.5 | 523.7 | 567.0 |
| Dry Weight + Pan | 502.1 | 493.1 | 545.4 |
| Weight of Pan | 255.0 | 255.3 | 260.1 |
| Weight of Moisture | 19.5 | 30.6 | 21.6 |
| Dry Weight of Soil | 247.1 | 237.7 | 285.3 |
| % Moisture | 7.9 | 12.9 | 7.6 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|-------|-------|-------|
| Dry Soil Before Burn + Pan | 502.1 | 493.1 | 545.4 |
| Dry Soil After Burn + Pan | 484.0 | 478.0 | 536.2 |
| Weight of Pan | 255.0 | 255.3 | 260.1 |
| Wt. Loss Due to Ignition | 18.1 | 15.1 | 9.2 |
| Actual Wt. Of Soil After Burn | 229.0 | 222.7 | 276.1 |
| % Organics | 7.3 | 6.3 | 3.2 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-----------------------------|--------------------------------|--|
| Project Name: | Auburn Pick Quick (Basin C) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 8/10/2023 | Wetted Area (sq. feet): | 10:30: 104 ft^2 / 16:00: 210 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Dispersal Pipe |
| Test No.: | IT-1 | Test Depth (feet): | 0.28 |
| Performed By: | APJ | Receptor Soils: | Bioretention Soil Mix / Green River Alluvium |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|---|
| 10:01 | 15.25 | 0.00 | 2.9 | dry | | Water on |
| 10:03 | 15.25 | 0.06 | | | 107 | |
| 10:05 | 15.24 | 0.04 | | | 128 | Flow turned down |
| 10:07 | 54.26 | | 2.1 | | 184 | Slowly increasing flow rate to decrease scouring water observed in CB (2.1) |
| 10:10 | 35.85 | 0.08 | | | 303 | |
| 10:15 | 36.13 | 0.10 | | | 481 | Flow increased ~45 gpm |
| 10:20 | 35.9 | 0.10 | | | 663 | |
| 10:25 | 45.36 | 0.12 | | | 882 | |
| 10:27 | | | 1.86 | dry | | |
| 10:31 | 45.3 | 0.10 | | | 1,153 | |
| 10:45 | 45.19 | 0.10 | 1.68 | | 1,783 | CB filling |
| 11:00 | 44.96 | 0.10 | 1.62 | | 2,485 | |
| 11:15 | 44.85 | 0.10 | 1.5 | | 3,137 | |
| 11:41 | 44.9 | 0.10 | 1.41 | dry | 4,290 | |
| 11:45 | 44.9 | 0.10 | 1.4 | | 4,504 | |
| 12:00 | 44.74 | 0.10 | 1.36 | dry | 5,147 | No changes in ponded area |
| 12:01 | | 0.11 | | | | |
| 12:16 | 45.63 | 0.11 | 1.33 | | 5,895 | Flow up to 60 |
| 12:30 | 63.46 | 0.14 | 1.24 | | 6,715 | |
| 12:46 | 63.97 | 0.14 | 1.21 | 5.57 | 7,765 | |
| 13:00 | 63.97 | 0.14 | 1.21 | 5.42 | 8,655 | Flow up to 82 |
| 13:15 | 81.95 | 0.17 | 1.05 | 5.19 | 9,872 | |
| 13:30 | 82.69 | 0.18 | 0.97 | 5.01 | 11,115 | |
| 13:45 | 82.8 | 0.18 | 0.91 | 4.89 | 12,333 | |
| 14:00 | 82.46 | 0.18 | 0.85 | 4.76 | 13,621 | |
| 14:15 | 82.52 | 0.19 | 0.82 | 4.68 | 14,832 | |
| 14:32 | 82.91 | 0.20 | 0.75 | 4.59 | 16,184 | Flow down to 70 |
| 14:45 | 71.67 | 0.19 | 0.83 | 4.58 | 17,155 | Flow up to 87 |
| 15:02 | 79.46 | 0.20 | 0.74 | 4.51 | 18,520 | |
| 15:15 | 79.3 | 0.20 | 0.72 | 4.46 | 19,523 | |
| 15:30 | 79.07 | 0.20 | 0.68 | 4.4 | 20,713 | |
| 15:45 | 78.79 | 0.22 | 0.67 | 4.37 | 21,895 | |
| 16:00 | 78.61 | 0.22 | 0.63 | 4.32 | 23,093 | |
| 16:11 | 78.61 | 0.24 | 0.62 | 4.36 | 23,942 | |
| 16:20 | 79.62 | 0.24 | 0.6 | 4.26 | 24,660 | |
| 16:31 | 79.57 | 0.25 | 0.55 | 4.23 | 25,537 | |
| 16:40 | 80 | 0.26 | 0.54 | 4.2 | 26,245 | |
| 16:50 | 80.09 | 0.27 | 0.51 | 4.18 | 27,048 | |
| 17:03 | 80 | 0.28 | 0.52 | 4.15 | 28,088 | Water Off |
| 17:03:30 | | 0.26 | 0.52 | | | |
| 17:04 | | 0.24 | | | | |
| 17:05 | | 0.20 | | | | |
| 17:06 | | 0.14 | | | | |

| | | | | | | |
|-------|--|------|------|------|--|---|
| 17:07 | | 0.06 | | | | |
| 17:08 | | 0.00 | | 4.28 | | |
| 17:13 | | | 1.26 | 4.53 | | |
| 17:18 | | | 1.46 | 4.64 | | |
| 17:23 | | | 1.62 | 4.87 | | |
| 17:26 | | | 1.73 | 5.03 | | |
| 17:35 | | | 2.12 | 5.56 | | |
| 17:46 | | | dry | 5.92 | | Catch basin observed to be dry, may have gone dry sooner. |
| 17:51 | | | | 6.08 | | |
| 18:00 | | | | 6.39 | | Removed wellpoint |

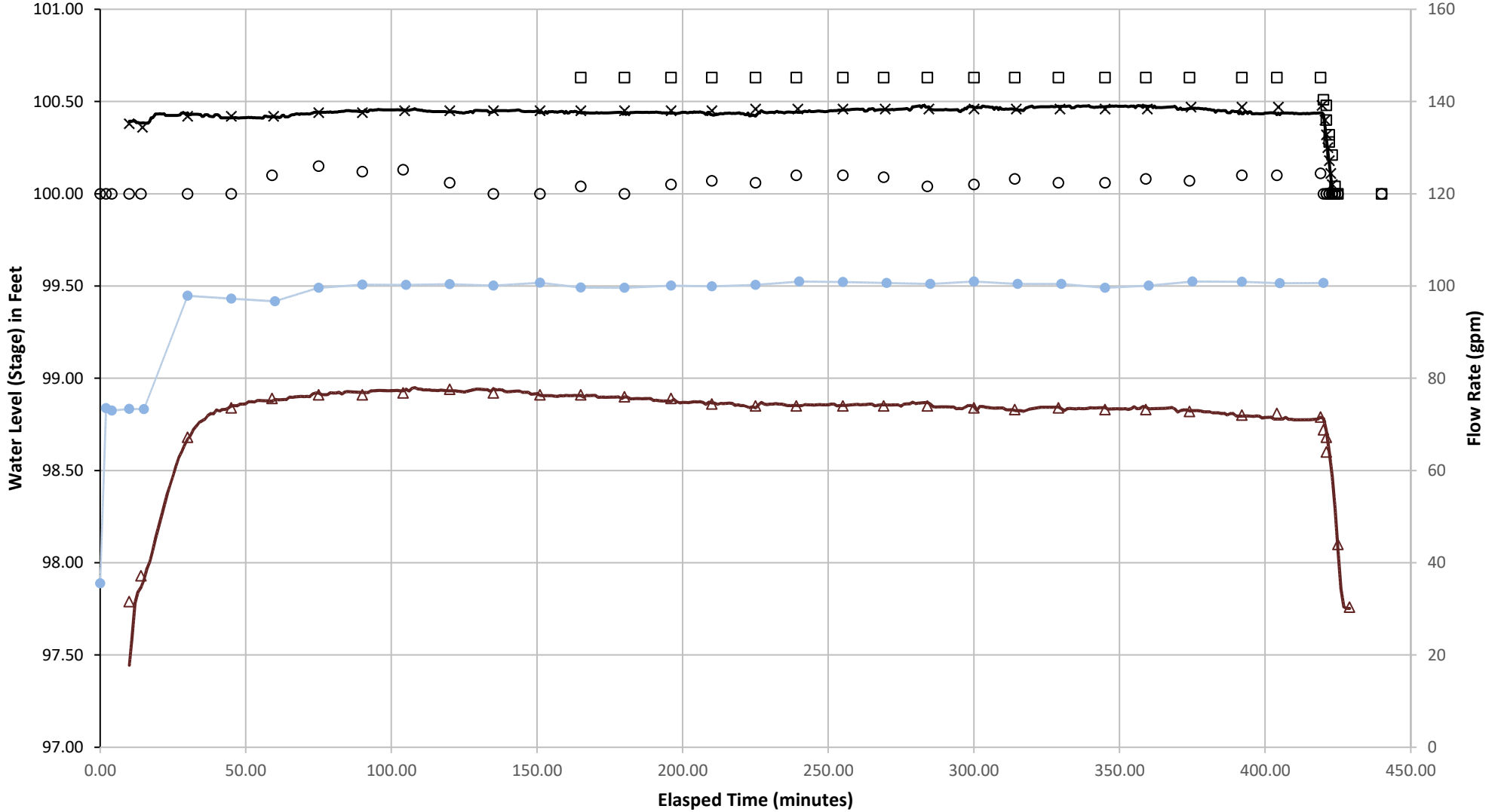
| | |
|--|------|
| SG-1 Bioretention Soil Average Infiltration Rate (in/hr) during last hour of inflow: | 35.7 |
| SG-1 Bioretention Soil Average Infiltration Rate (in/hr) during falling head: | 33.6 |

| | |
|---|------|
| Native Soils Average Infiltration Rate (in/hr) during last hour of inflow (Wellpoint Response): | 38.3 |
| Native Soils Average Infiltration Rate (in/hr) during falling head (Wellpoint Response): | 29.2 |

| | |
|---|------|
| Native Soils Average Infiltration Rate (in/hr) during last hour of inflow (Catch Basin Response): | 37.8 |
| Native Soils Average Infiltration Rate (in/hr) during falling head (Catch Basin Response): | 26.0 |

Airport Boulevard South (Lot 2) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand Data
- Staff Gauge #2 Hand Data
- Wellpoint Logger Data
- Staff Gauge #3 Hand Data
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
Cell: Basin C Raingarden

Assessed On:
August 10, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The Pick Quick raingarden was constructed in 2011 and collects roof runoff from the adjacent building. The cell design calls for 1.5' of amended soil above 1' of washed gravels wrapped in filter fabric set above native soils. Within the gravels sits a perforated dispersal pipe which connects to an open bottomed catch basin set in underlying native soils. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 0.5-1.1

The apparent thickness of loose bioretention soil based on probe data and hand augers ranged from 0.5' in the center of the cell and increased towards the edges of the cell base to a maximum depth of 1.1'. The average thickness of the bioretention soil was 0.7'.

Composition: The plans called for amended consisting of 10% planting soil, 40% Grade A compost and 50% C-33 Sand. The tested material had a higher silt and fine gravel content than the specification for C-33 but was otherwise generally consistent. In comparison to the 2019 Ecology specification, the tested material fell within the recommended guidelines for sand gradation but exceeded the specifications for fine gravel and silt content. The organic matter content also exceeded the 2019 Ecology recommendations.

Organic Matter Content (% by weight): 11.5

Percent passing #200 sieve: 8.5

Coefficient of Uniformity (Cu): 11.2

Coefficient of Curvature (Cc): 2.1

SUBGRADE CONDITIONS:

Geologic Unit: Green River Alluvium

Soil Description: Loose, slightly moist, dark brownish gray, gravelly, fine to medium SAND, some coarse sand, trace silt; trace rootlets (SP)

BUILT PER PLAN:

The depth of the bioretention soil was found to be less than the designed 1.5'. The stream cobbles adjacent the inlet pipe buried in sediment, organics, and recently placed beauty bark. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

The design plans indicate that seasonal groundwater high is approximately 6.5' below ground surface. The temporary wellpoint we installed screened 3-5.6' below ground surface did not encounter groundwater. The wellpoint responded to infiltration testing with the minimum measured water level below the ground surface as 2.7'. The catch basin which water is collected in the catch basin and conveyed responded to infiltration testing and rose to within inches of the ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 35.7

Subgrade Soil Rate (in/hr): N/A

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
 Cell: Basin C Raingarden

Assessed On:
 August 10, 2023



In 2011 AESI conducted an infiltration test of the amended soils and measured the infiltration rate to be 13.8 in/hr. The geotechnical report proposed a long-term infiltration rate of the native soils to be 1 inch per hour. The bioretention soils were assumed to have a long-term infiltration rate of 2 inches per hour.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

During AESI field work in 2011 the amended soil depth was measured to be between 1.5-2'. Our 2023 field investigations found the soil depth to be between .5-1.1' which is less than the 1.5' of soil specified by the plans. Fresh beauty bark had recently been applied to the surface and our hypothesis is that bioretention soil has been scraped off the surface during subsequent replacements of the bark.

Field Conditions

| | | | |
|-----------------|---------------|------------------|------------------|
| Weather | Clear, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.03" | Two Days Ago: 0" |
| Field Reps | Full Day: APJ | | Half Day: CSI |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 4 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230810-143014.jpg



Site Photo: FA_SitePhotos-20230810-143048.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
 Cell: Basin C Raingarden

Assessed On:
 August 10, 2023



Site Photo: FA_SitePhotos-20230810-200930.jpg



Site Photo: FA_SitePhotos-20230810-201002.jpg

Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation lines run down the long axis of the cell on both sides. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width 5.5' Trench width estimated as 5.5' from probe data, approximately the same width as the cell base. Trench about 1' deep. Perforated pipe lies in the bottom of the trench. Conveys water to the catch basin which infiltrates water to native soils. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Cell has freshly laid beauty bark above bioretention soil above a gravel underdrain trench (with perforated pipe) that conveys water to an infiltrating catch basin. During infiltration testing, water hit the underdrain pipe within 10 minutes and head began to rise in the CB. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
Cell: Basin C Raingarden

Assessed On:
August 10, 2023



Inlets

| | |
|--|---|
| <p>IN-1</p> <p><input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Pipe: Material <input checked="" type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.45'</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: Buried Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230810-143034.jpg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 30% blocked</p> <p>Types: <input type="checkbox"/> Sediment <input type="checkbox"/> Organic <input type="checkbox"/> Rock <input checked="" type="checkbox"/> Trash <input type="checkbox"/> Vegetation</p> <p>Additional Details: Pipe blocked in leaf litter, trash, beauty bark.</p> |
| <p>Additional Details: Buried stream cobbles under 0.3 feet of sedimentation.</p> | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
Cell: Basin C Raingarden

Assessed On:
August 10, 2023



Design Overflow/Outlet

| | | |
|--|-------------------------------|--|
| DO - 1 | |  <p>FA_DOPhoto-20230810-215432.jpg</p> |
| Shape: <input checked="" type="checkbox"/> Round <input type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Diameter: 1.5' | |
| Additional Details: | | |
| Stickup (ft) From Ground: 0.49 Relative from staff gauge: | | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Overflow structure base covered in litter, trash which may obstruct infiltrating water. | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

Cell Surface and Geotech Probe Observations

| | |
|---|--|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input checked="" type="checkbox"/> Coarse Mulch Depth (ft): 0.3 | |
| Cell Coverage | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Entire cell is covered in 'beauty bark' (coarse, brown, fibrous mulch) recently placed by owner. Abundant garbage on the cell base (>20) pieces including cans, assorted plastics, food wrappers. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |
| Vegetation Description Manicured shrubs placed around the upper zone of the cell. | |
| Additional Details Geotech Probe Observations: Probe depths from the center of the cell ranged from 0.5-0.9 feet where they met resistance due to gravels (plans call for 1.5' of bioretention soil). Probe depths were measured to be the shallowest in the central portion of the cell (0.5'). The width of the underdrain trench ranged from 5.5'-7.5' wide and the length was estimated to be ~60'. No zones of excessive compaction were observed. | |

Hand Auger

| | |
|--|--|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
 Cell: Basin C Raingarden


Assessed On:
 August 10, 2023



| | |
|---|---|
| HA-1-WP | |
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | |
| to Import/Underdrain: | 0.5 |
| Total Depth: | 7 |
| Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown, f-m SAND, some coarse sand, some silt, abundant organics (SW-SM) | |
| Native Soil Texture: Loose, sl. moist, dark brownish-gray, gravelly, f-m SAND, some coarse sand, trace silt, trace rootlets (SP). | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Filter fabric above and below gravel trench. |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 2.7 | |



AUPQ HA-1.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
 Cell: Basin C Raingarden

Assessed On:
 August 10, 2023



HA-1-WP

IMG_1723.jpg



IMG_3434.jpg

Additional Details

- 0-0.3': Beauty bark
- 0.3-0.5': Bioretention soil mix
- 0.5': Geotextile filter fabric
- 0.5-1.5': Underdrain gravels
- 1.5': Filter fabric
- 1.5-7': Green River Alluvium (Native)

HA-2

- Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.3

to Native Soil:

to Import/Underdrain: 0.9

Total Depth: 0.9

Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown, f-m SAND, some coarse sand, some silt, abundant organics (SW-SM)

Native Soil Texture: N/A

Liner Present:

- Yes No

Filter Fabric Present:

- Yes No

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
 Cell: Basin C Raingarden

Assessed On:
 August 10, 2023



| | |
|---|---------------|
| HA-2 | |
| | Fabric at 0.9 |
|  | |
| IMG_3436.jpg | |
| Additional Details | |

| | |
|--|---|
| HA-3 | |
| <input type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input checked="" type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | 0.8 |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown, f-m SAND, some coarse sand, some silt, abundant organics (SW-SM) Native Soil Texture: Loose, moist, grayish brown silty f-m SAND (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
 Cell: Basin C Raingarden

Assessed On:
 August 10, 2023



HA-3



IMG_3437.jpg

Additional Details

Exploration completed outside the underdrain trench approximately 85' from the overflow structure. No filter fabric or underdrain gravels were encountered.

Outside trench. No filter fabric, no gravels encountered.

HA-4

- Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.2

to Native Soil:

to Import/Underdrain: 0.7

Total Depth: 0.7

Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown, f-m SAND, some coarse sand, some silt, abundant organics (SW-SM)

Native Soil Texture:

Liner Present:

- Yes No

Filter Fabric Present:

- Yes No
 Fabric at 0.7

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
Cell: Basin C Raingarden

Assessed On:
August 10, 2023



HA-4



IMG_3438.jpg

Additional Details

Infiltration Test

IT-1

| | |
|--|--------|
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 210 |
| Ponded Depth (ft) | 0.28 |
| Total Gallons | 28,088 |
| Steady State Flow Rate (GPM) | 80 |

Additional Details:
Water hit the underdrain pipe within 10 minutes of the test start time.



BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
Cell: Basin C Raingarden

Assessed On:
August 10, 2023



IT_Photo-20230810-215547.jpg



IT_Photo-20230810-215614.jpg



IT_Photo-20230810-215629.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Pick Quick (AUPQ)
Cell: Basin C Raingarden










Assessed On:
August 10, 2023



SITE: PICK QUICK (AUPQ) CELL: CELL 1



LEGEND

-  WELL POINT
-  HAND AUGER
-  TEMPORARY STAFF GAUGE
-  INLET
-  OVERFLOW STRUCTURE
-  DIFFUSER
-  TOP OF FACILITY
-  BASE OF FACILITY
-  WETTED AREA



1 in = 40 ft

LOCATION AND DISTANCES
ARE APPROXIMATE.



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Well Point

AUPQ-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 2

Multiple Locations

Start Date: 8/10/23

Logged By: APJ

20150387H008

Ending Date: 8/10/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 7

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 6.2

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 101.5

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction | |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|----|-------------------|---|
| | | | | | | Blows/6" | 10 | 20 | 30 | 40 | | 50+ |
| 0 | | | | Bark Loose, coarse, woody bark. | | | | | | | | Stick up -1.5 to 0 feet |
| | Hand | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt; abundant organics (SW-SM). Black, geotextile, filter fabric. | | | | | | | | Existing bioretention soil 0 to 0.8 feet |
| 1 | Hand | 2 | | Gravel Drain Rock Loose, slightly moist, gray, GRAVEL (GP). Black, geotextile, filter fabric. | | | | | | | | Existing gravel drain rock 0.8 to 1.5 feet |
| 2 | Hand | 3 | | Green River Alluvium Loose, slightly moist, dark brownish gray, gravelly, fine to medium SAND, some coarse sand, trace silt; trace rootlets (SP). Becomes some silt; present in clumps (SW-SM). | | | | | | | | Medium grain silica filter sand 1.5 to 2.6 feet |
| 3 | | | | Interbed of dark brown silt recovered as clasts. Becomes trace silt. | | | | | | | | 1.25-inch I.D. threaded galvanized steel casing -1.5 to 3 feet |
| 4 | Hand | 4 | | Becomes moist; increasing augering resistance. | | | | | | | | 3/8-inch bentonite chips 2.6 to 2.8 feet |
| 5 | Hand | 5 | | Becomes lightly oxidized. | | | | | | | | Native sand 2.8 to 6.2 feet |
| 6 | Hand | 6 | | | | | | | | | | 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 3 to 5.6 feet |
| 7 | Hand | 7 | | Bottom of hole. No seepage. No caving. Stopped excavation for | | | | | | | | Cast iron end cap 5.6 to 5.9 feet |
| | | | | | | | | | | | | Cast iron drive point 5.9 to 6.2 feet |

1/24/2024

20150387H008



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Well Point

AUPQ-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 2 of 2

Multiple Locations
20150387H008

Start Date: 8/10/23
Ending Date: 8/10/23

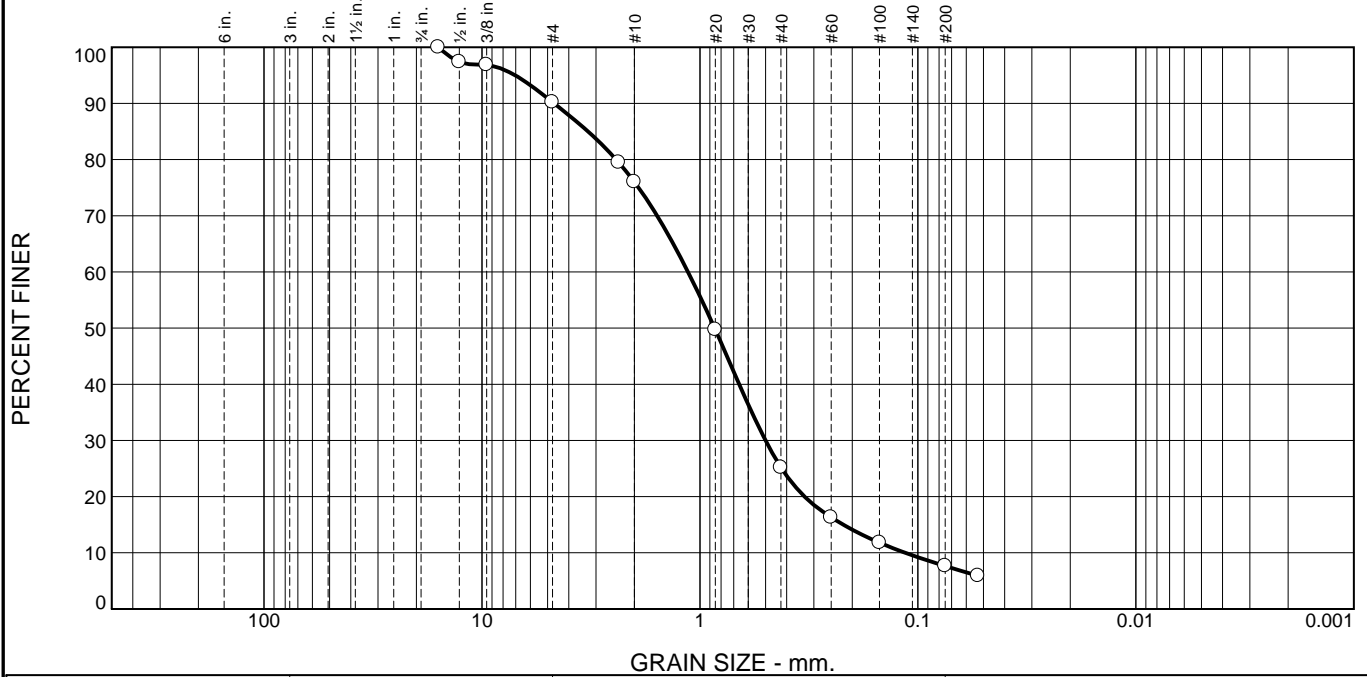
Logged By: APJ
Approved By: JHS

Driller/Equipment: Hand Auger
Hammer Weight/Drop: N/A
Hole Diameter (in): 4
Ground Surface Elevation (ft): 100
Water Level Elevation (ft): N/A
Total Depth (ft): 7
Well Completion Depth (ft): 6.2
Well Tag No.: N/A
Top of Well Casing Elevation (ft): 101.5
Datum: Project Datum
Groundwater Depth ATD (ft): Not encountered
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|----|-------------------|
| | | | | | | Blows/6" | 10 | 20 | 30 | 40 | |
| 8 | | | | time constraints and maximum wellpoint depth. Hole backfilled 0.8 feet to allow for wellpoint stickup. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 9 | | | | | | | | | | | |
| 10 | | | | | | | | | | | |
| 11 | | | | | | | | | | | |
| 12 | | | | | | | | | | | |
| 13 | | | | | | | | | | | |
| 14 | | | | | | | | | | | |

1/24/2024
20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.8 | 14.2 | 50.8 | 17.6 | 7.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 97.4 | | |
| 3/8" | 96.8 | | |
| #4 | 90.2 | | |
| #8 | 79.5 | | |
| #10 | 76.0 | | |
| #20 | 49.7 | | |
| #40 | 25.2 | | |
| #60 | 16.3 | | |
| #100 | 11.8 | | |
| #200 | 7.6 | | |
| #270 | 5.9 | | |

Material Description

SAND, some gravel, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 4.6692 D₈₅= 3.2619 D₆₀= 1.1345
D₅₀= 0.8566 D₃₀= 0.5003 D₁₅= 0.2200
D₁₀= 0.1143 C_u= 9.92 C_c= 1.93

Remarks

Date Received: 8/10/2023 Date Tested: 9/21/2023

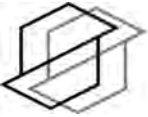
Tested By: FEW

Checked By: APJ/JHS

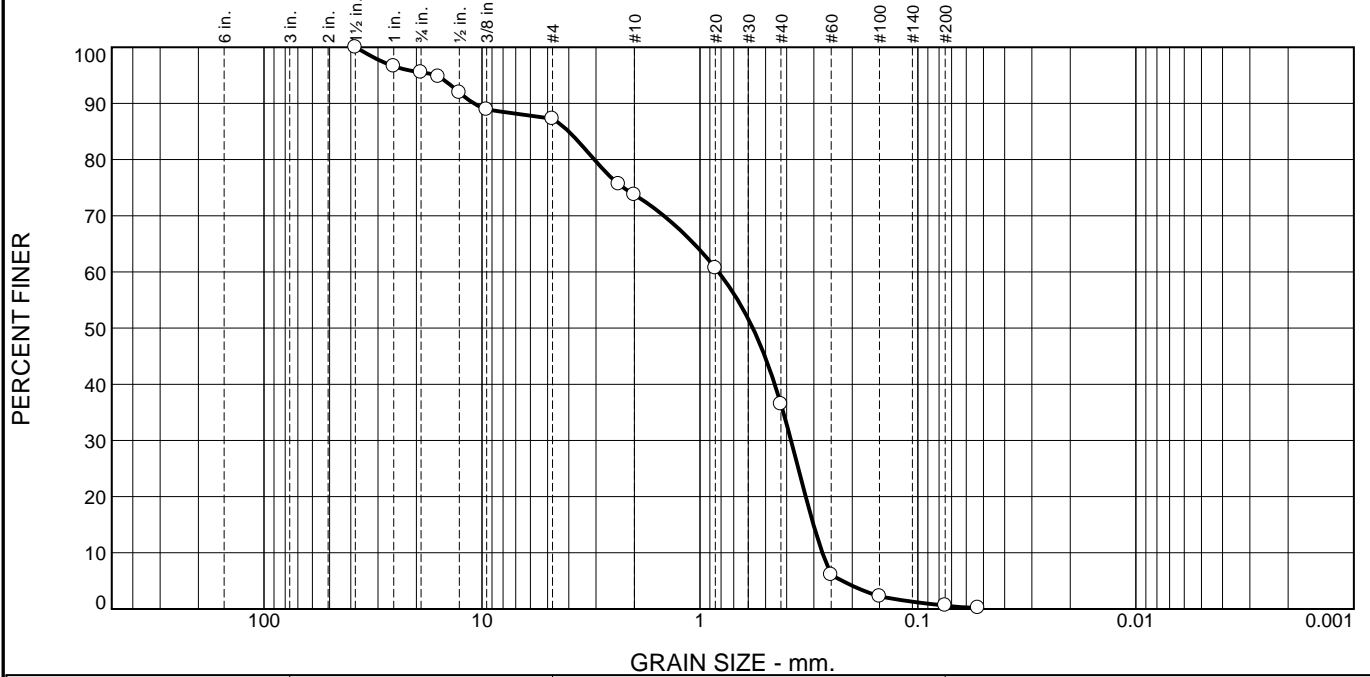
Title: _____

* (no specification provided)

Location: Onsite - Pick Quick Date Sampled: 8/10/2023
Sample Number: HA-1 Depth: .5'

| | | |
|---|--|---------------|
|  | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 | Figure |
|---|--|---------------|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 4.5 | 8.2 | 13.5 | 37.3 | 35.9 | 0.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 96.6 | | |
| 3/4" | 95.5 | | |
| 5/8" | 94.8 | | |
| 1/2" | 91.9 | | |
| 3/8" | 88.9 | | |
| #4 | 87.3 | | |
| #8 | 75.6 | | |
| #10 | 73.8 | | |
| #20 | 60.7 | | |
| #40 | 36.5 | | |
| #60 | 6.1 | | |
| #100 | 2.2 | | |
| #200 | 0.6 | | |
| #270 | 0.2 | | |

* (no specification provided)

Material Description

gravelly SAND, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 10.8838 D₈₅= 4.0015 D₆₀= 0.8234
D₅₀= 0.5720 D₃₀= 0.3820 D₁₅= 0.3013
D₁₀= 0.2745 C_u= 3.00 C_c= 0.65

Remarks

Date Received: 8/10/2023 Date Tested: 9/7/2023

Tested By: FEW

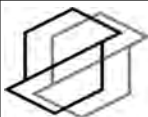
Checked By: APJ/JHS

Title: _____

Location: Onsite - AUPQ
Sample Number: HA-1

Depth: 1.5-2.3'

Date Sampled: 8/10/2023



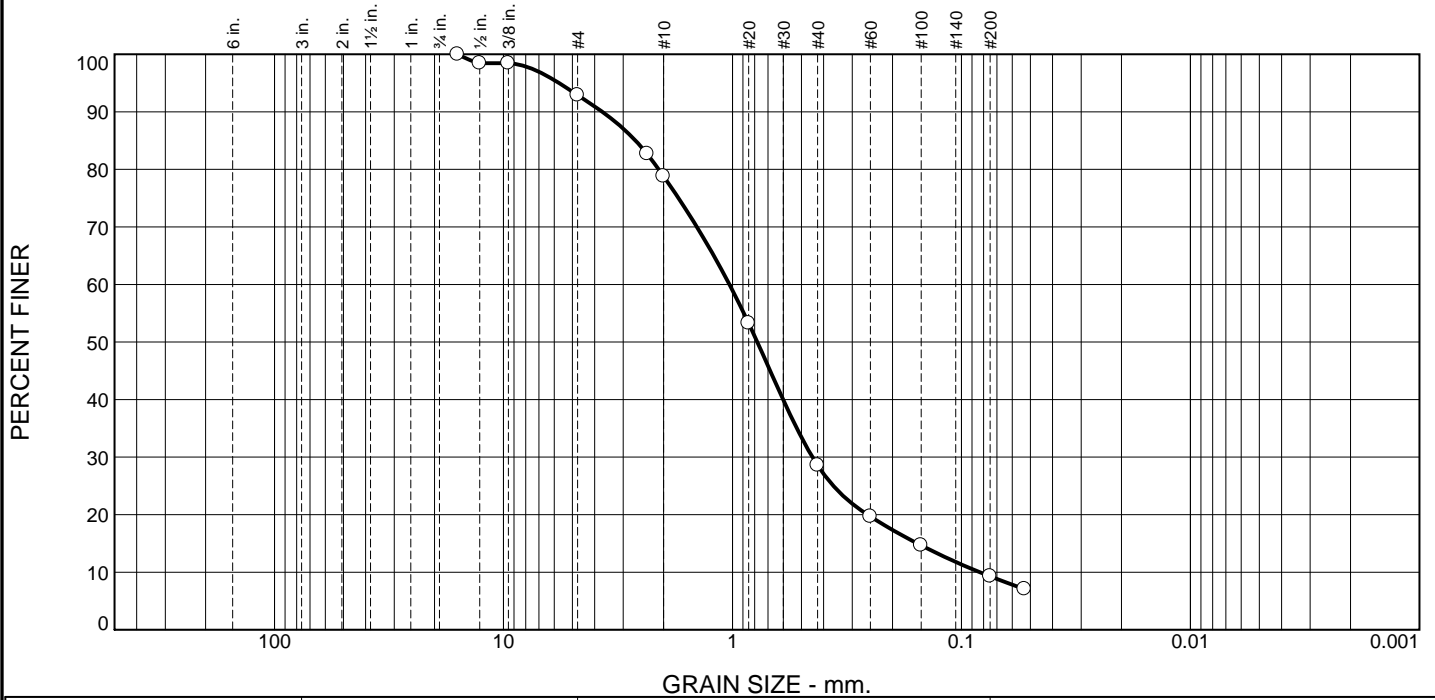
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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 7.1 | 14.1 | 50.2 | 19.3 | 9.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 98.5 | | |
| 3/8" | 98.5 | | |
| #4 | 92.9 | | |
| #8 | 82.7 | | |
| #10 | 78.8 | | |
| #20 | 53.3 | | |
| #40 | 28.6 | | |
| #60 | 19.7 | | |
| #100 | 14.7 | | |
| #200 | 9.3 | | |
| #270 | 7.1 | | |

* (no specification provided)

Material Description

BSM
SAND, some gravel, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.7045 | D ₈₅ = 2.6510 | D ₆₀ = 1.0307 |
| D ₅₀ = 0.7790 | D ₃₀ = 0.4474 | D ₁₅ = 0.1558 |
| D ₁₀ = 0.0832 | C _u = 12.39 | C _c = 2.34 |

Remarks

Date Received: 8/10/2023 Date Tested: 9/21/2023

Tested By: FEW

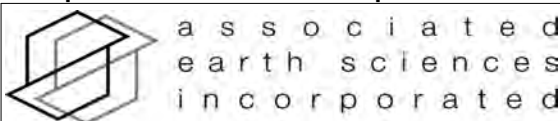
Checked By: APJ/JHS

Title: _____

Location: Onsite - Pick Quick
Sample Number: HA-4

Depth: 0.2-0.7'

Date Sampled: 8/10/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|-------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/10/2023 | Project BHPS - AUPQ | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Auburn, WA | EB/EP No. AUPQ-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.5' | HA-4 @ 0.2-0.7' |
|--------------------|-------------|-----------------|
| Wet Weight + Pan | 861.58 | 991.18 |
| Dry Weight + Pan | 830.03 | 919.59 |
| Weight of Pan | 247.10 | 391.95 |
| Weight of Moisture | 31.55 | 71.59 |
| Dry Weight of Soil | 582.93 | 527.64 |
| % Moisture | 5.41 | 13.57 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 830.03 | 919.59 |
| Dry Soil After Burn + Pan | 758.34 | 863.53 |
| Weight of Pan | 247.10 | 391.95 |
| Wt. Loss Due to Ignition | 71.69 | 56.06 |
| Actual Wt. Of Soil After Burn | 511.24 | 471.58 |
| % Organics | 12.30 | 10.62 |

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| | | | |
|------------------------|-----------------------------|--------------------------------|-----------------------------------|
| Project Name: | Auburn Pick Quick (Basin C) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 8/10/2023 | Wetted Area (sq. feet): | 10:30: 104 ft^2 / 16:00: 210 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Dispersal Pipe |
| Test No.: | IT-1 | Test Depth (feet): | 0.28 |
| Performed By: | APJ | Receptor Soils: | Green River Alluvium |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|---|
| 10:01 | 15.25 | 0.00 | 2.9 | dry | | Water on |
| 10:03 | 15.25 | 0.06 | | | 107 | |
| 10:05 | 15.24 | 0.04 | | | 128 | Flow turned down |
| 10:07 | 54.26 | | 2.1 | | 184 | Slowly increasing flow rate to decrease scouring water observed in CB (2.1) |
| 10:10 | 35.85 | 0.08 | | | 303 | |
| 10:15 | 36.13 | 0.10 | | | 481 | Flow increased ~45 gpm |
| 10:20 | 35.9 | 0.10 | | | 663 | |
| 10:25 | 45.36 | 0.12 | | | 882 | |
| 10:27 | | | 1.86 | dry | | |
| 10:31 | 45.3 | 0.10 | | | 1,153 | |
| 10:45 | 45.19 | 0.10 | 1.68 | | 1,783 | CB filling |
| 11:00 | 44.96 | 0.10 | 1.62 | | 2,485 | |
| 11:15 | 44.85 | 0.10 | 1.5 | | 3,137 | |
| 11:41 | 44.9 | 0.10 | 1.41 | dry | 4,290 | |
| 11:45 | 44.9 | 0.10 | 1.4 | | 4,504 | |
| 12:00 | 44.74 | 0.10 | 1.36 | dry | 5,147 | No changes in ponded area |
| 12:01 | | 0.11 | | | | |
| 12:16 | 45.63 | 0.11 | 1.33 | | 5,895 | Flow up to 60 |
| 12:30 | 63.46 | 0.14 | 1.24 | | 6,715 | |
| 12:46 | 63.97 | 0.14 | 1.21 | 5.57 | 7,765 | |
| 13:00 | 63.97 | 0.14 | 1.21 | 5.42 | 8,655 | Flow up to 82 |
| 13:15 | 81.95 | 0.17 | 1.05 | 5.19 | 9,872 | |
| 13:30 | 82.69 | 0.18 | 0.97 | 5.01 | 11,115 | |
| 13:45 | 82.8 | 0.18 | 0.91 | 4.89 | 12,333 | |
| 14:00 | 82.46 | 0.18 | 0.85 | 4.76 | 13,621 | |
| 14:15 | 82.52 | 0.19 | 0.82 | 4.68 | 14,832 | |
| 14:32 | 82.91 | 0.20 | 0.75 | 4.59 | 16,184 | Flow down to 70 |
| 14:45 | 71.67 | 0.19 | 0.83 | 4.58 | 17,155 | Flow up to 87 |
| 15:02 | 79.46 | 0.20 | 0.74 | 4.51 | 18,520 | |
| 15:15 | 79.3 | 0.20 | 0.72 | 4.46 | 19,523 | |
| 15:30 | 79.07 | 0.20 | 0.68 | 4.4 | 20,713 | |
| 15:45 | 78.79 | 0.22 | 0.67 | 4.37 | 21,895 | |
| 16:00 | 78.61 | 0.22 | 0.63 | 4.32 | 23,093 | |
| 16:11 | 78.61 | 0.24 | 0.62 | 4.36 | 23,942 | |
| 16:20 | 79.62 | 0.24 | 0.6 | 4.26 | 24,660 | |
| 16:31 | 79.57 | 0.25 | 0.55 | 4.23 | 25,537 | |
| 16:40 | 80 | 0.26 | 0.54 | 4.2 | 26,245 | |
| 16:50 | 80.09 | 0.27 | 0.51 | 4.18 | 27,048 | |
| 17:03 | 80 | 0.28 | 0.52 | 4.15 | 28,088 | Water Off |
| 17:03:30 | | 0.26 | 0.52 | | | |
| 17:04 | | 0.24 | | | | |
| 17:05 | | 0.20 | | | | |
| 17:06 | | 0.14 | | | | |

| | | | | | | |
|-------|--|------|------|------|--|---|
| 17:07 | | 0.06 | | | | |
| 17:08 | | 0.00 | | 4.28 | | |
| 17:13 | | | 1.26 | 4.53 | | |
| 17:18 | | | 1.46 | 4.64 | | |
| 17:23 | | | 1.62 | 4.87 | | |
| 17:26 | | | 1.73 | 5.03 | | |
| 17:35 | | | 2.12 | 5.56 | | |
| 17:46 | | | dry | 5.92 | | Catch basin observed to be dry, may have gone dry sooner. |
| 17:51 | | | | 6.08 | | |
| 18:00 | | | | 6.39 | | Removed wellpoint |

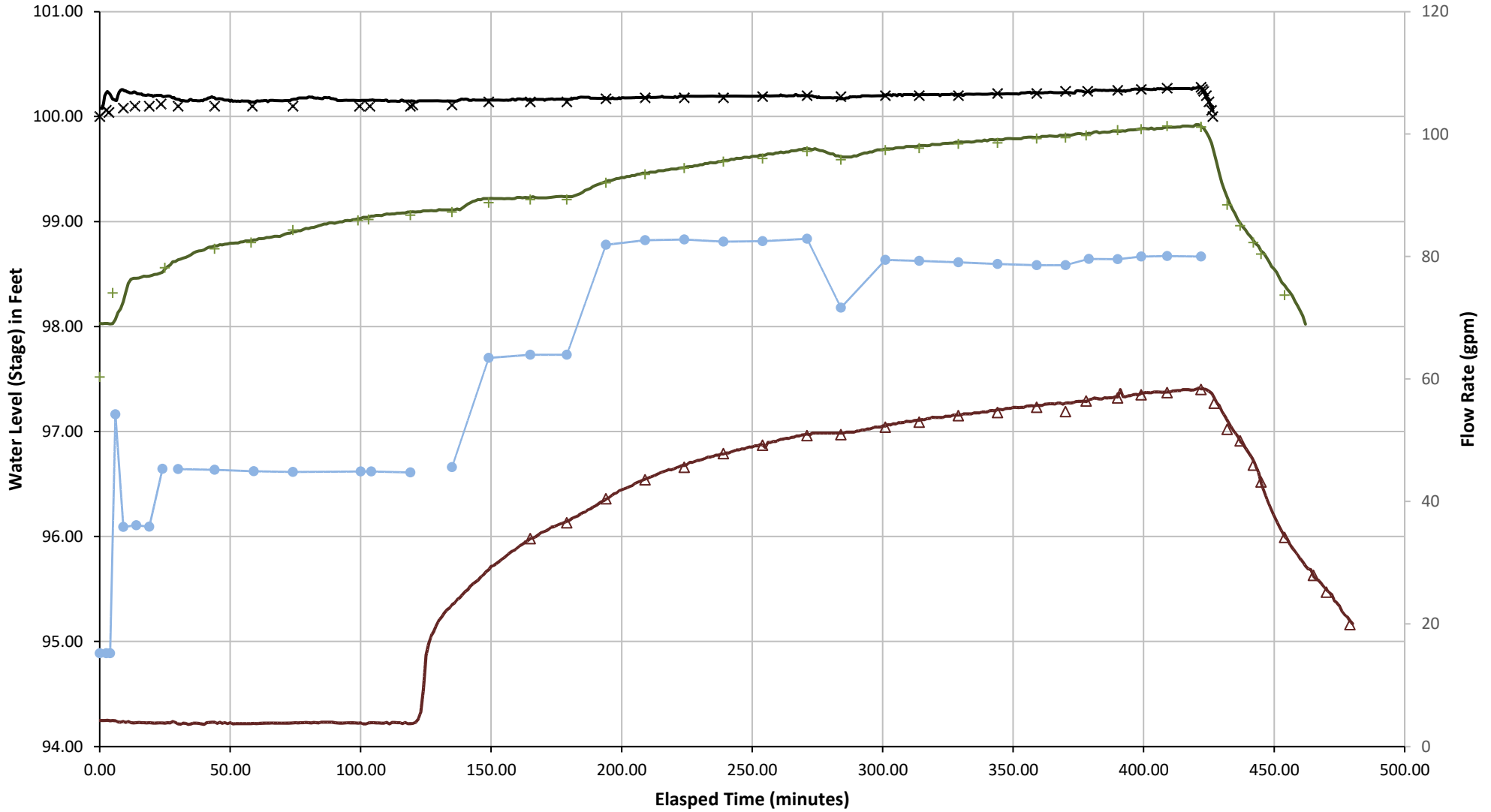
| | |
|--|------|
| SG-1 Bioretention Soil Average Infiltration Rate (in/hr) during last hour of inflow: | 35.7 |
| SG-1 Bioretention Soil Average Infiltration Rate (in/hr) during falling head: | 33.6 |

| | |
|---|------|
| Native Soils Average Infiltration Rate (in/hr) during last hour of inflow (Wellpoint Response): | 38.3 |
| Native Soils Average Infiltration Rate (in/hr) during falling head (Wellpoint Response): | 29.2 |

| | |
|---|------|
| Native Soils Average Infiltration Rate (in/hr) during last hour of inflow (Catch Basin Response): | 37.8 |
| Native Soils Average Infiltration Rate (in/hr) during falling head (Catch Basin Response): | 26.0 |

Pick Quick Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface. Catch Basin set in native soils

- × Staff Gauge #1 Hand Data
- △ Wellpoint Hand Data
- Catch Basin Logger
- Flow Rate (gpm)
- Staff Gauge #1 Logger
- Wellpoint Logger Data
- + Catch Basin Hand

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
Cell: Cell 1

Assessed On:
July 5, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2003 and collects runoff through two curb cut inlets from the adjacent parking lot. The cell is constructed with 1.5-2' of bioretention soil set above geomembrane filter fabric. The cell is divided into three sections by two sets of 2"x8' "plastic wood spreader weirs" which run northeast-southwest along the cell base. Beneath the bioretention soil and filter fabric sits 3 six-inch lifts of gravel drain rock, each lift wrapped in filter fabric. There is no underdrain set in the gravels and all water is designed to infiltrate into the subsurface. A 6-inch diameter, 3.8' deep PVC monitoring well sits in the center of the cell. A surface level overflow structure is set behind a semi-circular curb which would overtop during overflow conditions.

BIORETENTION SOIL:

Thickness: 1-1.7'

The thickness of the loose bioretention soil ranged from 1-1.7' based on soil probes and hand auger explorations with an average depth of 1.4'. This is slightly less than the 1.5' minimum specified by the plans. The thickness of the soil was observed to decrease away from the inlets. HA-1 encountered 1.7' of soil before encountering filter fabric, HA-2 encountered 1.4' of soil, and HA-3 encountered 1' of soil. These depths were confirmed with probe measurements directly adjacent to the hand auger.

Composition: The plans call for the filter material to consist of 20-25% organic matter and 75-80% medium sand with a specified gradation. The sand gradation for the tested material was finer than these specifications and the silt content fell just above the less than 2% specified by the plans. In comparison to the 2019 Ecology specifications, the tested material fell within the specified range for sand gradation but exceeded the silt content specifications. The organic matter content fell within the specified range.

The fines content was observed to decrease with distance away from the inlets in the southwest side of the cell. HA-1, located in weir zone 1 had a fines content of 9.5%, HA-2, located in weir zone 2 had a fines content of 7.5%, and HA-3 located in weir zone 3 had a fines content of 6.0%.

Organic Matter Content (% by weight): 6.9

Percent passing #200 sieve: 7.7

Coefficient of Uniformity (Cu): 7.1

Coefficient of Curvature (Cc): 1.5

SUBGRADE CONDITIONS:

Geologic Unit: Recent Alluvium

Soil Description: N/A

Hand auger explorations did not penetrate the gravel drain rock underneath the bioretention soil.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations. A temporary wellpoint was not installed prior to testing and instead the existing monitoring well was measured during testing. The monitoring

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
Cell: Cell 1

Assessed On:
July 5, 2023



well had a stickup of 0.5' and a total depth of 3.8'. A static water level of 3.14' below top of casing was taken prior to infiltration testing. The monitoring well was observed to increase 1.66' to a maximum depth of 1.49' below top of casing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 98

Subgrade Soil Rate (in/hr): N/A

Since the water supply (hose bib) was not sufficient to fill the entire cell three infiltration tests (IT-1, IT-2, IT-3) were performed in the test cell, one in each weir zone. IT-1 was performed weir zone 1, closest to the inlets and recorded an infiltration rate of 94.1 in/hr. IT-2 was performed in weir zone 2 and recorded an infiltration rate of 101 in/hr. IT-3 was performed in weir zone 3 and recorded an infiltration rate of 162 in/hr.

Infiltration testing performed during phase one of this study in 2016 measured an infiltration rate of 25 in/hr. This test was conducted exclusively in weir zone one.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------|---------------|------------------|
| Weather | Clear, 80s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: APJ | Half Day: | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Parkland |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
 Cell: Cell 1

Assessed On:
 July 5, 2023



Site Photo: FA_SitePhotos-20230705-231112.jpg



Site Photo: FA_SitePhotos-20230705-231206.jpg



Site Photo: FA_SitePhotos-20230705-231146.jpg



Site Photo: FA_SitePhotos-20230705-231225.jpg

Cell Construction

| | |
|-----------------------------|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Additional Comments

Water is conveyed to the cell from a low asphalt berm, and the edge of the sidewalk, that channels run off from the adjacent parking lot to the cell via two curb cuts. Water is designed to infiltrate through the bioretention soil before reaching 3 layers of drain rock lined with filter fabric. Cell is separated into three segments divided by 'weirs' overlapping plastic wooden planks that are designed to pool water before passing to the next segment. The rain garden overflow is down gradient of the cell and conveys overflow water to the storm drain network. A monitoring well is located near the center of the cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
Cell: Cell 1

Assessed On:
July 5, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230705-233238.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: There is 0.15 feet of sediment buildup on the downhill, eastern, edge of curb cut. Trace amounts of sediment buildup was observed along the cell bottom. Deposition of sediment and matted organic material was observed behind the inlet.



FA_INBLPhoto-20230705-233552.jpg

Additional Details: No energy dissipation was observed.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
Cell: Cell 1

Assessed On:
July 5, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230705-234001.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 35% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Sediment accumulation was observed on the downhill, southern, side if inlet. Matted leaves fixed to the sides of plants adjacent to the inlet up to 0.7' above ground. A plant was observed growing in the organic buildup on the inlet.



FA_INBLPhoto-20230705-233949.jpg

Additional Details: No energy dissipation was observed.


BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
 Cell: Cell 1

Assessed On:
 July 5, 2023



Design Overflow/Outlet

| | |
|--|---|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input type="checkbox"/> Rectangular <input checked="" type="checkbox"/> Other: Semicircle Additional Details: The overflow is a 9.5' diameter semicircle which divides the bioretention cell from the overflow catch basin at ground level. | Dimensions:  |
| Stickup (ft) From Ground: 0.5 Relative from staff gauge: 0.3 | FA_DOPhoto-20230705-234423.jpg |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

| | |
|--|---|
| DO - 2 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other Additional Details: | Dimensions: Length: 1.75' Width: 1.4' |
| Stickup (ft) From Ground: 0 Relative from staff gauge: |  |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

Cell Surface and Geotech Probe Observations

| | |
|--|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | |
| Cell Coverage | |
| Mulch | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% |
| Natural mulch covers nearly 100% of the cell. Primarily dead sticks and leaves. Up to 0.4' deep of debris. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
 Cell: Cell 1

Assessed On:
 July 5, 2023



Large Deposition of Feces Yes No

Additional Details:

Vegetation Description

The cell is densely vegetated. Vegetation limits access to interior of the cell and limits visibility and access to measure pond. Only passageways into the cell are near parking spot in between two inlets and from the northeast near IT-3.

Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 1-1.7' of bioretention soil, with an average probe depth of 1.4' before encountering the underdrain gravels. This is slightly less than the 1.5' minimum specified by the plans. No zones of compaction were observed. Some areas of the cell could not be probed due to thick, prickly vegetation.

Hand Auger

HA-1

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.2

to Native Soil:

to Import/Underdrain: 1.7

Total Depth: 1.7

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, some silt, trace gravel, abundant organics (SW-SM)

Native Soil Texture: Drain rock: Loose, moist, gray, rounded, 1" GRAVEL (GP)

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Black geomembrane filter fabric encountered at 1.7'

Additional Details

HA-2

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0

to Native Soil:

to Import/Underdrain: 1.4

Total Depth: 1.5

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, some silt, trace gravel, abundant organics (SW-SM)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)
Cell: Cell 1

Assessed On:
July 5, 2023



| | |
|---|--|
| HA-2 | |
| Native Soil Texture: Drain rock: Loose, moist, gray, rounded, 1" GRAVEL (GP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black geomembrane filter fabric encountered at 1.4' |
| Additional Details | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1 |
| Total Depth: | 1 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, some silt, trace gravel, abundant organics (SP-SM) | |
| Native Soil Texture: Drain rock: Loose, moist, gray, rounded, 1" GRAVEL (GP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |
| No filter fabric was called out on HA-3 logs, filter fabric was encountered in HA-1 and HA-2. | |

Infiltration Test

| | |
|--|----------|
| IT-1 | |
| Water Supply | |
| <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-3 (3-50) | |
| Wetted Pond Area (sq. ft) | 5.4 |
| Ponded Depth (ft) | 0.1 |
| Total Gallons | 1,948.27 |
| Steady State Flow Rate (GPM) | 5.3 |
| Additional Details: | |
| Three infiltration tests were performed. Test statistics above came from IT-1, with the total gallons being the sum of all three tests. IT-1 had the diffuser located closest to inlets 1 & 2. IT-2 had the diffuser located in the middle of the cell, close to Wellpoint. IT-3 had the diffuser located in | |



IT_Photo-20230705-235400.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bloedel Donovan Park (BHBD)

Cell: Cell 1

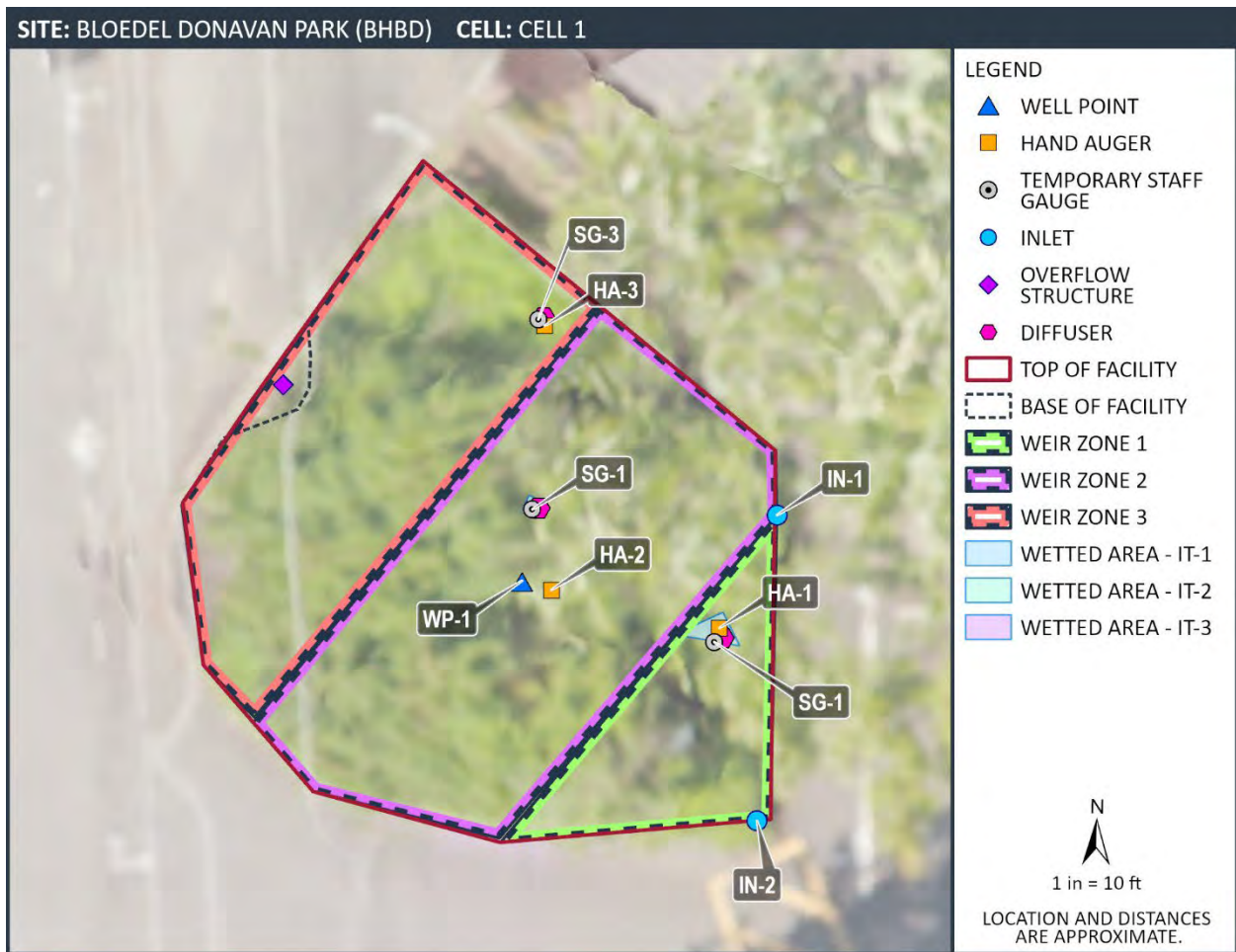
Assessed On:

July 5, 2023



NE edge of the cell, closer to the outlet. Additional test details can be found in the executive summary.

Additional Comments





associated
earth sciences
incorporated

Exploration Boring

BHBD-HA-1

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 07/05/23

Logged By: APJ

20150387H008

Ending Date: 07/05/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.7

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

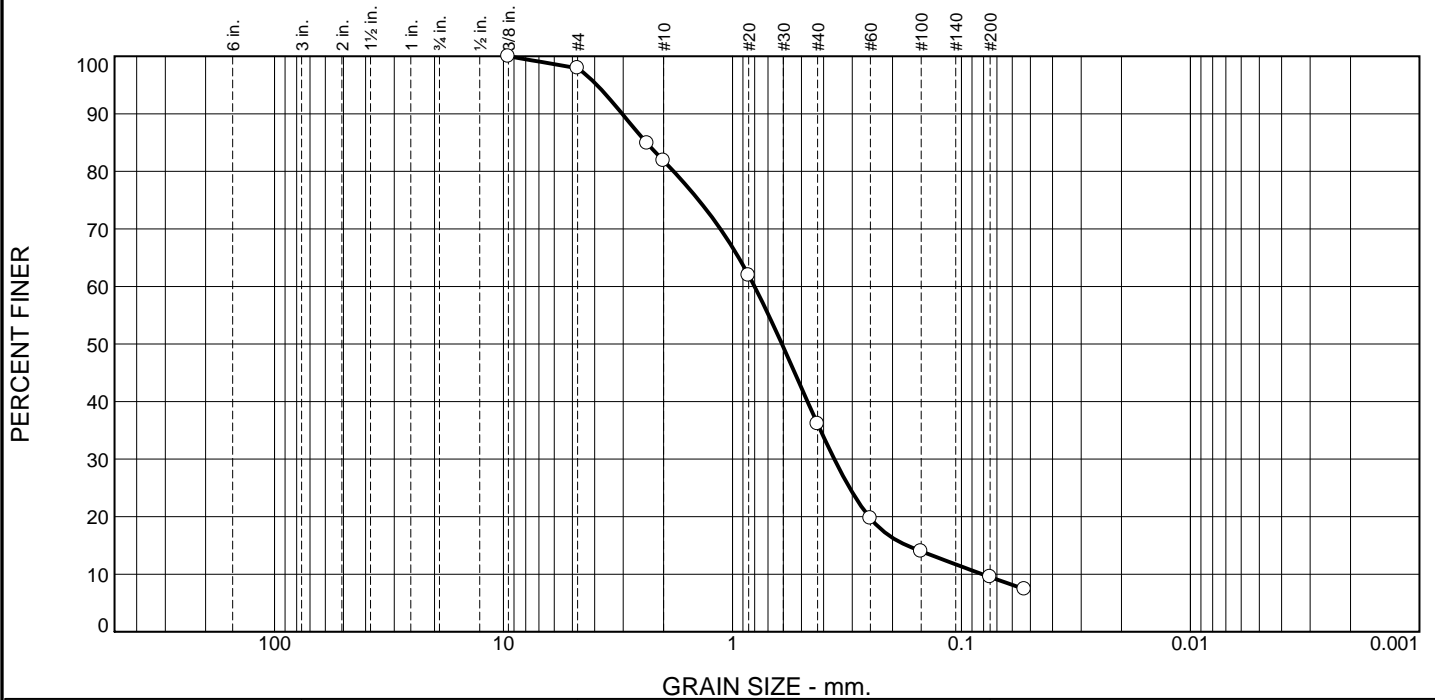
Groundwater Depth Post Drilling (ft) (Date): N/A ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | | |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|--|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | | |
| 0 | | | | | Mulch Loose leaf litter and organic debris. | | | | | | | | | | |
| 1 | | 1 | | | Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, some silt, trace gravel; abundant organics and rootlets (SW-SM). | | | | | | | | | | |
| 2 | | 2 | | | | | | | | | | | | | |
| 4 | | 4 | | | | | | | | | | | | | |
| 2 | | | | | No groundwater encountered. Slough and caving within bioretention soil mix. Black geotextile filter fabric; unable to penetrate filter fabric, underdrain gravel inferred to lie beneath. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | | |

12/18/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.1 | 16.0 | 45.8 | 26.6 | 9.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 97.9 | | |
| #8 | 84.9 | | |
| #10 | 81.9 | | |
| #20 | 62.0 | | |
| #40 | 36.1 | | |
| #60 | 19.7 | | |
| #100 | 14.0 | | |
| #200 | 9.5 | | |
| #270 | 7.4 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.0316 | D ₈₅ = 2.3745 | D ₆₀ = 0.8008 |
| D ₅₀ = 0.6081 | D ₃₀ = 0.3591 | D ₁₅ = 0.1732 |
| D ₁₀ = 0.0811 | C _u = 9.88 | C _c = 1.99 |

Remarks

Date Received: 7/5/2023 Date Tested: 9/21/2023

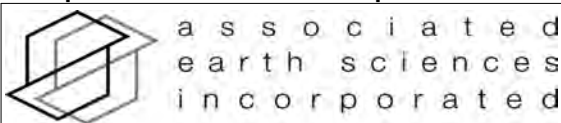
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Bloedel Donovan Park
Sample Number: HA-1 **Depth:** 0-0.7'

Date Sampled: 7/05/2023

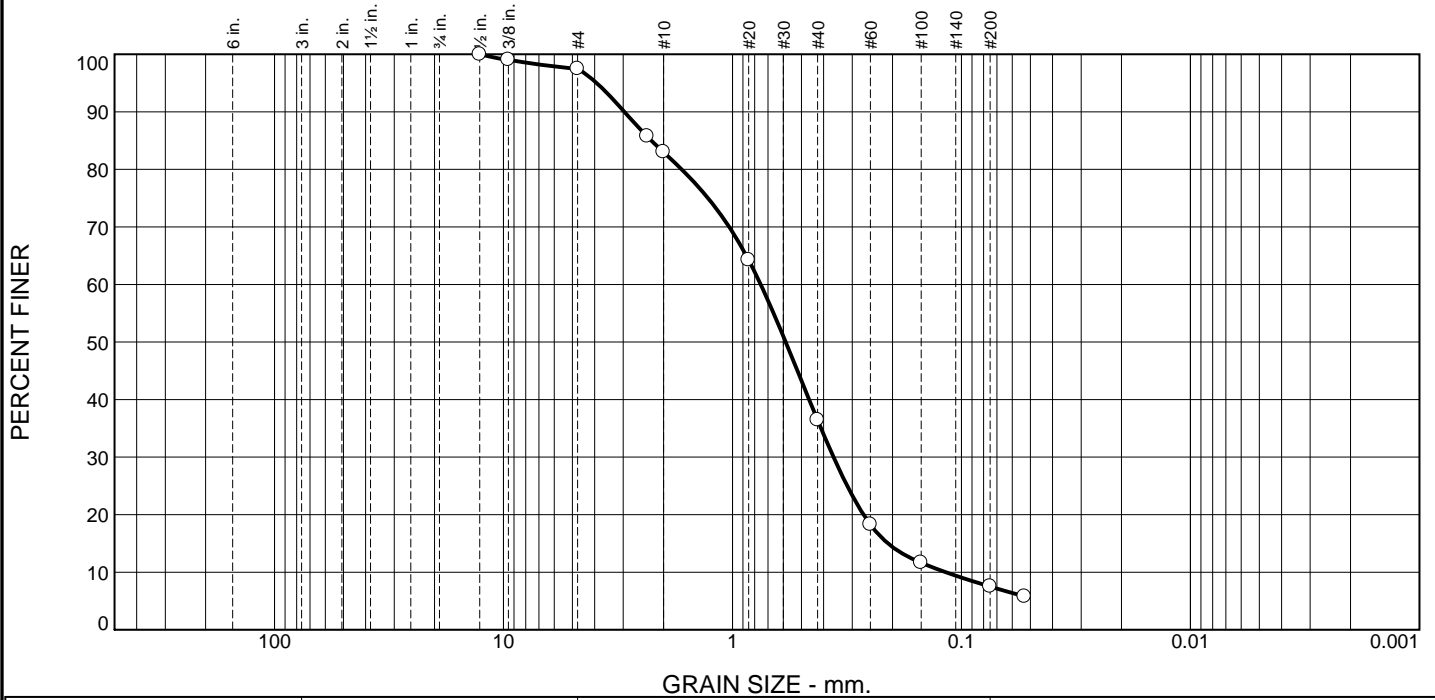


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.5 | 14.5 | 46.6 | 28.9 | 7.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.0 | | |
| #4 | 97.5 | | |
| #8 | 85.7 | | |
| #10 | 83.0 | | |
| #20 | 64.3 | | |
| #40 | 36.4 | | |
| #60 | 18.3 | | |
| #100 | 11.7 | | |
| #200 | 7.5 | | |
| #270 | 5.8 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 2.9646 | D ₈₅ = 2.2602 | D ₆₀ = 0.7527 |
| D ₅₀ = 0.5854 | D ₃₀ = 0.3620 | D ₁₅ = 0.2096 |
| D ₁₀ = 0.1171 | C _u = 6.43 | C _c = 1.49 |

Remarks

Date Received: 7/05/2023 Date Tested: 9/21/2023

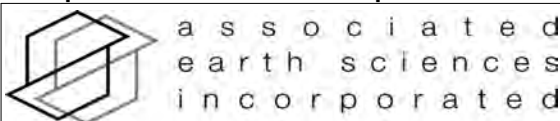
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Bloedel Donovan Park
Sample Number: HA-2 **Depth:** 0-0.5'

Date Sampled: 7/05/2023

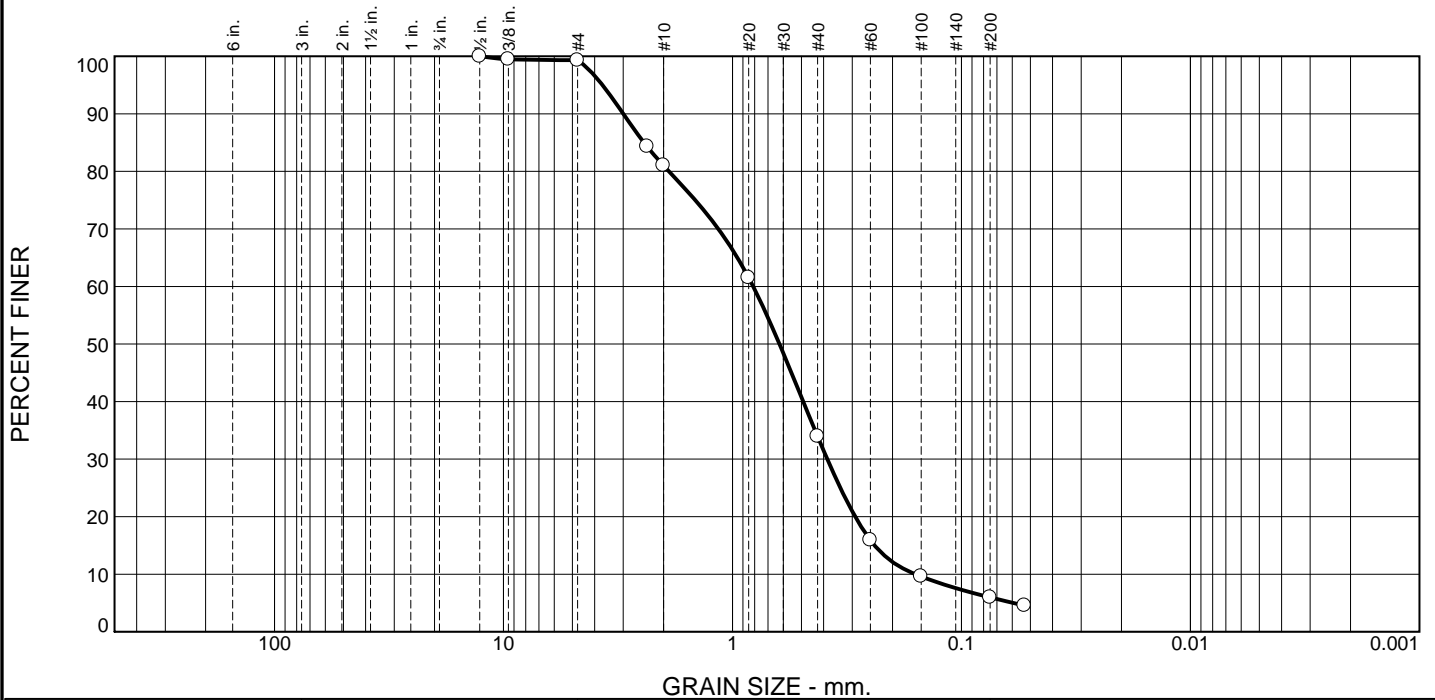


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.7 | 18.3 | 47.0 | 28.0 | 6.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.5 | | |
| #4 | 99.3 | | |
| #8 | 84.3 | | |
| #10 | 81.0 | | |
| #20 | 61.5 | | |
| #40 | 34.0 | | |
| #60 | 15.9 | | |
| #100 | 9.6 | | |
| #200 | 6.0 | | |
| #270 | 4.5 | | |

* (no specification provided)

Material Description

SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 2.9974 | D ₈₅ = 2.4364 | D ₆₀ = 0.8117 |
| D ₅₀ = 0.6235 | D ₃₀ = 0.3854 | D ₁₅ = 0.2395 |
| D ₁₀ = 0.1590 | C _u = 5.10 | C _c = 1.15 |

Remarks

Date Received: 7/05/2023 Date Tested: 8/29/2023

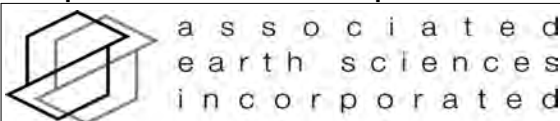
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Bloedel Donovan Park
Sample Number: HA-3 **Depth:** 0.3'

Date Sampled: 7/05/2023

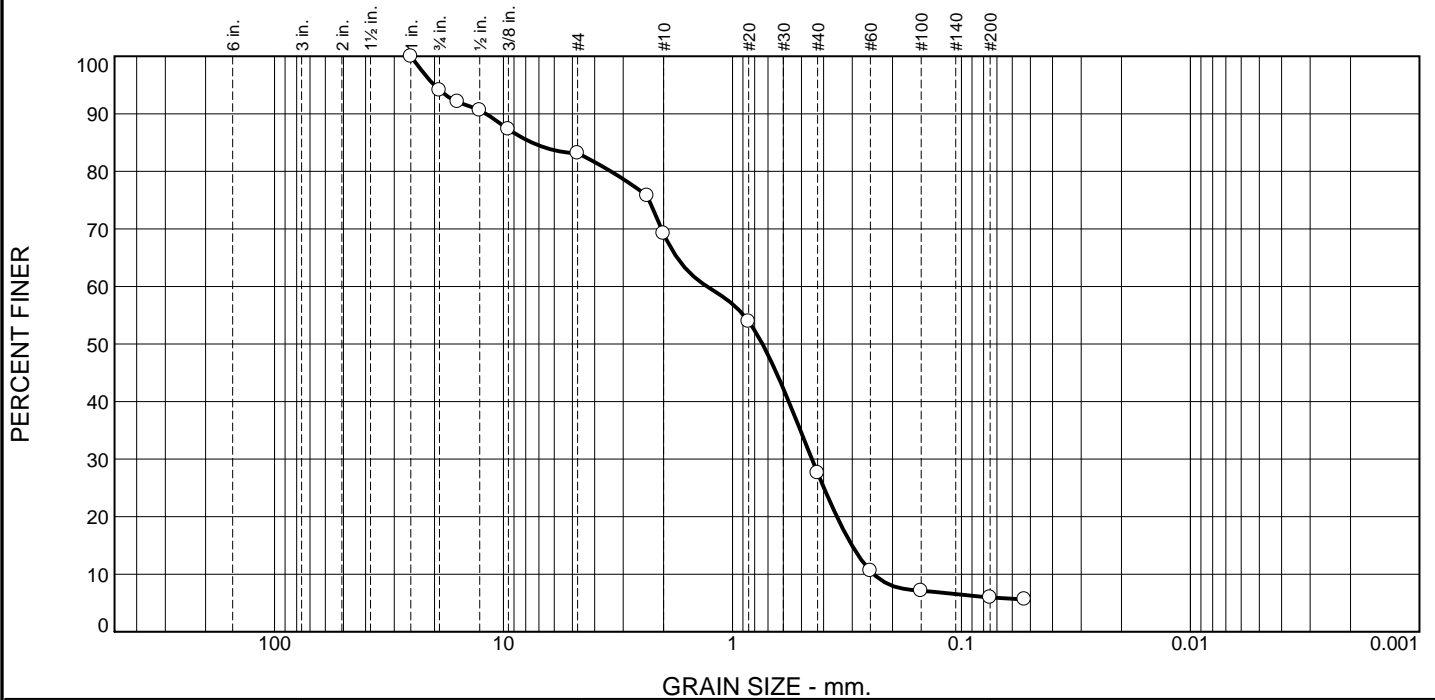


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.9 | 11.0 | 13.9 | 41.6 | 21.6 | 6.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 94.1 | | |
| 5/8" | 92.1 | | |
| 1/2" | 90.6 | | |
| 3/8" | 87.3 | | |
| #4 | 83.1 | | |
| #8 | 75.8 | | |
| #10 | 69.2 | | |
| #20 | 53.9 | | |
| #40 | 27.6 | | |
| #60 | 10.6 | | |
| #100 | 7.1 | | |
| #200 | 6.0 | | |
| #270 | 5.6 | | |

* (no specification provided)

Material Description

BSM
gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 11.9207 D₈₅= 7.4971 D₆₀= 1.2921
D₅₀= 0.7393 D₃₀= 0.4496 D₁₅= 0.3006
D₁₀= 0.2417 C_u= 5.35 C_c= 0.65

Remarks

Composite Sieve

Date Received: 7/05/2023 Date Tested: 7/25/2023

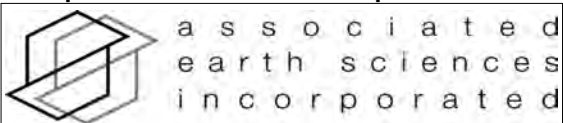
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Bellingham Bloedel Donovan Park
Sample Number: HA-3 **Depth:** 2.5-2.8'

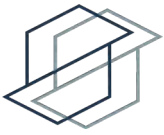
Date Sampled: 7/05/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|---------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 7/5/2023 | Project BHPS - BHBD | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Bellingham, WA | EB/EP No. BHBD-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.7' | HA-2 @ 0-0.5' | HA-3 @ 0.3' |
|--------------------|---------------|---------------|-------------|
| Wet Weight + Pan | 1207.05 | 802.25 | 1443.70 |
| Dry Weight + Pan | 1105.81 | 741.71 | 1327.77 |
| Weight of Pan | 357.95 | 247.49 | 391.95 |
| Weight of Moisture | 101.24 | 60.54 | 115.93 |
| Dry Weight of Soil | 747.86 | 494.22 | 935.82 |
| % Moisture | 13.54 | 12.25 | 12.39 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|---------|--------|---------|
| Dry Soil Before Burn + Pan | 1105.81 | 741.71 | 1327.77 |
| Dry Soil After Burn + Pan | 1044.56 | 705.38 | 1279.15 |
| Weight of Pan | 357.95 | 247.49 | 391.95 |
| Wt. Loss Due to Ignition | 61.25 | 36.33 | 48.62 |
| Actual Wt. Of Soil After Burn | 686.61 | 457.89 | 887.20 |
| % Organics | 8.19 | 7.35 | 5.20 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-----------------------------|--------------------------------|-----------------|
| Project Name: | Bloedel Donovan Park (IT-1) | Water Source: | Hose Bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 7/5/2023 | Wetted Area (sq. feet): | 13:10: 5.4 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Gravel Sump |
| Test No.: | IT-1 | Test Depth (feet): | 0.08 |
| Performed By: | APJ | Receptor Soils: | Fill/Unknown |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #2 (ft) | Monitoring Well (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------------|---------------------|---|
| 11:26 | 7.84 | | 3.15 | | Water on |
| 11:27 | 5.35 | | | 5 | |
| 11:32 | 5.3 | | | 32 | No Ponding |
| 11:35 | 5.3 | | | 51 | |
| 11:36 | 5.3 | | | 53.47 | Water off |
| 11:37 | | | | | Water on - adjust SG closer to SG-1 |
| 11:38 | | | | | Adjust SG again |
| 11:45 | 5.3 | 0.1 | 3.1 | 93 | |
| 11:54 | | | 3.05 | | |
| 12:00 | 5.3 | 0.1 | 2.99 | 172 | |
| 12:15 | 5.3 | 0.1 | 2.92 | 252 | |
| 12:30 | 5.3 | 0.1 | 2.82 | 330 | |
| 12:45 | 5.32 | 0.1 | 2.72 | 409 | |
| 13:00 | 5.32 | 0.1 | 2.63 | 488 | |
| 13:12 | | 0.06 | | | Head drop observed at 13:12; may have occurred sooner |
| 13:15 | 5.26 | 0.04 | 2.54 | 570 | |
| 13:25 | | 0.06 | | | |
| 13:30 | 5.32 | 0.07 | | 645 | |
| 13:45 | 5.32 | 0.08 | 2.41 | 725 | Water off. End of IT-1, move diffuser, clear totalizer. |
| 13:45:30 | | 0 | | | Pond dry |

| | |
|---|-------|
| Average Infiltration Rate (in/hr) during last hour of inflow: | 94.1 |
| Average Infiltration Rate (in/hr) during falling head: | 115.2 |

| | | | |
|------------------------|-----------------------------|--------------------------------|----------------------------|
| Project Name: | Bloedel Donovan Park (IT-2) | Water Source: | Hose Bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 7/5/2023 | Wetted Area (sq. feet): | 15:51: 4.8 ft ² |
| Weather: | Clear, 70's | Underdrain: | Gravel Sump |
| Test No.: | IT-2 | Test Depth (feet): | 0.06 |
| Performed By: | APJ | Receptor Soils: | Fill/Unknown |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Monitoring Well (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------------|---------------------|---|
| 14:07 | 5.34 | | | | Water on IT-2. Briefly ran test in center of cell from 13:48-14:05. Water flowed into catch basin and monitoring point and test was terminated and relocated. |
| 14:10 | | 0.02 | | | |
| 14:12 | 5.34 | 0.02 | | 29 | |
| 14:15 | 5.32 | 0 | | 44 | |
| 14:30 | 5.34 | 0 | 2.24 | 126 | Adjust diffuser. |
| 14:45 | 5.38 | 0.06 | 2.15 | 203 | |
| 15:00 | 5.15 | 0.04 | 2.09 | 283 | |
| 15:15 | 5.2 | 0.06 | 2.02 | 357 | |
| 15:30 | 5.06 | 0.06 | 1.95 | 433 | |
| 15:45 | 5.2 | 0.06 | 1.88 | 510 | |
| 16:00 | 5.2 | 0.06 | 1.84 | 588 | Water off |
| 16:00:30 | | 0 | | | Pond dry |

| | |
|---|-------|
| Average Infiltration Rate (in/hr) during last hour of inflow: | 101.6 |
| Average Infiltration Rate (in/hr) during falling head: | 86.4 |

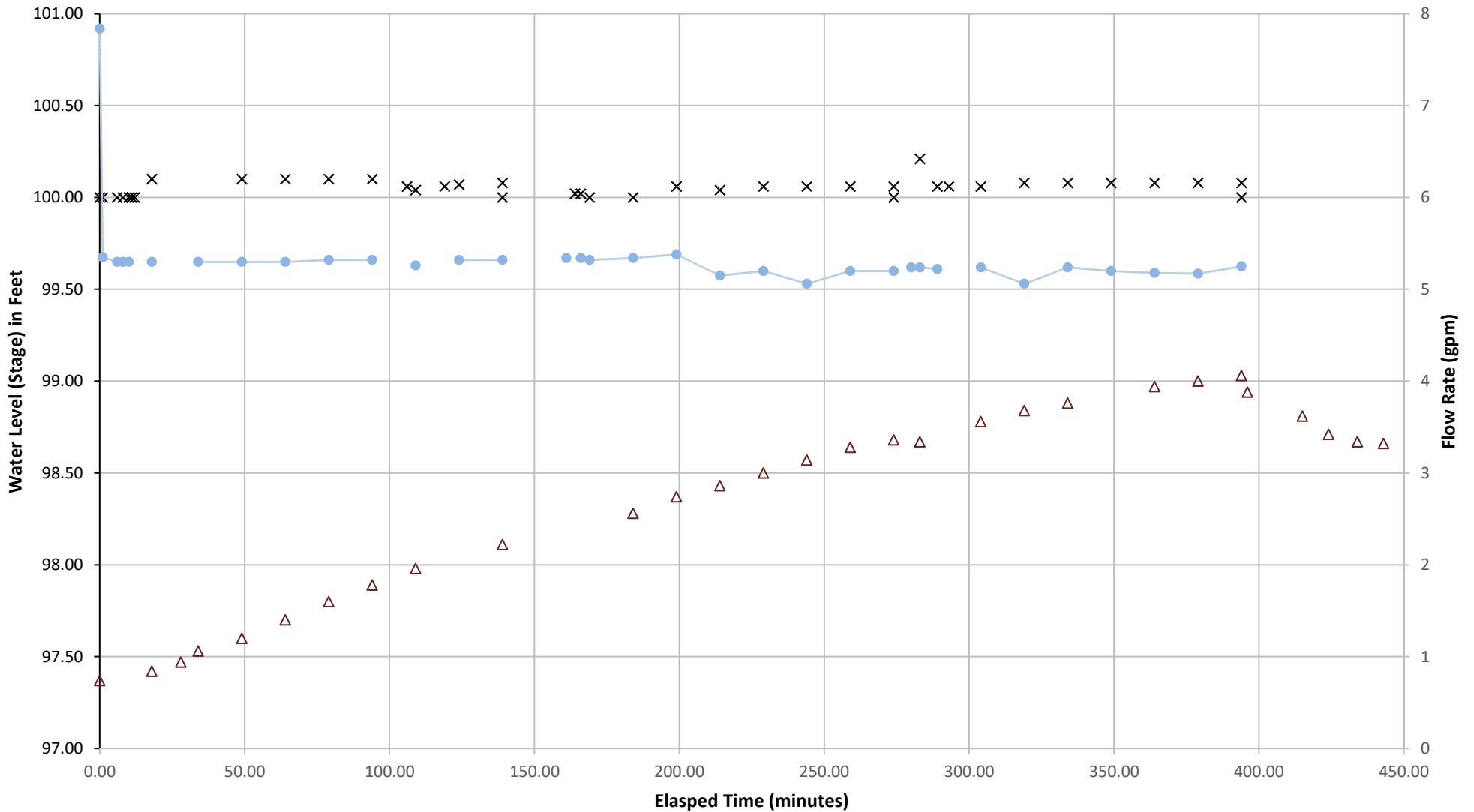
| | | | |
|------------------------|-----------------------------|--------------------------------|---------------|
| Project Name: | Bloedel Donovan Park (IT-3) | Water Source: | Hose Bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 7/5/2023 | Wetted Area (sq. feet): | 17:45: 3 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Gravel Sump |
| Test No.: | IT-3 | Test Depth (feet): | 0.08 |
| Performed By: | APJ | Receptor Soils: | Fill/Unknown |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Monitoring Well (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------------|---------------------|-------------------------------|
| 16:06 | 5.24 | | | | Begin IT-3, Water on |
| 16:09 | 5.24 | 0.21 | 1.85 | 604 | |
| 16:15 | 5.22 | 0.06 | | 640 | Adjust diffuser & staff gauge |
| 16:20 | | 0.06 | | | |
| 16:30 | 5.24 | 0.06 | 1.74 | 712 | |
| 16:45 | 5.06 | 0.08 | 1.68 | 788 | |
| 17:00 | 5.24 | 0.08 | 1.64 | 865 | |
| 17:15 | 5.2 | 0.08 | | 940 | |
| 17:30 | 5.18 | 0.08 | 1.55 | 1020 | |
| 17:45 | 5.17 | 0.08 | 1.52 | 1092 | |
| 18:00 | 5.25 | 0.08 | 1.49 | 1169 | Water off |
| 18:00:15 | | 0 | | | Pond dry |
| 18:02 | | | 1.58 | | |
| 18:21 | | | 1.71 | | |
| 18:30 | | | 1.81 | | |
| 18:40 | | | 1.85 | | |
| 18:49 | | | 1.86 | | Falling head |

| | |
|--|-------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 162.6 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 230.4 |

Bloedel Donovan Park Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

x Staff Gauge #1 Hand Data
△ Monitoring Well Hand Data
—●— Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2003 and collects runoff through three curb cut inlets from the adjacent City Hall parking lot. The cell is constructed with 1.5-2' of bioretention soil set above geomembrane filter fabric. Beneath the filter fabric sits 3 six-inch lifts of gravel drain rock wrapped in filter fabric. There is no underdrain set in the gravels and all water is designed to infiltrate into the subsurface. A surface level overflow structure is set behind a semi-circular curb which would overtop during overflow conditions.

BIORETENTION SOIL:

Thickness: 2.3-2.7

The thickness of the loose bioretention based on hand augers and probe measurements soil ranges from 2.3-2.7' below ground surface with an average thickness of 2.5'. This is greater than the 2' maximum depth specified by the plans.

Composition: The plans call for the filter material to consist of 20-25% organic matter and 75-80% medium sand with a specified gradation. The sand gradation for the tested material was finer than these specifications. The silt content was greater than the less than 2% specified by the plans. In comparison to the 2019 Ecology standards, the sand gradation and silt content fell within the specified range. Soil samples taken from the near IN-2 show evidence of fines and organic accumulation. The fines were measured to be 19.7% and the organic matter content was 19.79%.

Organic Matter Content (% by weight): 4.1

Percent passing #200 sieve: 5.0

Coefficient of Uniformity (Cu): 5.1

Coefficient of Curvature (Cc): 1.3

SUBGRADE CONDITIONS:

Geologic Unit: Fill/Unknown

Soil Description: N/A

BUILT PER PLAN:

More bioretention soil was observed in the cell than was designed. The cell base was also observed to grade towards Whatcom Creek. The elevation in the southwest corner was higher than the overflow curb to the north. Otherwise, the cell was built to plan.

GROUNDWATER CONDITIONS:

No groundwater was encountered during the excavation of hand augers. The temporary wellpoint was screened from 1.-2.8' below ground surface and did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 67.7

Subgrade Soil Rate (in/hr): N/A

Two infiltration tests were performed (IT-1 & IT-2) to test multiple areas of the cell since the soil had a

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



high infiltration rate and our water source (hose bib from adjacent building) did not fill the entire pond. IT-1 was conducted in the southwestern corner of the cell and had a lower infiltration rate (22 in/hr), IT-2 was conducted in the northern corner of the cell, near the overflow structure, and had a higher infiltration rate (67.7 in/hr). The test results from IT-2 were selected as the representative bioretention soil rate.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Heavy accumulation of sediment and organic debris was observed near the inlets which may prevent water from entering the cell.

Field Conditions

| | | | |
|-----------------|---------------|---------------|------------------|
| Weather | Clear, 70's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: APJ | | Half Day: EAP |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 3 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230629-181023.jpg



Site Photo: FA_SitePhotos-20230629-181047.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



Site Photo: FA_SitePhotos-20230629-181116.jpg



Site Photo: FA_SitePhotos-20230629-181138.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell by three curb cuts from the adjacent parking lot. Water is designed to infiltrate through the bioretention soil before reaching drain rock wrapped in geomembrane fabric located below soil and infiltrating into native substrate. The overflow mechanism is a semicircular curb (max height of 0.37 feet from asphalt surface) with catch basin at ground level behind it which discharges to Whatcom creek. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



Inlets

| | |
|--|--|
| IN-1 | |
| <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.1' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  FA_INphoto-20230629-182054.jpg |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor There was a 0.2' deep scour observed in a 1.5' diameter zone near the inlet. | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation mechanism was observed. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.5'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: Buried



FA_INphoto-20230629-182849.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 70% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: The inlet is not immediately blocked but there is significant sediment blocking inlet which would prevent low levels of water from actually entering the cell.



FA_INBLPhoto-20230629-182800.jpg

Additional Details: There is a vertical concrete apron which terminates 6.2' from sidewalk that appears like it was designed to direct water into the center of the cell. However the concrete apron is buried and has created a build up of sediment that partially blocks entry into the cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)

Cell: Cell 1

Assessed On:

June 29, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: Buried



FA_INphoto-20230629-185739.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)

Cell: Cell 1

Assessed On:

June 29, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 70% blocked

Types:

- Sediment
- Organic
- Rock
- Trash
- Vegetation

Additional Details: Sediment and organic debris blocks the the pathway for water to enter the cell.



FA_INBLPhoto-20230629-185720.jpg

Additional Details: There is a vertical concrete apron which terminates 6.2' from sidewalk that appears like it was designed to direct water into the center of the cell. However the concrete apron is buried and has created a build up of sediment that significantly blocks run off into the cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



Design Overflow/Outlet

| | | |
|---|---------------|--|
| DO - 1 | |  <p>FA_DOPhoto-20230629-190005.jpg</p> |
| Shape: | | |
| <input type="checkbox"/> Round | Dimensions: | |
| <input checked="" type="checkbox"/> Rectangular | Length: 1.73' | |
| <input type="checkbox"/> Other | Width: 1.52' | |
| Additional Details: | | |
| Stickup (ft) | | |
| From Ground: 0 | | |
| Relative from staff gauge: -0.37 | | |
| Damage Indicators: | | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: | | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|---|--|--|-----------------------------------|-----------------------------------|---|
| Mulch: <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.2 | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Relatively fresh mulch layer covers the cell base. Natural mulch was observed on the vegetated portion of cell. One can on cell bottom | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Additional Details: | | | | | |
| Vegetation Description | | | | | |
| There is 50% vegetation coverage on the northern side of the cell, including 4 wide trees. Trees on the east side of the cell have been chopped down to their base. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 2.3-2.7 feet of bioretention soil before encountering the filter fabric/underdrain gravels. This is more than the 2' maximum specified by the plans. On the cell edges, near the inlets, less than 1 foot of soil was encountered above existing subgrade. This is consistent with the cell design which shows a steep slope from the base to the edges of the cell. No zones of compaction were observed. | | | | | |

Hand Auger

| | |
|--|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 | <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

Assessed On:
June 29, 2023



| | |
|---|--|
| HA-1 | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | 2.4 |
| Total Depth: | 2.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black geomembrane fabric at 2.4 ft. |
|  | |
| FA_FPhoto-20230629-105811.jpg | |
| Additional Details Sample of filter fabric at 2.4 ft. Auger scraping gravel at 2.4 ft. | |

| | |
|---|---|
| HA-2-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | 2.3 |
| Total Depth: | 2.6 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, some silt, trace gravel, abundant organics, scattered rootlets (SW-SM) | |
| Native Soil Texture: Drain Rock: Loose, moist, brownish-gray, GRAVEL, trace silt (GP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Not encountered in HA-2 but found in HA-1. |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
 Cell: Cell 1

Assessed On:
 June 29, 2023



HA-2-WP

Well Point Detail

Is the well point dry? Yes No
 Depth to water from TOC (ft):
 Respond to Testing: Yes No
 Shallowest Depth to water during testing from Ground Surface (ft):



FA_FPhoto-20230629-110253.jpg

Additional Details

Drain rock gravel ranges from 0.25"-1" diameter.

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.1

to Native Soil: 3

to Import/Underdrain:

Total Depth: 3

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, silty, fine to medium SAND, trace gravel, abundant organics, scattered fine rootlets (SM)

Native Soil Texture: Sandy gravel

Liner Present:
 Yes No

Filter Fabric Present:
 Yes No

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
 Cell: Cell 1

Assessed On:
 June 29, 2023



HA-3



FA_FPhoto-20230629-110835.jpg

Additional Details

More than one unit may be present. Color change from dark brown to brown occurs at 0.8 feet. Auger hit refusal at 3 feet, at a sandy gravel which may be fill or native sediment. HA-3 sits atop surface runoff/ slightly higher elevation than HA-1 and HA-2.

Infiltration Test

IT-1

| | |
|--|----------|
| Water Supply | |
| <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-3 (3-50) | |
| Wetted Pond Area (sq. ft) | 38 |
| Ponded Depth (ft) | 0.12 |
| Total Gallons | 1,436.42 |
| Steady State Flow Rate (GPM) | 8.74 |

Additional Details:
 Two infiltration tests were performed. The first test was conducted near inlet 1 in the southeast corner. The second test was completed closer to the overflow on the north end of the cell. Additional test details can be found in the executive summary.



IT_Photo-20230629-215119.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellingham City Hall (BHCH)
Cell: Cell 1

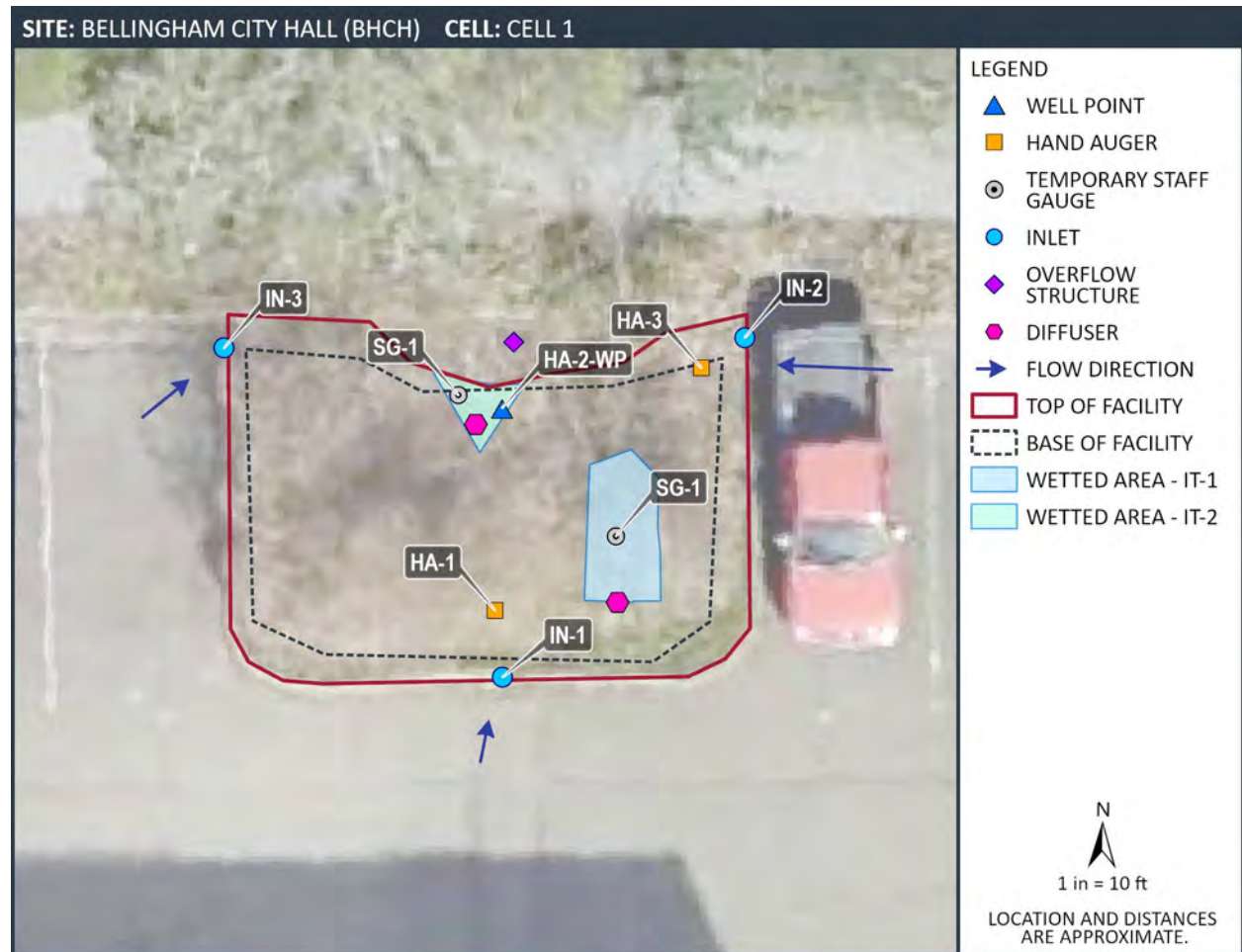
Assessed On:
June 29, 2023



Additional Comments

It is possible that inflows do not actually infiltrate runoff. Inlets 2 & 3 have significant blockages and it is not apparent how water would enter the cell from inlets 2 & 3.

The cell base grades towards the creek. Elevation in the SW is higher than the overflow curb to the north and it is not apparent how water could access that part of the cell. This portion also more vegetated.





associated
earth sciences
incorporated

Well Point

BHCH-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/23/23

Logged By: APJ

20150387H008

Ending Date: 6/23/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.6

Hammer Weight/Drop:

Well Completion Depth (ft): 3.4

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.2

Water Level Elevation (ft): N/A

Datum: Project Datum

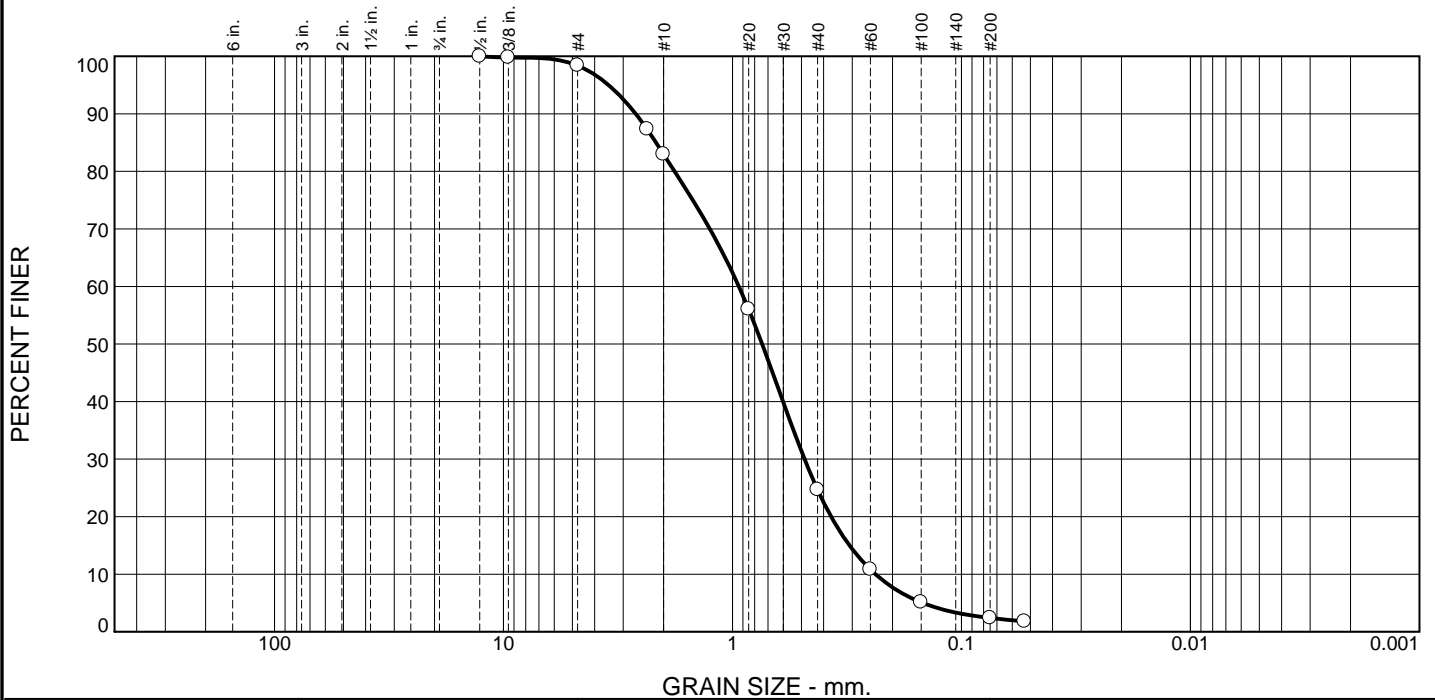
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction | |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|----|-------------------|---|
| | | | | | | Blows/6" | 10 | 20 | 30 | 40 | | 50+ |
| 0 | | | | Mulch Thin, prismatic woody debris. | | | | | | | | Stick up -4.2 to 0.9 feet Existing bioretention soil 0 to 0.8 feet |
| | | 1 | | Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, some silt, trace gravel; abundant fine organics and scattered rootlets (SW-SM). | | | | | | | | |
| 1 | | 2 | | | | | | | | | | 3/8-inch bentonite chips 0.8 to 1.4 feet |
| | | 3 | | | | | | | | | | Medium grained silica sand 1.4 to 3.4 feet |
| 2 | | 4 | | | | | | | | | | 1.25-inch I.D. threaded galvanized steel casing -4.2 to 0.1 feet; duct tape covered screen 0.1 to 1.8 feet |
| | | 5 | | Black geotextile filter fabric. | | | | | | | | 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel gauge 1.8 to 2.8 feet |
| | | 6 | | Gravel Drain Rock Loose, moist, brownish gray, GRAVEL, trace silt (GP). | | | | | | | | Cast iron drive endcap 2.8 to 3.1 feet |
| 3 | | | | No seepage. No caving. Exploration terminated at 2.6 feet maximum hand exploration depth; wellpoint advanced to 3.4 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | Cast iron drive point 3.1 to 3.4 feet |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |

12/18/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.6 | 15.4 | 58.3 | 22.3 | 2.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.8 | | |
| #4 | 98.4 | | |
| #8 | 87.3 | | |
| #10 | 83.0 | | |
| #20 | 56.0 | | |
| #40 | 24.7 | | |
| #60 | 10.8 | | |
| #100 | 5.1 | | |
| #200 | 2.4 | | |
| #270 | 1.8 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 2.6460 | D ₈₅ = 2.1573 | D ₆₀ = 0.9375 |
| D ₅₀ = 0.7420 | D ₃₀ = 0.4844 | D ₁₅ = 0.3083 |
| D ₁₀ = 0.2374 | C _u = 3.95 | C _c = 1.05 |

Remarks

Date Received: 6/29/2023 Date Tested: 9/7/2023

Tested By: FEW

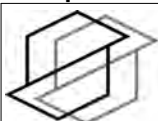
Checked By: APJ/JHS

Title: _____

Location: Onsite - BHCH
Sample Number: HA-1

Depth: 0.4-0.9'

Date Sampled: 6/29/2023



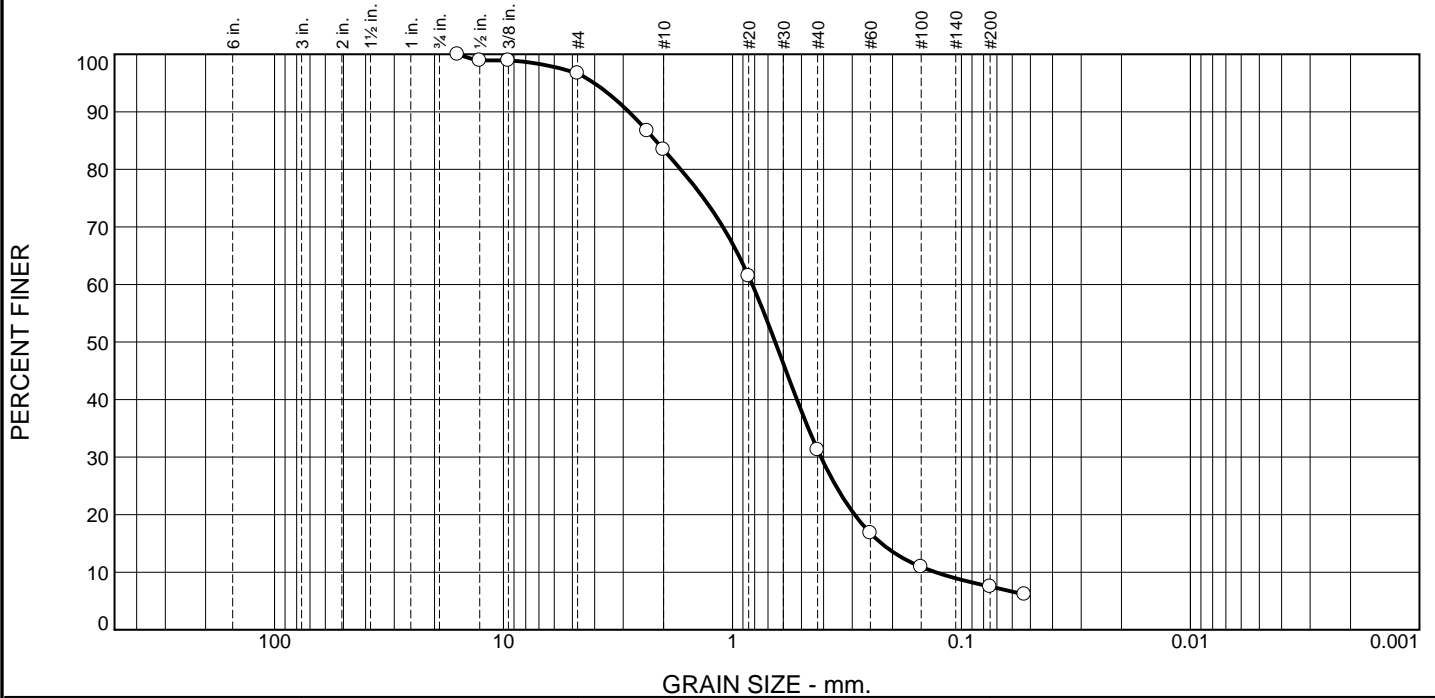
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 3.3 | 13.3 | 52.1 | 23.8 | 7.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 98.9 | | |
| 3/8" | 98.9 | | |
| #4 | 96.7 | | |
| #8 | 86.7 | | |
| #10 | 83.4 | | |
| #20 | 61.5 | | |
| #40 | 31.3 | | |
| #60 | 16.8 | | |
| #100 | 10.9 | | |
| #200 | 7.5 | | |
| #270 | 6.1 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 2.8341 | D ₈₅ = 2.1640 | D ₆₀ = 0.8190 |
| D ₅₀ = 0.6505 | D ₃₀ = 0.4107 | D ₁₅ = 0.2234 |
| D ₁₀ = 0.1299 | C _u = 6.31 | C _c = 1.59 |

Remarks

Date Received: 6/29/2023 Date Tested: 9/7/2023

Tested By: FEW

Checked By: APJ/JHS

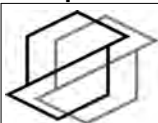
Title: _____

Location: Onsite - BHCH

Sample Number: HA-2

Depth: 0.2-0.8'

Date Sampled: 6/29/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

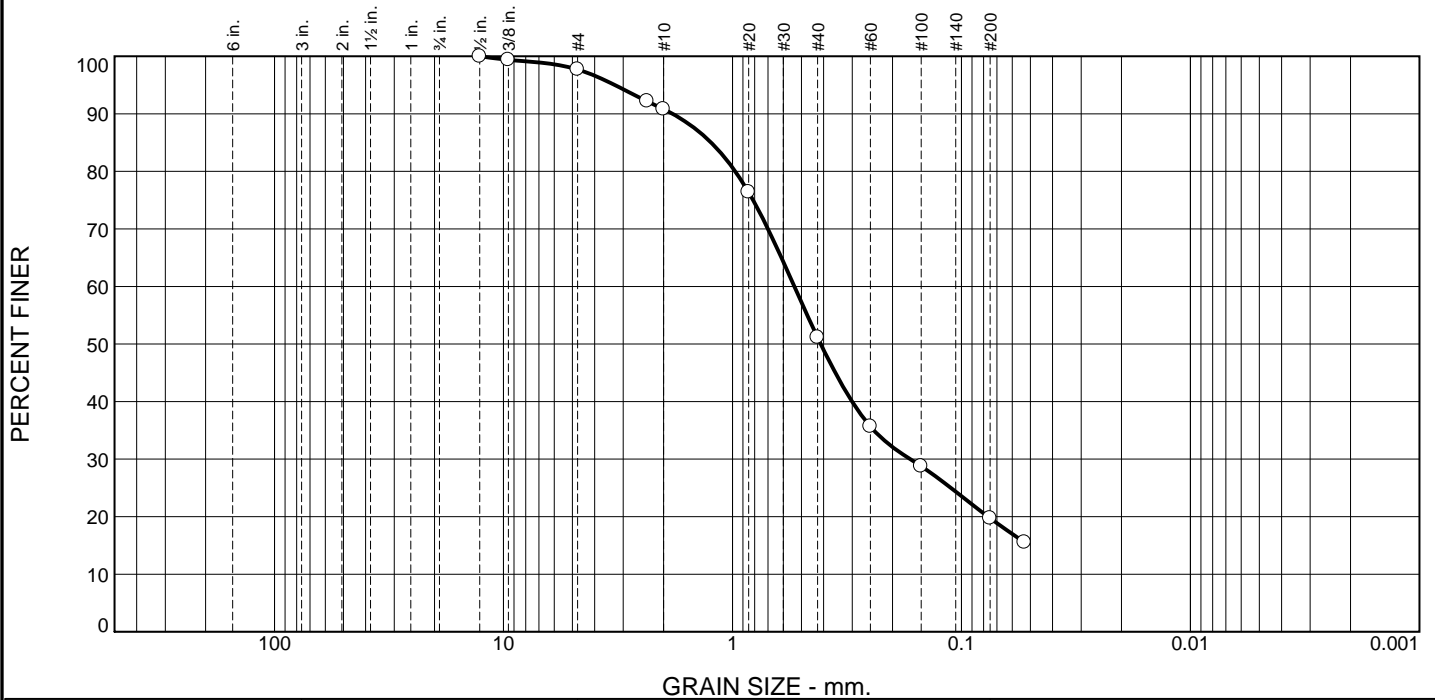
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.3 | 6.9 | 39.6 | 31.5 | 19.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.4 | | |
| #4 | 97.7 | | |
| #8 | 92.2 | | |
| #10 | 90.8 | | |
| #20 | 76.4 | | |
| #40 | 51.2 | | |
| #60 | 35.7 | | |
| #100 | 28.8 | | |
| #200 | 19.7 | | |
| #270 | 15.5 | | |

* (no specification provided)

Material Description

BSM
silty SAND, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 1.8261 D₈₅= 1.2388 D₆₀= 0.5367
D₅₀= 0.4117 D₃₀= 0.1675 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 6/29/2023 Date Tested: 9/20/2023

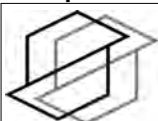
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Bellingham City Hall
Sample Number: HA-3 **Depth:** 0.1-0.8'

Date Sampled: 6/29/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 6/29/2023 | Project BHPS - BHCH | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Bellingham, WA | EB/EP No. BHCH-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.4-0.9' | HA-2 @ 0.2-0.8' | HA-3 @ 0.1-0.8' |
|--------------------|-----------------|-----------------|-----------------|
| Wet Weight + Pan | 1017.5 | 1073.9 | 1021.9 |
| Dry Weight + Pan | 985.5 | 1024.6 | 819.3 |
| Weight of Pan | 247.0 | 392.0 | 391.9 |
| Weight of Moisture | 32.1 | 49.3 | 202.6 |
| Dry Weight of Soil | 738.5 | 632.6 | 427.4 |
| % Moisture | 4.3 | 7.8 | 47.4 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|-------|--------|-------|
| Dry Soil Before Burn + Pan | 985.5 | 1024.6 | 819.3 |
| Dry Soil After Burn + Pan | 965.7 | 989.5 | 734.7 |
| Weight of Pan | 247.0 | 392.0 | 391.9 |
| Wt. Loss Due to Ignition | 19.8 | 35.1 | 84.6 |
| Actual Wt. Of Soil After Burn | 718.7 | 597.5 | 342.8 |
| % Organics | 2.7 | 5.5 | 19.8 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|----------------------|--------------------------------|----------------------------|
| Project Name: | Bellingham City Hall | Water Source: | Hose Bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 6/29/2023 | Wetted Area (sq. feet): | 1134: 38.2 ft ² |
| Weather: | Clear, 80s | Underdrain: | Gravel Sump |
| Test No.: | IT-1 | Test Depth (feet): | 0.12 |
| Performed By: | APJ | Receptor Soils: | Gravel Drain Rock |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|--|
| 10:00 | 5.32 | | Dry | | Water on |
| 10:02 | 5.35 | | | 11 | Max flow obtainable |
| 10:05 | 5.42 | | | 29 | 10:06 water approaching SG#1 and dissipating |
| 10:15 | 5.42 | | | 78 | |
| 10:16 | 5.42 | | | 84 | Water off - switch hose |
| 10:18 | 7.3 | | | 84 | Water on |
| 10:20 | 7.26 | | | 99 | |
| 10:24 | 7.23 | | | 127 | Water off - new hose |
| 10:30 | 8.6 | | | 127 | Water on. Max flow obtainable |
| 10:32 | 8.65 | | | 145 | |
| 10:35 | 8.7 | 0.06 | | 171 | Water at SG#1 |
| 10:45 | 8.7 | 0.02 | | 258 | Moving diffuser toward SG |
| 11:00 | 8.77 | 0.11 | | 389 | |
| 11:15 | 8.74 | 0.11 | | 525 | |
| 11:30 | 8.74 | 0.12 | | 654 | |
| 11:45 | 8.74 | 0.12 | | 782 | |
| 12:00 | 8.74 | 0.12 | | 912 | |
| 12:15 | 8.74 | 0.12 | | 1044 | Stable pond |
| 12:30 | 8.73 | 0.12 | | 1174 | |
| 12:45 | 8.68 | 0.12 | | 1307 | |
| 12:50 | 8.72 | 0.12 | | 1355 | |
| 13:00:00 | 8.72 | 0.12 | | 1436 | Water off |
| 13:00:30 | | 0.1 | | | |
| 13:01:00 | | 0.06 | | | |
| 13:01:30 | | 0.04 | | | |
| 13:02:00 | | 0 | Dry | | |

| | |
|---|------|
| Average Infiltration Rate (in/hr) during last hour of inflow: | 22.0 |
| Average Infiltration Rate (in/hr) during falling head: | 38.4 |

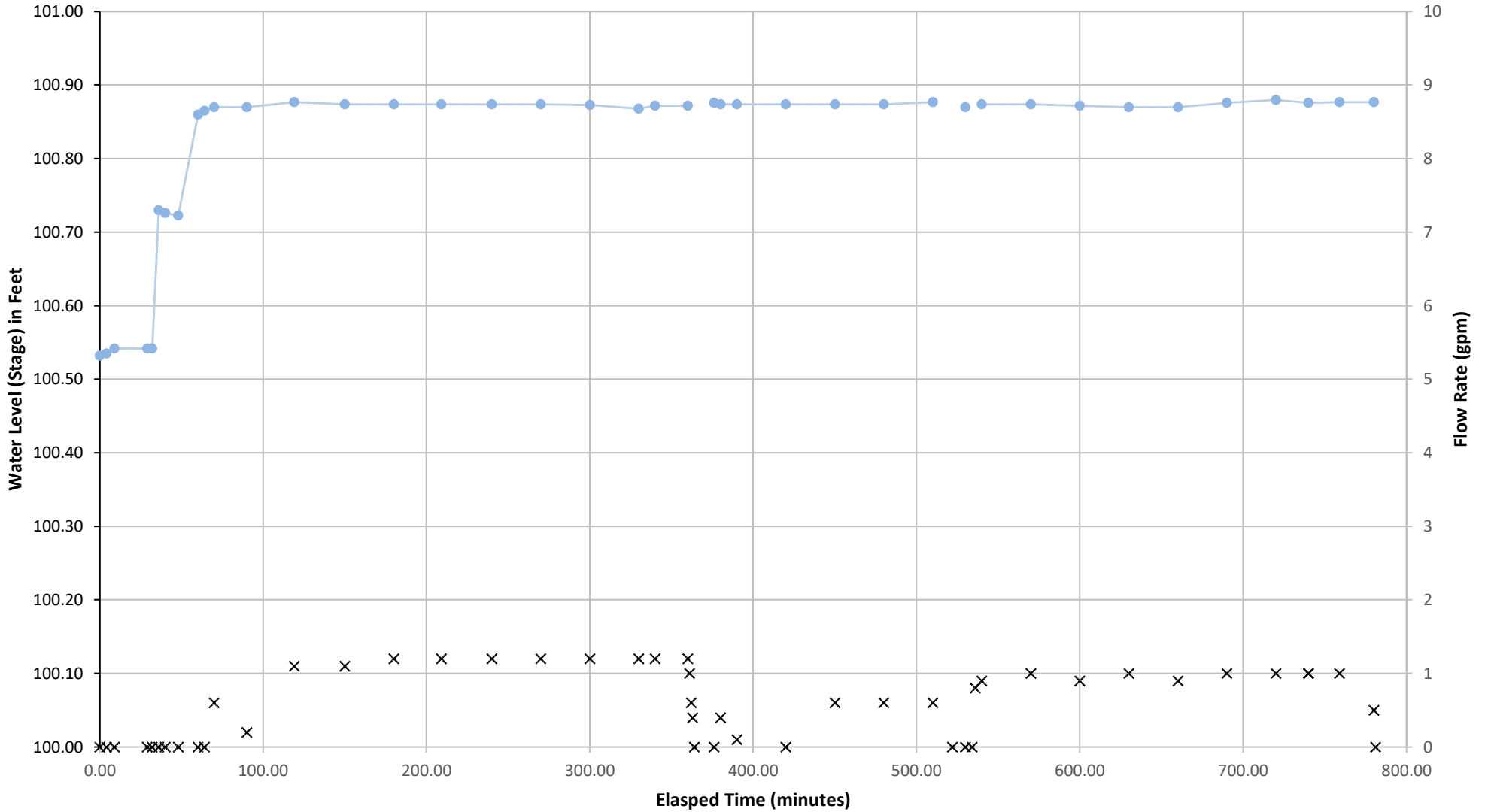
| | | | |
|------------------------|----------------------|--------------------------------|---|
| Project Name: | Bellingham City Hall | Water Source: | Hose Bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 6/29/2023 | Vetted Area (sq. feet): | 14:06 16.5 ft ² / 15:07: 11.8 ft ² / 16:00 12.4 ft ² |
| Weather: | Clear, 80s | Underdrain: | Gravel Sump |
| Test No.: | IT-2 | Test Depth (feet): | 0.1 |
| Performed By: | APJ | Receptor Soils: | Gravel Drain Rock |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|--|
| 13:08 | 8.76 | | | | Water on |
| 13:10 | 8.74 | 0.04 | | 17 | Flow reached diffuser |
| 13:15 | 8.74 | 0.01 | | 60 | Adjusted diffuser |
| 13:30 | 8.74 | 0 | | 191 | Adjusted diffuser again closer to SG |
| 13:45 | 8.74 | 0.06 | | 323 | Head rose to 0.08 and fell back to 0.06 between reading WP |
| 14:00 | 8.74 | 0.06 | | 449 | |
| 14:15 | 8.77 | 0.06 | | 586 | |
| 14:21 | | | | | SG went dry, pond shrank |
| 14:25 | 8.7 | | | 670 | |
| 14:27 | | | | | Adjusted diffuser closer to SG |
| 14:28 | | 0.08 | | | |
| 14:30 | 8.74 | 0.09 | | 715 | |
| 14:45 | 8.74 | 0.1 | | 845 | |
| 15:00 | 8.72 | 0.09 | | 979 | |
| 15:15 | 8.7 | 0.1 | | 1109 | |
| 15:30 | 8.7 | 0.09 | | 1238 | |
| 15:45 | 8.76 | 0.1 | | 1369 | |
| 16:00 | 8.8 | 0.1 | | 1500 | |
| 16:10 | 8.76 | 0.1 | | 1587 | |
| 16:20 | 8.77 | 0.1 | | 1674 | |
| 16:30 | 8.77 | 0.1 | | 1762.17 | Water off |
| 16:30:30 | | 0.05 | | | |
| 16:30 | | 0 | | | |

| | |
|---|------|
| Average Infiltration Rate (in/hr) during last hour of inflow: | 67.7 |
| Average Infiltration Rate (in/hr) during falling head: | 72.0 |

Bellingham City Hall Infiltration Test (IT-1 & IT-2)

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used a relative reference.
 Elevation 100 represents ground surface.

× Staff Gauge #1 Hand Data

—●— Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The Lahti Drive bioinfiltration swale was constructed in 2011 and collects runoff from the adjacent roadways and is designed to remove phosphorous from the water. The design calls for 7 overflow concrete weir structures that separate the bioinfiltration swale into segments, designed to reduce flow rates during large storm events and distribute the infiltration capacity. Weir structures are designed with 2" of freeboard on the upgradient side, and 8" on the downgradient side with an overall elevation change of 3.5' over the 140 foot length of the facility. Each segment is constructed with a minimum of 21" of bioinfiltration swale soil, underlain by 5-6" of filter media which is then under drained by drain rock with at least one perforated underdrain pipe, the segments on the south end have multiple underdrains. Underdrain pipes are designed to be set in the center of 13"-14" of drain rock. Additionally, there is a diversion control structure upgradient and northwest of the cell that has a 18" bypass pipe that runs parallel to the main underdrain to the same catch basin and storm drain network. Excess storm water is designed to overflow into the same catch basin that drains the underdrain pipes.

BIORETENTION SOIL:

Thickness: 1.0'-2.5'

The apparent thickness of the bioretention soil in the cell base based on probe data and hand augers ranged from 1.0'-2.5' below the ground surface with an average thickness of 1.9'. This is consistent with the 1.75' minimum depth specified by the plans. On the cell edges, probe measurements were less than 1 foot in depth.

Composition: The biofiltration soil media was designed to meet the requirements of "Bioretention Soil Mix Review and Recommendations for Western Washington" by Curtis Hinman, January 2009 with modifications made to the organic matter content (10%) and fines content (<2.5%). In comparison to the design mix, the organic matter content was found to be less than 10% while the fines were found to be greater than 2.5%. In comparison to the 2019 Ecology specifications, the tested material had a sand gradation and silt content which met the standard while the organic matter content fell below the specified range.

The bioretention soil sample from HA-5, which is located in the 3rd weir zone segment, measured high in fines content (18%) and organic matter content (15.9%). This may be due to fines and organic matter deposition from large storm events which have enough energy to entrain fine materials and bypass segments one and two before settling from suspension in the 3rd weir zone.

Organic Matter Content (% by weight): 3.4

Percent passing #200 sieve: 3

Coefficient of Uniformity (Cu): 1.0

Coefficient of Curvature (Cc): 3.6

SUBGRADE CONDITIONS:

Geologic Unit: Till

Soil Description: Not encountered. Property owners state site had previously been backfilled with non-native clayey material (Whatcom County Public Works: Lahti Drive Stormwater Improvements Stormwater Design Report, 2010)

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



BUILT PER PLAN:

The depth of the bioretention soil was found to be slightly less than the 1.75 ft minimum depth specified in the plans in some places. Otherwise the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

According to the Stormwater Design Report, seasonal highwater table is at a depth of 3.5 -5 ft, the WellPoint was located in the farthest downgradient section and screened 1.5 -2 ft and did not encounter groundwater. Standing water was observed near inlet #1 (10/3/23) likely due to fine sediment build up and recent rain.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 42
Subgrade Soil Rate (in/hr): N/A

Three infiltration tests were performed with water supplied by a water truck. IT-1 (43.2 in/hr) was completed in the farthest upgradient segment closest to inlet #1, with some spill into the second segment. IT-2 (38.6 in/hr) was completed in the third segment from inlet #1, and IT-3 (46.3 in/hr) was completed in the fourth segment from inlet #1. The bioretention soil mix tested in the central segment of the cell had the highest fines content and had the slowest infiltration rate. The presented bioretention soil rate is an averaged value from the three infiltration tests.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Fine sand and silt deposits have buried the stream cobble energy dispersion feature at inlet #1. The underdrain cleanout near the center of the cell was inaccessible, but otherwise the site appears well maintained and functional.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------------|---------------------|
| Weather | Overcast | | |
| Recent Rainfall | Today: 0.01" | Yesterday: 0.21" | Two Days Ago: 0.01" |
| Field Reps | Full Day: Sarah Faubion | Half Day: Evan Paul | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 4 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Hand Augers | 5 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



Site Photo: FA_SitePhotos-20231003-184342.jpg



Site Photo: FA_SitePhotos-20231003-191652.jpg



Site Photo: FA_SitePhotos-20231003-184428.jpg



Site Photo: IMG_0696.jpg



Site Photo: FA_SitePhotos-20231003-191638.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



Site Photo: IMG_0697.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
 Cell: Bioinfiltration Swale

Assessed On:
 October 3, 2023



Cell Construction

| | |
|--|--|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 10% |
| Standing Water | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth: 0.14' Possible Cause: <input checked="" type="checkbox"/> Recent Rain <input type="checkbox"/> Clogged bottom <input type="checkbox"/> Blocked Underdrain <input type="checkbox"/> Unknown About 1 cubic foot at IN-1 |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 1' Full Width Width 14' Underdrain trench varies in width, widens as it progresses down slope. Additional underdrains (#2 & #3) are added in the southern cells 7 through 9 where the cell widens out considerably. The underdrain pipes are designed to be set in the center of 13"-14" of drain rock. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from the adjacent roadways through water collected in 2 catch basins and piped into the cell, and through 14 curb cuts along Lahti Drive. Water is designed to infiltrate through the bioretention soil before reaching the underdrain pipe where it flows to a catch basin and out to the storm drain network. The cell is designed with 7 overflow concrete weir structures that separate the cell into segments, designed to reduce flow rates during large storm events and distribute the infiltration capacity. Each segment is under drained by at least one underdrain pipe, the segments on the south end have multiple underdrains. Additionally there is a diversion control structure upgradient and northwest of the cell that has a 18" bypass pipe that runs parallel to the main underdrain to the same catch basin and storm drain network. Excess storm water is designed to overflow into the same catch basin that drains the underdrain pipes. | |

Cleanouts

| | |
|----------------------------------|---|
| CL-1 | |
| Condition | Accessible: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Sediment Accumulation: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Distance from overflow/outlet: ' | |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20231003-193742.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Minimal blockage of pine needles was observed.



FA_INBLPhoto-20231003-193253.jpg

Additional Details: Standing water with fine silt deposits have buried the stream cobbles at this inlet.

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.3'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 15% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: This inlet is composed of 14 curb cuts along Lahti Drive, each 1.3' in length, blockage varies by specific curb cut, but most are minimally blocked by vegetation and soil build up



FA_INBLPhoto-20231003-193958.jpg

Additional Details: None apparent

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Other: Other

Diameter: 1'

Energy Dissipation

Angular Rock: Buried

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20231003-202232.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 35% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Outfall of pipe is blocked by build up of sediment and thick grasses.



FA_INBLPhoto-20231003-202212.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



| | |
|---|---|
| IN-4 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input checked="" type="checkbox"/> Other: Energy Dissipation Angular Rock: n/a Stream Cobble: Buried Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 50% blocked Types: <input checked="" type="checkbox"/> Sediment <input type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input checked="" type="checkbox"/> Vegetation Additional Details: This area was buried with soil and dense vegetation, but still would function fairly consistent with plans. No pictures were taken. |
| Additional Details: Plans show a rock check dam inlet feature on the south west edge of the cell to limit water coming from the preexisting western ditch. There is an associated catch basin (CB#5) on the far side that is set much lower than the bioinfiltration facility, and leads directly to underdrain pipe #3, so is not an additional inlet. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
 Cell: Bioinfiltration Swale

Assessed On:
 October 3, 2023



Design Overflow/Outlet

| | | |
|--|-----------------------------|--|
| DO - 1 | |  |
| Shape: <input checked="" type="checkbox"/> Round <input type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Diameter: 2' | |
| Additional Details: | | |
| Stickup (ft) From Ground: 0.32 Relative from staff gauge: | | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No *Not damaged but a note that the relative stick up of the catch basin is below staff gauge zero as the concrete weirs step the base of the cell down by several feet. | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | FA_DOPhoto-20231003-202513.jpg |

| | | |
|--|-------------|--|
| DO - 2 | |  |
| Shape: <input type="checkbox"/> Round <input type="checkbox"/> Rectangular <input checked="" type="checkbox"/> Other: Concrete weir | Dimensions: | |
| Additional Details: Dimensions vary, most are 15.5' by 0.4' with a 0.15' to 0.5' stick up. 7 weirs in total, gradually getting longer down slope about 0.2' stick up on upslope side, 0.5' stickup on down slope side. | | |
| Stickup (ft) From Ground: 0.16 Relative from staff gauge: 0.1 | | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | FA_DOPhoto-20231003-231120.jpg |

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
 Cell: Bioinfiltration Swale

Assessed On:
 October 3, 2023



Cell Surface and Geotech Probe Observations

| | | | | | |
|--|---|--------------------------------|-----------------------------------|-----------------------------------|---|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Healthy grass with thick rootlet mat covers cell. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | | | |
| Additional Details: Abundant deer droppings were observed in the cell, several deer were observed throughout the duration of the tests. | | | | | |
| Vegetation Description | | | | | |
| The cell is predominantly covered in grass, and does not limit work within the cell. The edge of the cell, on the east side, is densely covered with thick shrubs. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.0'-2.5' of bioretention soil, with an average of 1.9', before encountering the underdrain gravels. This is consistent with the 1.75' minimum depth specified by the plans. On the cell edges, probe measurements were less than 1 foot in depth. This is consistent with the cell design which shows a 3:1 or 2:1 slope with no additional bioretention soil above the existing subgrade. No zones of compaction were observed. | | | | | |

Hand Auger

| | |
|---|---|
| HA-1WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.6 |
| to Import/Underdrain: | |
| Total Depth: | 2 |
| Rain/Garden Mix Soil Texture: Moist, loose, oxidized brown to dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: FILTER MEDIA: Moist, loose, oxidized brown to dark brown, sandy fine GRAVEL, trace silt, moderate organics (GP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): | |
| Additional Details | |



IMG_0686.jpg


BIORETENTION CELL FIELD ASSESSMENT


Site: Lahti Drive (BHLA)
 Cell: Bioinfiltration Swale

Assessed On:
 October 3, 2023



| |
|--------|
| HA-1WP |
|--------|

| | | |
|--|---|--|
| HA-2 <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |  <p>IMG_0688.jpg</p> |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | 2 | |
| to Import/Underdrain: | | |
| Total Depth: | 2.2 | |
| Rain/Garden Mix Soil Texture: Moist, loose, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: FILTER MEDIA: Moist, loose, oxidized brown to dark brown sandy f GRAVEL trace silt, moderate organics (GP) | | |
| Liner Present: | Filter Fabric Present: | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |

| | | |
|--|--|---|
| HA-3 <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |  <p>FA_FPhoto-20231003-212900.jpg</p> |
| Depth (ft) | | |
| to Bioretention Soil: | 0.4 | |
| to Native Soil: | 1.4 | |
| to Import/Underdrain: | | |
| Total Depth: | 1.4 | |
| Rain/Garden Mix Soil Texture: Moist, medium dense, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: | | |
| Liner Present: | Filter Fabric Present: | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Stopped at fabric | |
| Additional Details Topsoil 0-0.4ft depth: Moist, medium dense, dark brown to black, silty SAND, abundant organics (SM) | | |


| | |
|---|--|
| HA-4 <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
|---|--|

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023



| | | |
|---|---|---|
| HA-4 | |  <p>IMG_0761.jpg</p> |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | | |
| to Import/Underdrain: | | |
| Total Depth: | 0.5 | |
| Rain/Garden Mix Soil Texture: Loose, very moist to wet, dark brown, fine to medium SAND, some coarse sand, trace silt, abundant organics (SP) | | |
| Native Soil Texture: | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |

| | | |
|---|---|--|
| HA-5 | | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | | |
| to Import/Underdrain: | | |
| Total Depth: | 0.5 | |
| Rain/Garden Mix Soil Texture: Loose, very moist, dark brown, silty fine to medium SAND, some coarse sand, abundant organics (SM) | | |
| Native Soil Texture: | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
 Cell: Bioinfiltration Swale

Assessed On:
 October 3, 2023



HA-5



IMG_0762.jpg

Additional Details

Infiltration Test

IT-1

| | |
|--|-----------------------|
| Water Supply | |
| <input type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input checked="" type="checkbox"/> Water Truck | |
| AESI Meter# | Watertruck FM 3-30gpm |
| Wetted Pond Area (sq. ft) | 58 |
| Ponded Depth (ft) | 0.14 |
| Total Gallons | 3,089 |
| Steady State Flow Rate (GPM) | 29 |



Additional Details:

Three infiltration tests were conducted in this facility, the first test includes cells 1 and 2, IT-2 is in cell 3, and IT-3 is in cell 4. Additional test details can be found in the executive summary. Flags in the first image indicate the different ponded areas for each test.

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
Cell: Bioinfiltration Swale

Assessed On:
October 3, 2023

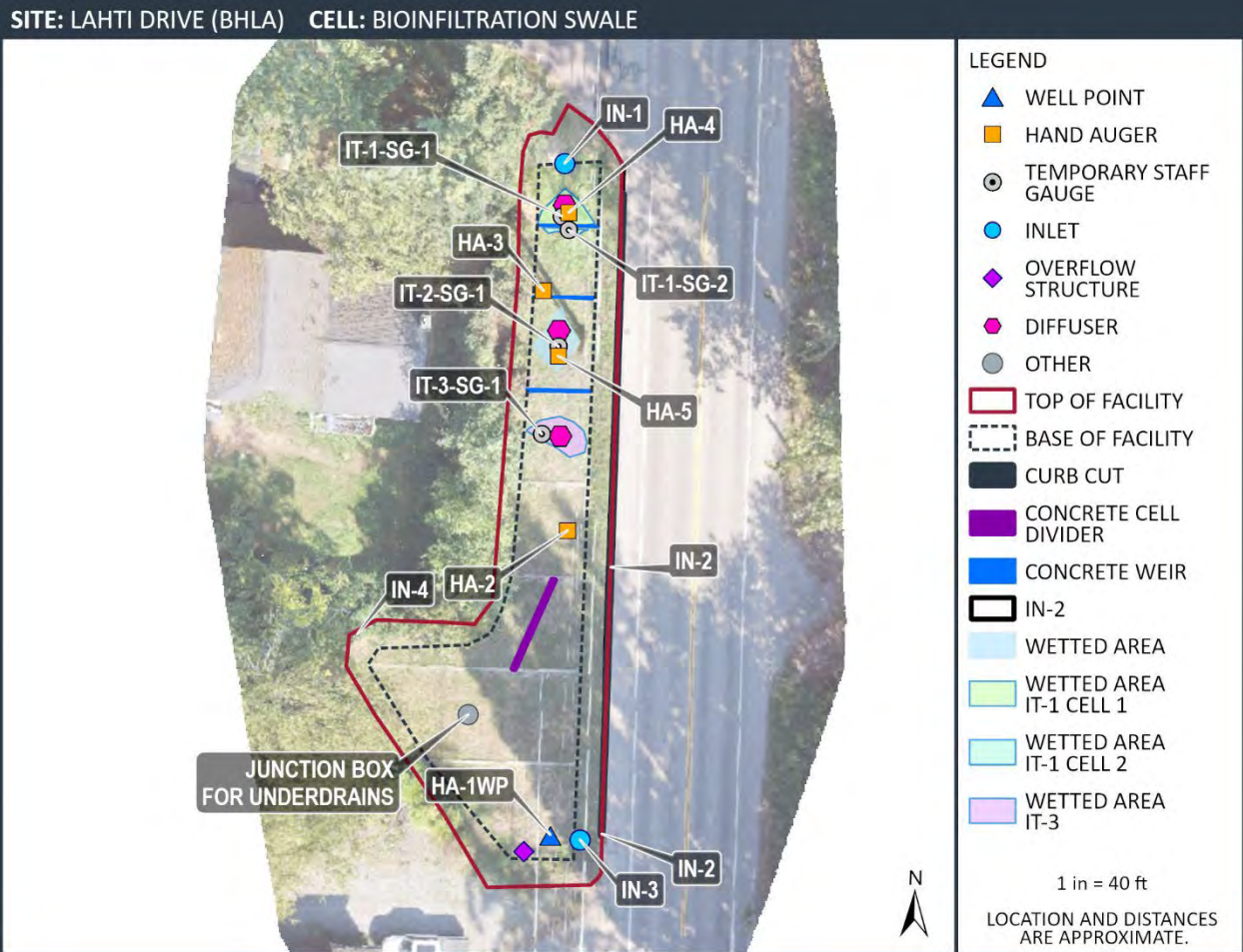


Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Lahti Drive (BHLA)
 Cell: Bioinfiltration Swale

Assessed On:
 October 3, 2023





associated
earth sciences
incorporated

Well Point

BHLA-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 10/3/23

Logged By: SNCF/EAP

20150387H008

Ending Date: 10/3/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.6

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.1

Water Level Elevation (ft): N/A

Datum: Project Elevation

Groundwater Depth ATD (ft): N/A

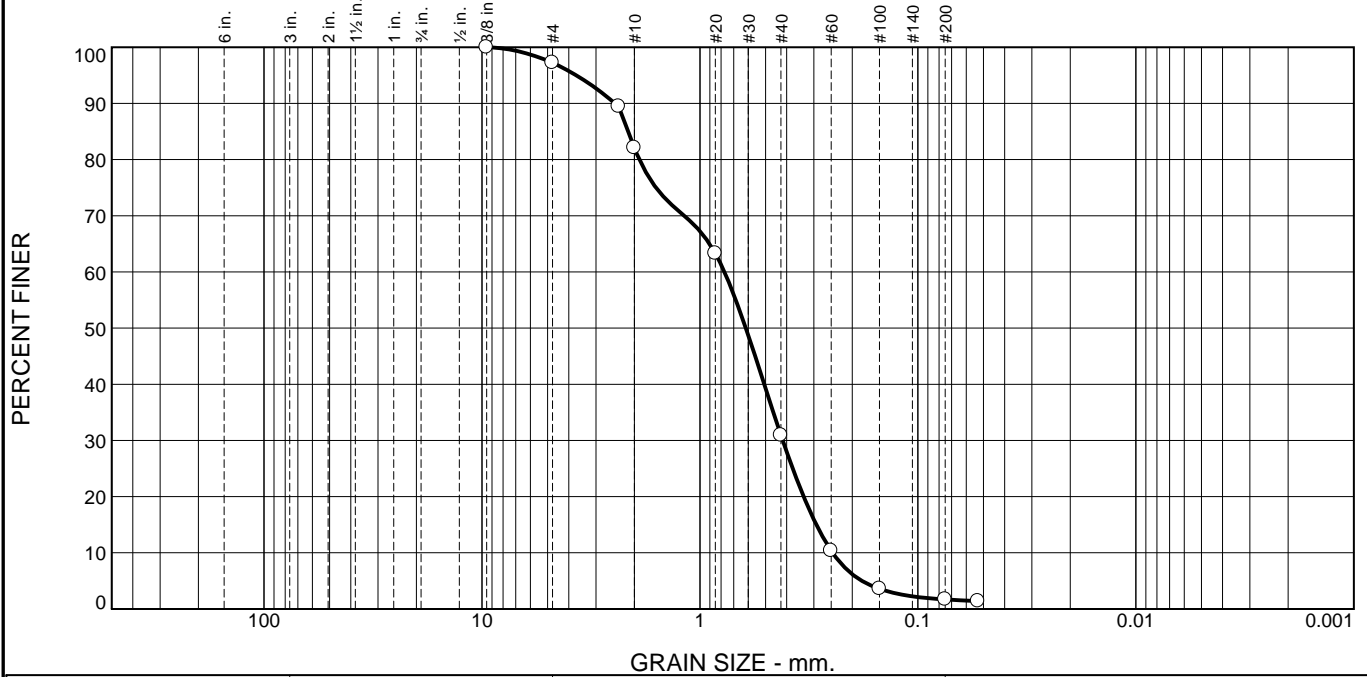
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | <p>Bioretention Soil Mix Moist, loose, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt; abundant organics (SP). As above; slightly moist. Same as above, trace gravel.</p> | | | | | | | <p>Stick up -5.1 to 0 feet Existing bioretention soil 0 to 1 foot 1.25 in I.D. Threaded galvanized casing -0.5 to -5.1 Duct tape covered screen -0.5 to 1.5 feet 1.25-inch I.D. threaded galvanized steel casing -0.5 to -5.1 feet 3/8 inch Bentonite chips 1 to 1.3 feet Medium grained silica sand 1.3 to 2.1 feet 1.25-inch I.D. Stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.5 to 2 feet Cast iron endcap 2.0 to 2.3 feet Cast iron drivepoint 2.3 to 2.6</p> |
| 1 | | | | <p>Same as above; moist.</p> | | | | | | | |
| 2 | | | | <p>Filter Media Moist, loose, oxidized brown to dark brown, sandy, fine GRAVEL, trace silt; moderate organics (GP).</p> | | | | | | | |
| 3 | | | | <p>No groundwater encountered. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/23/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.8 | 15.1 | 51.2 | 29.2 | 1.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 97.2 | | |
| #8 | 89.4 | | |
| #10 | 82.1 | | |
| #20 | 63.3 | | |
| #40 | 30.9 | | |
| #60 | 10.4 | | |
| #100 | 3.6 | | |
| #200 | 1.7 | | |
| #270 | 1.4 | | |

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.4523 D₈₅= 2.1353 D₆₀= 0.7721
D₅₀= 0.6161 D₃₀= 0.4172 D₁₅= 0.2923
D₁₀= 0.2463 C_u= 3.13 C_c= 0.92

Remarks

Date Received: 10-3-2023 Date Tested: 11-27-2023

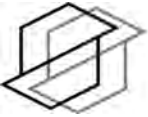
Tested By: FEW

Checked By: SNCF/JHS

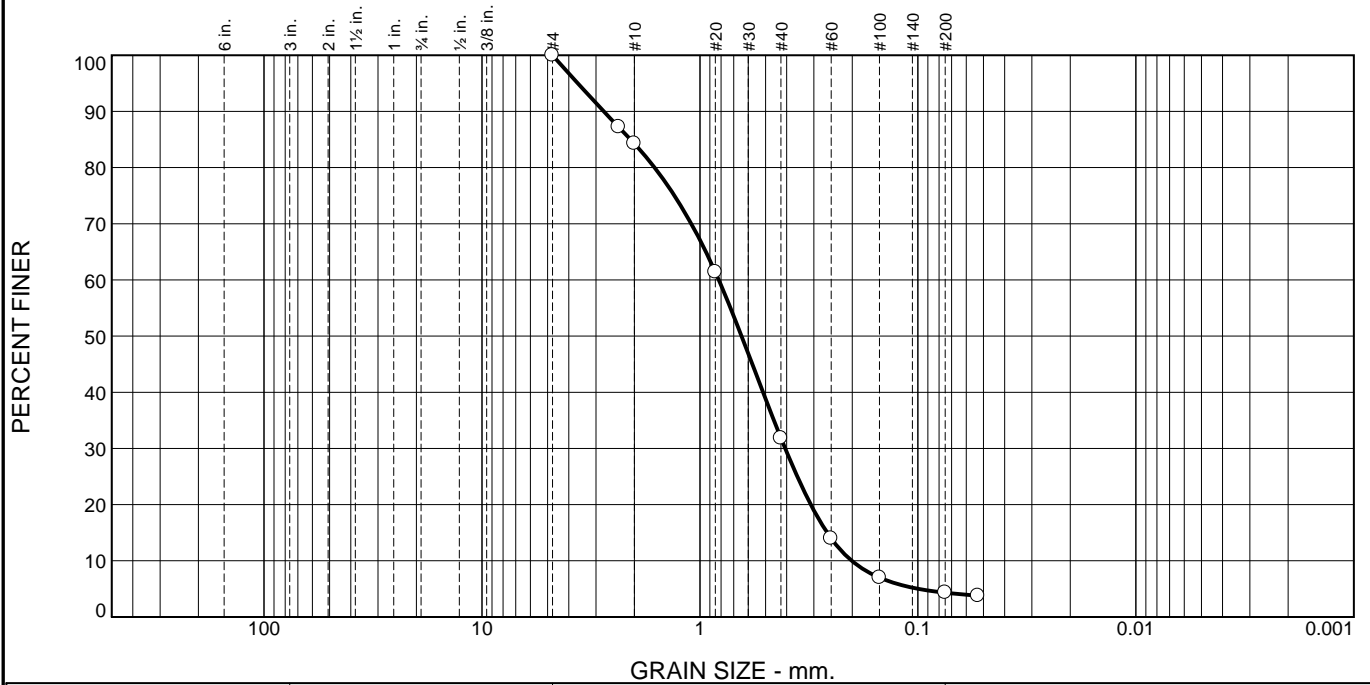
Title: _____

* (no specification provided)

Location: Onsite - Bellingham Lahti Dr. Date Sampled: 10-3-2023
Sample Number: HA-1WP Depth: 0-0.7'

| | | |
|---|--|---------------|
|  | <p>Client: City of Olympia</p> <p>Project: Bioretention Hydrologic Performance Monitoring Study</p> <p>Project No: 20150387 H008</p> | <p>Figure</p> |
|---|--|---------------|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 0.0 | 0.0 | 15.7 | 52.5 | 27.5 | 4.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #4 | 100.0 | | |
| #8 | 87.2 | | |
| #10 | 84.3 | | |
| #20 | 61.4 | | |
| #40 | 31.8 | | |
| #60 | 14.0 | | |
| #100 | 7.0 | | |
| #200 | 4.3 | | |
| #270 | 3.8 | | |

Material Description

SAND trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.7619 D₈₅= 2.0816 D₆₀= 0.8197
D₅₀= 0.6442 D₃₀= 0.4064 D₁₅= 0.2607
D₁₀= 0.2014 C_u= 4.07 C_c= 1.00

Remarks

Date Received: 10-3-2023 Date Tested: 11-8-2023

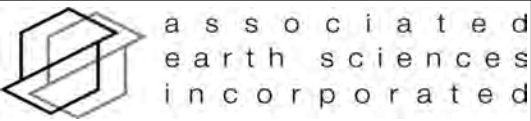
Tested By: FEW

Checked By: SNCF/JS

Title: _____

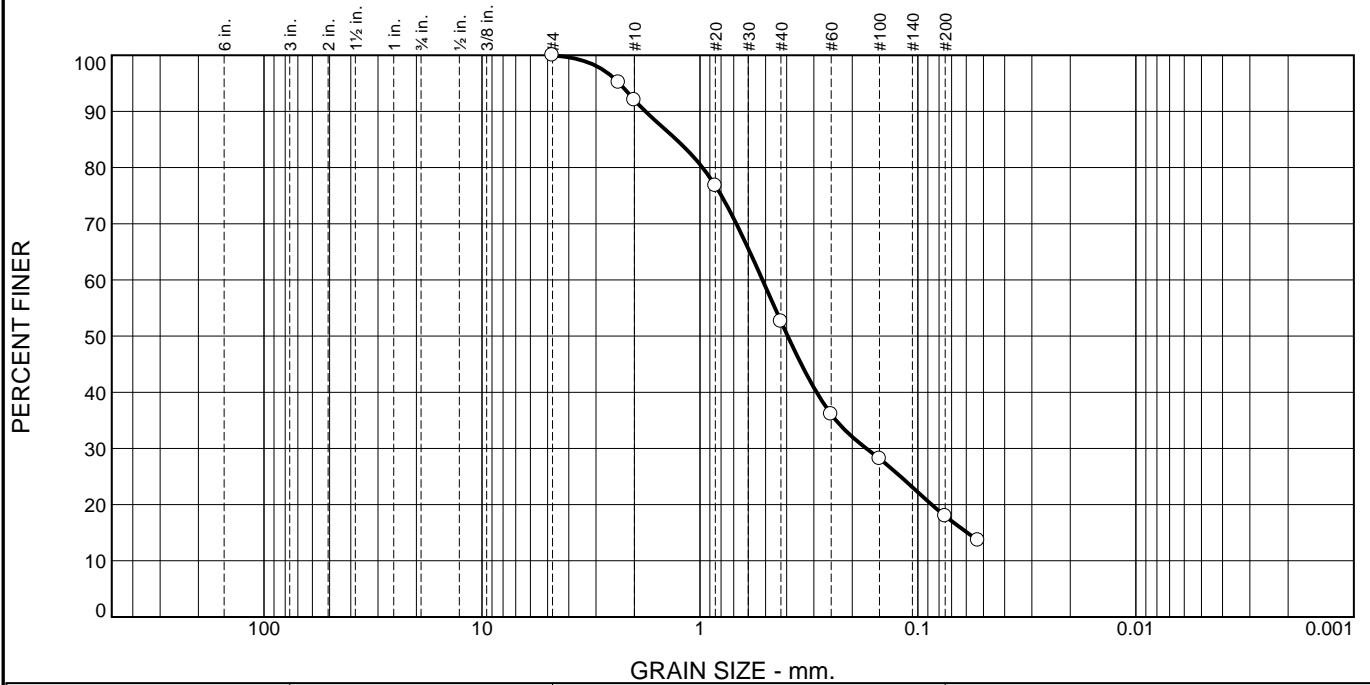
* (no specification provided)

Location: Onsite - BHPS-Lathi Dr Date Sampled: 10-3-2023
Sample Number: BHLA-HA-4 Depth: 0.1-0.5'



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.0 | 8.0 | 39.4 | 34.6 | 18.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #4 | 100.0 | | |
| #8 | 95.1 | | |
| #10 | 92.0 | | |
| #20 | 76.8 | | |
| #40 | 52.6 | | |
| #60 | 36.1 | | |
| #100 | 28.2 | | |
| #200 | 18.0 | | |
| #270 | 13.6 | | |

Material Description

Silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 1.7795 D₈₅= 1.2839 D₆₀= 0.5167
D₅₀= 0.3956 D₃₀= 0.1724 D₁₅= 0.0594
D₁₀= C_u= C_c=

Remarks

Date Received: 10-3-2023 Date Tested: 11-8-2023

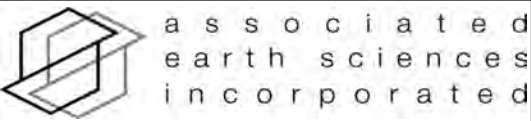
Tested By: FEW

Checked By: SNCF/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Lahti Dr Date Sampled: 10-3-2023
Sample Number: BHLA-HA-5 Depth: 0.1-0.5'



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 10/3/2023 | Project BHPS-Lahti Dr. | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellingham, WA | EB/EP No. BHLA-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1WP @ 0-0.7' | HA-4 @ 0.1-0.5' | HA-5 @ 0.1-0.5' |
|--------------------|-----------------|-----------------|-----------------|
| Wet Weight + Pan | 573.30 | 497.3 | 488.6 |
| Dry Weight + Pan | 562.72 | 454.4 | 383.4 |
| Weight of Pan | 255.31 | 258.2 | 255.0 |
| Weight of Moisture | 10.58 | 42.8 | 105.3 |
| Dry Weight of Soil | 307.41 | 196.2 | 128.4 |
| % Moisture | 3.44 | 21.8 | 82.0 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|--------|-------|-------|
| Dry Soil Before Burn + Pan | 562.72 | 454.4 | 383.4 |
| Dry Soil After Burn + Pan | 558.15 | 444.1 | 363.0 |
| Weight of Pan | 255.31 | 258.2 | 255.0 |
| Wt. Loss Due to Ignition | 4.57 | 10.3 | 20.4 |
| Actual Wt. Of Soil After Burn | 302.84 | 185.9 | 108.0 |
| % Organics | 1.49 | 5.3 | 15.9 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------|--------------------------------|--------------------------------|
| Project Name: | Lahti Drive | Water Source: | Water Truck |
| Project Number: | 20150387 H008 | Meter: | NW Excavating 3-30 |
| Date: | 10/3/2023 | Wetted Area (sq. feet): | 11:30 58 (cell 1)/7.5 (cell 2) |
| Weather: | Cloudy | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.14 |
| Performed By: | SNCF/EAP | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | CB-SG (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|------------|----------------------|---------------------|-------------------------|
| 9:55 | | | | | Dry | | Water on ~10 gpm |
| 9:58 | 21.1 | | | | | 51 | pump on |
| 10:02 | 25.6 | | | | | 149 | |
| 10:05 | 25.6 | | | | | 235 | |
| 10:15 | 25.6 | | | 1.13 | | 480 | |
| 10:33 | 25.48 | 0.04 | | | | 947 | SG-1 moved to cell 1 |
| 10:40 | 28.9 | 0.08 | | | | 1,135 | Increase flow to 30 gpm |
| 10:45 | 29.9 | 0.08 | | | | 1,272 | |
| 11:00 | 29.86 | 0.12 | 0.1 | 1.16 | | 1,720 | SG-2 added to cell 2 |
| 11:16 | 29.6 | 0.13 | 0.11 | 1.17 | | 2,210 | SG-1 fell over |
| 11:30 | 29.7 | 0.14 | 0.11 | 1.17 | | 2,612 | |
| 11:45 | 29.4 | 0.12 | 0.11 | | | 3,057 | Water off - truck empty |
| 11:47 | | 0 | 0 | 1.16 | Dry | 3,089 | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 43.2 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 43.2 |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 43.5 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 39.6 |

| | | | |
|------------------------|---------------|--------------------------------|--------------------|
| Project Name: | Lahti Drive | Water Source: | Water Truck |
| Project Number: | 20150387 H008 | Meter: | NW Excavating 3-30 |
| Date: | 10/3/2023 | Wetted Area (sq. feet): | 14:30 75 ft^2 |
| Weather: | Cloudy | Underdrain: | Yes |
| Test No.: | IT-2 | Test Depth (feet): | 0.12 |
| Performed By: | SNCF | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | CB-SG (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------|----------------------|---------------------|-----------|
| 12:40 | | | | Dry | 19 | Water on |
| 12:41 | 28 | | | | | Pump on |
| 12:43 | | 0.01 | | | 84 | |
| 12:45 | 29 | 0.04 | 1.14 | | 140 | |
| 13:00 | 29.1 | 0.11 | | | 599 | |
| 13:15 | 29 | 0.11 | | | 1,013 | |
| 13:30 | 29 | 0.11 | 1.18 | | 1,447 | |
| 13:48 | 30.1 | 0.11 | | | 1,993 | |
| 14:00 | 29.9 | 0.11 | 1.18 | | 2,352 | |
| 14:15 | 29.8 | 0.12 | | | 2,795 | |
| 14:30 | 29.6 | 0.12 | 1.18 | | 3,255 | |
| 14:40 | 29.5 | 0.12 | | | 3,537 | |
| 14:45 | 29.5 | 0.12 | | | 3,684 | |
| 14:50 | | 0.06 | | | 3,831 | Water off |
| 14:51 | | 0 | 1.18 | | | |
| 15:35 | | 0 | 1.14 | Dry | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 37.9 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 43.2 |

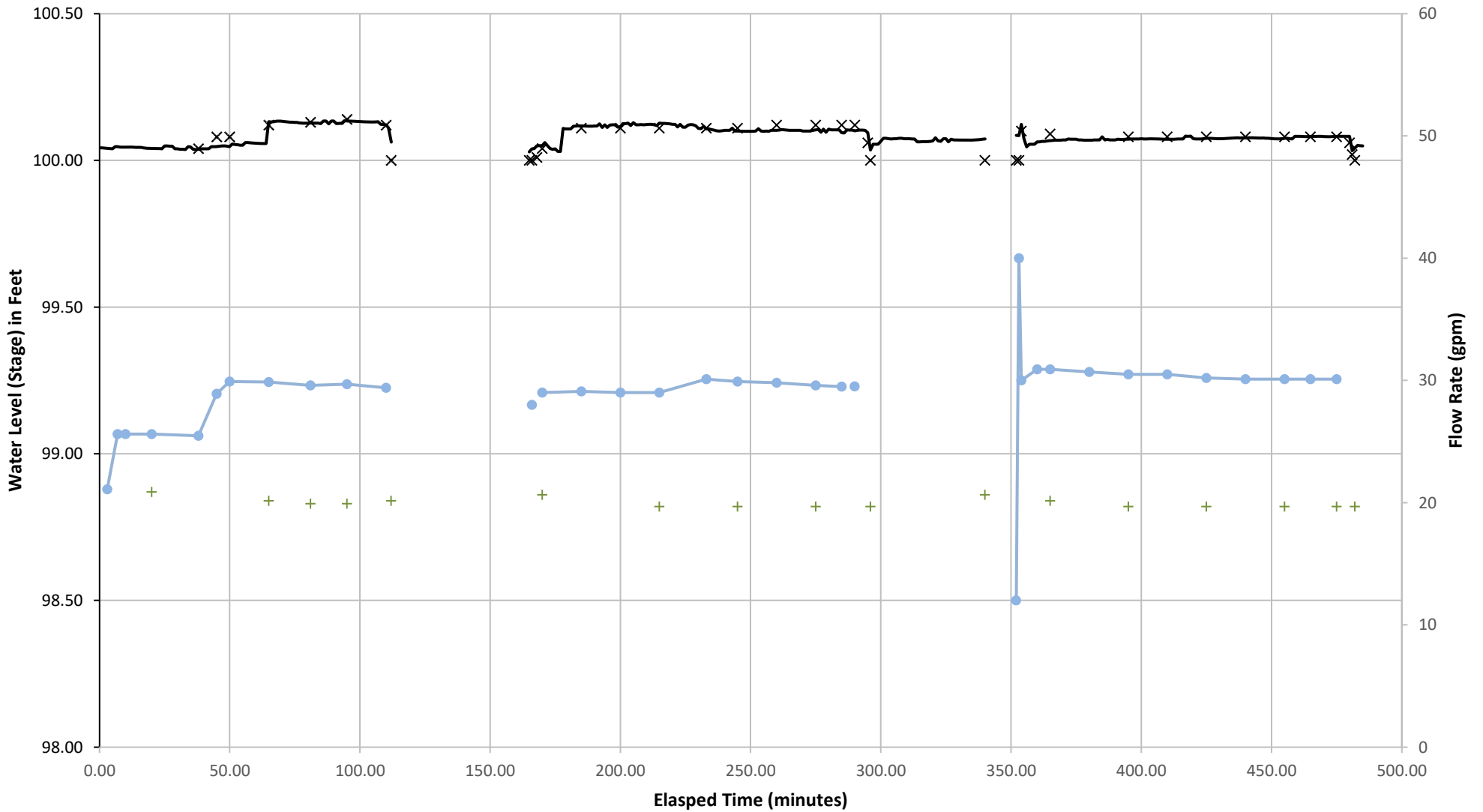
| | | | |
|------------------------|---------------|--------------------------------|----------------------------|
| Project Name: | Lahti Drive | Water Source: | Water Truck |
| Project Number: | 20150387 H008 | Meter: | NW Excavating 10-100 |
| Date: | 10/3/2023 | Wetted Area (sq. feet): | 17:15 62.7 ft ² |
| Weather: | Partly Cloudy | Underdrain: | Yes |
| Test No.: | IT-3 | Test Depth (feet): | 0.08 |
| Performed By: | SNCF/EAP | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | CB-SG (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------|----------------------|---------------------|-------------------------------|
| 15:47 | 12 | | | Dry | | Water on |
| 15:48 | 40 | | | | 19 | Pump on |
| 15:49 | 30 | 0.1 | | | 73 | Flow adjusted for consistency |
| 15:55 | 30.9 | | | | 259 | |
| 16:00 | 30.9 | 0.09 | 1.16 | | 390 | |
| 16:15 | 30.7 | | | | 864 | |
| 16:30 | 30.5 | 0.08 | 1.18 | | 1,311 | |
| 16:45 | 30.5 | 0.08 | | | 1,773 | |
| 17:00 | 30.2 | 0.08 | 1.18 | | 2,225 | |
| 17:15 | 30.1 | 0.08 | | | 2,681 | |
| 17:30 | 30.1 | 0.08 | 1.18 | | 3,136 | |
| 17:40 | 30.1 | 0.08 | | | 3,433 | |
| 17:50 | 30.1 | 0.08 | 1.18 | | 3,735 | |
| 17:55 | | 0.06 | | | 3,883 | Water off |
| 17:56 | | 0.02 | | | | |
| 17:57 | | 0 | 1.18 | Dry | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 46.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 28.8 |

Lahti Drive Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used for relative reference. Elevation 100 represents ground surface.

× SG-1 Hand
— SG-1 Logger
+ Catch Basin Hand
● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
Cell: Bioinfiltration Swale

Assessed On:
October 4, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This bioinfiltration swale, constructed in 2013, was designed to collect and provide treatment of stormwater from a portion of the Brownsville and Britton Manor neighborhoods subdivision before discharging into the west tributary of Silver Beach Creek. The basin draining into this bioinfiltration swale is roughly 41 acres according to the Silver Beach Creek West Tributary Stormwater Improvements report by Osborn Consulting Inc. The design incorporates a bioinfiltration swale outfall structure that acts as a sump to slow the flow of the stormwater and collect fines before the water flows through the rest of the swale. There is a high flow bypass pipe at the upgradient catch basin that connects to the downgradient overflow catch basin before discharging to the creek. The outfall structure is a concrete cylinder, 8 ft in diameter set flush with the bioinfiltration swale, with 0.6 ft freeboard. The cylinder is filled with 3.5' of drain rock underlain by a 0.5' layer of concrete, with 12 mil plastic sheeting at the base. For the swale the design calls for 2 ft minimum of bioinfiltration swale soil underlain by 0.5 ft of filter media, underlain by drain rock and an 8" perforated underdrain pipe that connects to the downgradient catch basin. The design states the full width of the cell is underlain by construction geotextile for underground drainage.

BIORETENTION SOIL:

Thickness: 1.0-3.0+ ft

The apparent thickness of the bioretention soil based on probe data and hand augers ranged from 1.0 – 3.0+ ft below the ground surface with an average thickness of 2.1 ft. The soil is thinner and slightly more compacted in the visible flow path of the water around the northern side of the base, otherwise it is consistent with the design.

Composition :

The bioinfiltration swale soil specifications are designed to target phosphorous removal and is based on the mix used for Lahti Drive. The tested material met these specifications for fines content while the organic matter content was below the standard. In comparison with the 2019 Ecology specifications, the tested material had a sand gradation finer than the standard, while the fine content met the standard. The organic matter content fell below the specified range.

Additional soil samples were taken from the surface (0-0.1' bgs) from both infiltration test areas. The sample from the center of the cell (IT-1) met the guidance on organic content, the sample from the compacted, northern portion of the cell (IT-2) had a very high organic content, upwards of 40%, though this number may be slightly overstated due to a later sample testing time and opportunity for dormant seeds to sprout.

Organic Matter Content (% by weight): 1.8

Percent passing #200 sieve: 2.1

Coefficient of Uniformity (Cu): 2.7

Coefficient of Curvature (Cc): 0.9

SUBGRADE CONDITIONS:

Geologic Unit: Everson Glaciomarine Drift

Soil Description: N/A Subgrade soil not encountered.

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
Cell: Bioinfiltration Swale

Assessed On:
October 4, 2023



BUILT PER PLAN:

There is compaction of the bioretention soil in the observed water flow path, which reduces the infiltration rate of that portion of the cell. The outfall structure is mostly working to trap fine sediment from entering the main portion of the cell, though this has filled up with said fine sediment and may not work as well as designed. Otherwise, the cell was generally constructed consistent with the design plans.

GROUNDWATER CONDITIONS:

Standing water was observed in the outfall structure, no groundwater was encountered in any of the hand augers. The Wellpoint we installed was screened 1.3-1.8 ft below ground surface and did not encounter groundwater. The Wellpoint responded to infiltration testing and rose to a minimum depth of 1.63' below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 76
Subgrade Soil Rate (in/hr): N/A

Two infiltration tests were conducted, IT-1 (76 in/hr) was located centrally in the cell in an area that had some evidence of past water flow. IT-2 (22.3 in/hr) was located in the northwest of the cell in a zone that showed greater evidence of past water ponding. IT-2 had a significantly lower infiltration rate, likely due to accumulation of fines and compaction of soil due to ponding water.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

- 1) Deer have significantly pruned the border of cypress trees up to a height they can reach, leaving a mushroomed appearance, some of the border trees have died.
- 2) The volume of fine sediment accumulation in the outfall structure appears to decrease the amount of designed freeboard, it appears that past maintenance measures of removing this sediment may have resulted in a mound of sediment northwest of the structure in the base of the cell. This mound influences the flow of water further northward around the perimeter of the cell, as shown in a blue arrow on the Bioretention Cell Field Assessment figure below. Considerations for future maintenance of this structure include removal of the fine sediment accumulated in the outfall structure, and level the mound adjacent to the structure. Consider placing this sediment accumulation on the side slopes or edges of the site as the fine sediment reduces the effectiveness of the base of the bioinfiltration facility.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------------|---------------------|
| Weather | Overcast | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.01" | Two Days Ago: 0.21" |
| Field Reps | Full Day: Sarah Faubion | Half Day: Evan Paul | |

Cell Overview

| | | | |
|------------------------|---|-------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023



| | | | |
|--------------------------------|---|----------------------------|---|
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 5 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20231004-160346.jpg



Site Photo: FA_SitePhotos-20231004-170245.jpg



Site Photo: FA_SitePhotos-20231004-160446.jpg



Site Photo: FA_SitePhotos-20231004-181537.jpg



Site Photo: FA_SitePhotos-20231004-160458.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth: 0.35' Possible Cause: <input checked="" type="checkbox"/> Recent Rain <input type="checkbox"/> Clogged bottom <input type="checkbox"/> Blocked Underdrain <input checked="" type="checkbox"/> Unknown About 12.6 square feet coming out of inlet 1, located in the area described as bioinfiltration swale outfall structure in the plans. |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.67' Full Width Width 20' The underdrain is a 8" pvc perforated pipe, within 8" of drain rock underlying 6" of filter media which is below the Bioretention soil mix. There is geotextile below the drain rock and up the side slopes for 1 foot. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from runoff of the adjacent roadway, and an inlet conveying water from the surrounding neighborhood storm drain network that all lead to a large catch basin with a manual Hi-Flow Bypass feature. Under most conditions water will enter the cell from this catch basin, through a pipe, to the Bioinfiltration Swale Outfall Structure that is designed to hold water in a 8' diameter cement cylinder filled with 3.5' of drain rock underlain by a 0.5' layer of concrete, with 12 mil plastic sheeting. Once water has met the 0.6' freeboard of the cement riser it will then flow into the bioinfiltration facility where is is designed to infiltrate through bioretention soil before infiltrating through filter media, before reaching the underdrain pipe that connects to a catch basin that eventually flows into the west tributary of Silver Beach Creek. | |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)

Cell: Bioinfiltration Swale

Assessed On:

October 4, 2023



IN-1

Curb cut Sheet Flow

Dispersed Flow Pipe

Other:

Pipe:

Material

PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20231004-163624.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
Cell: Bioinfiltration Swale

Assessed On:
October 4, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: The catch basin trash rack has some accumulation of pine needles and sediment. The 8' diameter outfall structure is buried under silty muck and thick grasses. Probe measurements found 0.2' to 0.8' of sediment build up over the concrete riser rim, raising the overflow elevation. The structure has frogs are living in the ponded water.



FA_INBLPhoto-20231004-163610.jpg

Additional Details: IN-1 flows into the bioinfiltration swale outfall structure, described previously.


BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023



Design Overflow/Outlet

| | |
|---|---|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.15' Width: 1.8' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.55 Relative from staff gauge: 8 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| FA_DOPhoto-20231004-163846.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|--|--|--|------------------------------------|-------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | | | | | Depth (ft): |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| The cell is predominantly covered by grass and low weeds. Natural mulch and cut grasses cover much of the cell. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: Deer have extensively pruned the border cypress trees up to a height they can reach, this appears cartoonish in nature and is not aesthetically pleasing. | | | | | | |
| Vegetation Description | | | | | | |
| The grasses are well cut back, there are some blackberries and shrubs too. Ornamental cypress trees border the cell on one side adjacent to the residential yard. | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.0'-3' of bioretention soil, with an average of 2.1', before encountering the underdrain gravels. This is consistent with the the 2' minimum specified by the plans. On the cell edges, 0.2-2.0 feet of soil was encountered above native soils. This is consistent with the cell design which shows a 2:1 slope with unspecified depth of soil above the existing subgrade. There were two | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023



zones of slight compaction observed, one in the center of the cell 40' and 60' from the east end of the cell; and one zone of higher compaction identified 50' from the east end of the cell and 5' from the north edge of the cell, in the area shown as wetted area from IT-2. The upper 0.4' of soil has more fines around north perimeter of cell, where the path of water flows from inlet1, shown by a blue arrow.

Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 2 |
| Total Depth: | 2.1 |
| Rain/Garden Mix Soil Texture: Slightly moist, medium dense, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: FILTER MEDIA: Moist, medium dense, grayish brown, sandy GRAVEL, trace silt (GP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| Additional Details *"Depth to saturated soil" is depth to the filter media, not specifically the underdrain. | |

FA_FPhoto-20231004-180143.jpg

| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 2.1 |
| to Import/Underdrain: | |
| Total Depth: | 2.2 |
| Rain/Garden Mix Soil Texture: Moist, medium dense, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: FILTER MEDIA: Moist, medium dense, grayish brown, sandy GRAVEL, trace silt (GP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023



HA-2



FA_FPhoto-20231004-180558.jpg

Additional Details

HA-3WP

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.4

to Native Soil: 1.9

to Import/Underdrain:

Total Depth: 2.3

Rain/Garden Mix Soil Texture: Moist medium dense, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP)

Native Soil Texture: FILTER MEDIA: Moist, medium dense, grayish brown, sandy GRAVEL, trace silt (GP)

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft): 1.63



FA_FPhoto-20231004-180915.jpg


BIORETENTION CELL FIELD ASSESSMENT


Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023



| |
|---|
| HA-3WP |
| Additional Details |
| Stick up 3.5ft |
| Relative stick up above SG-1 zero: 3.6 ft |

| | |
|---|---|
| GS-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.1 |
| Rain/Garden Mix Soil Texture: Moist, medium dense, dark brown, silty fine to medium SAND, trace coarse sand, trace gravel, abundant organics (SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| GS-1.jpg | |
| Additional Details | |
| This is a grab sample of IT-1 ponded area surface sediments. | |

| | |
|---|---|
| GS-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.1 |
| Rain/Garden Mix Soil Texture: Moist, medium dense, dark brown, silty fine SAND, abundant organics.....needs sieve (SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| GS-2.jpeg | |
| Additional Details | |
| This is a grab sample of IT-2 ponded area surface sediments. | |

Infiltration Test

| |
|--|
| IT-1 |
| Water Supply |
| <input type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input checked="" type="checkbox"/> Water Truck |
| AESI Meter# 10-100gpm |

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
Cell: Bioinfiltration Swale

Assessed On:
October 4, 2023



| | |
|---|-------|
| Wetted Pond Area (sq. ft) | 31 |
| Ponded Depth (ft) | 0.04 |
| Total Gallons | 3,896 |
| Steady State Flow Rate (GPM) | 24.5 |
| Additional Details: Two infiltration tests, IT-1 was located centrally in the cell in an area that had some evidence of water flow. IT-2 was located in the northwest of the cell in a zone that shows evidence of past water ponding. IT-2 had a significantly lower infiltration rate, possibly due to accumulation of fines and compaction of soil due to ponding water. | |



IT_Photo-20231004-204329.jpg



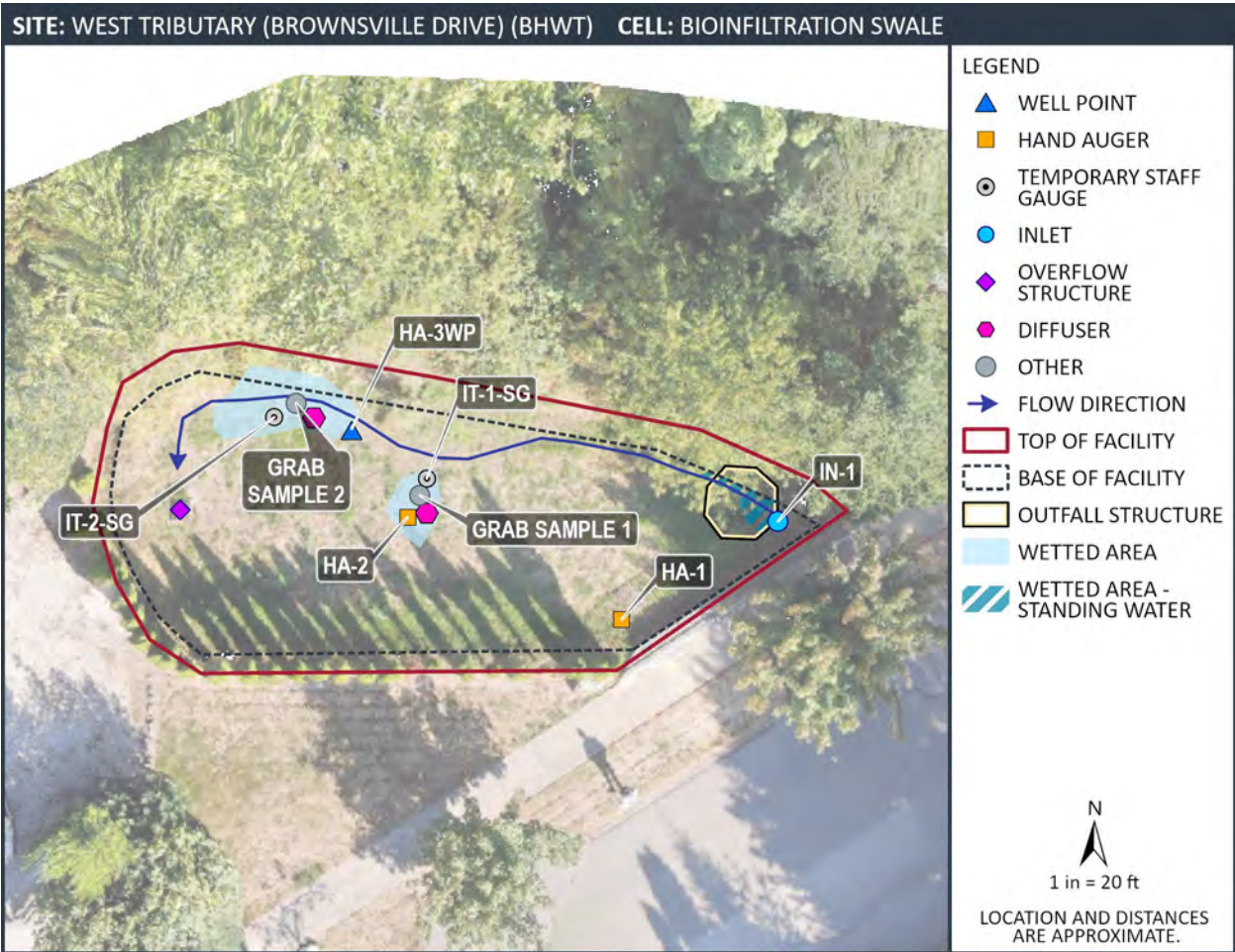
IMG_0701.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: West Tributary (Brownsville Drive) (BHWT)
 Cell: Bioinfiltration Swale

Assessed On:
 October 4, 2023





associated
earth sciences
incorporated

Well Point

BHWT-HA-3-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 10/3/23

Logged By: EAP

20150387H008

Ending Date: 10/3/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.4

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 103.5

Water Level Elevation (ft): N/A

Datum: Project Datum

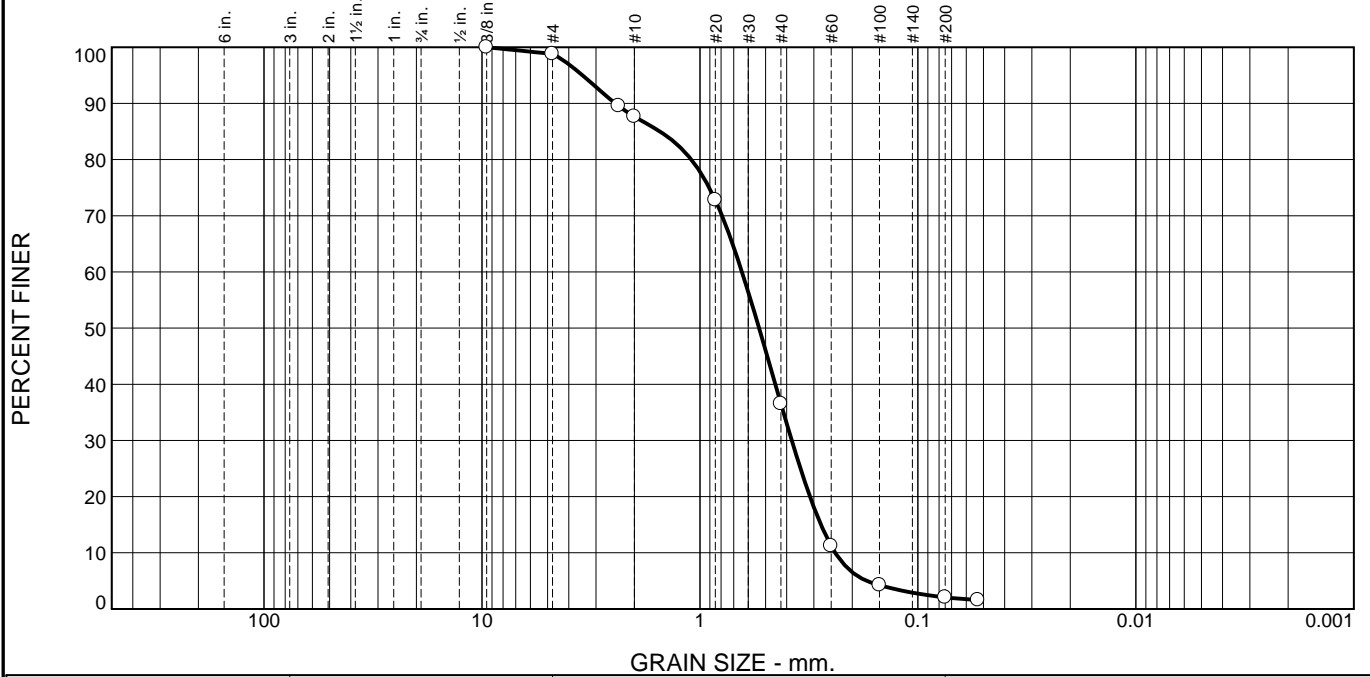
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Grass Healthy, fibrous grasses. | | | | | | | Stick up -3.5 to 0.5 feet Existing bioretention soil 0 to 0.5 feet 1.25-inch I.D. threaded galvanized steel casing -3.5 to -0.3 feet; duct tape covers screen -0.3 to 1.3 feet 3/8-inch bentonite chips 0.5 to 1 feet Medium grained silica sand 1 to 2.3 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.3 to 1.8 feet Cast iron endcap 1.8 to 2.1 feet Cast iron drivepoint 2.1 to 2.4 feet |
| 1 | | | | Bioretention Soil Mix Loose, moist, dark brown, silty, fine SAND, trace coarse sand; abundant organics (SP-SM). Medium dense, moist, dark brown, fine to medium SAND, trace silt, trace coarse sand; abundant organics (SP). | | | | | | | |
| 2 | | | | Loose, moist, dark brown, fine to medium SAND, trace silt, trace coarse sand; abundant organics (SP). Filter Media Medium dense, moist, grayish brown, sandy, fine GRAVEL, trace silt (GP). | | | | | | | |
| 3 | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/18/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.2 | 11.1 | 51.2 | 34.4 | 2.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 98.8 | | |
| #8 | 89.5 | | |
| #10 | 87.7 | | |
| #20 | 72.8 | | |
| #40 | 36.5 | | |
| #60 | 11.2 | | |
| #100 | 4.2 | | |
| #200 | 2.1 | | |
| #270 | 1.6 | | |

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.4448 D₈₅= 1.5254 D₆₀= 0.6416
D₅₀= 0.5355 D₃₀= 0.3791 D₁₅= 0.2787
D₁₀= 0.2394 C_u= 2.68 C_c= 0.94

Remarks

Date Received: 10-4-2023 Date Tested: 11-27-2023

Tested By: FEW

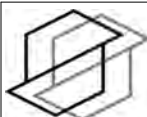
Checked By: EAP/SNCF/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Bellingham Brownsville Dr.
Sample Number: HA-2 **Depth:** 6"

Date Sampled: 10-4-2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 10/4/2023 | Project BHPS-Brownsville Drive | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellingham, WA | EB/EP No. BHWT-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0.5' | GS-01 @ 0-0.1' |
|--------------------|-------------|----------------|
| Wet Weight + Pan | 517.78 | 481.68 |
| Dry Weight + Pan | 495.46 | 422.76 |
| Weight of Pan | 259.53 | 264.99 |
| Weight of Moisture | 22.32 | 58.92 |
| Dry Weight of Soil | 235.93 | 157.77 |
| % Moisture | 9.46 | 37.35 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 495.46 | 422.76 |
| Dry Soil After Burn + Pan | 491.19 | 410.81 |
| Weight of Pan | 259.53 | 264.99 |
| Wt. Loss Due to Ignition | 4.27 | 11.95 |
| Actual Wt. Of Soil After Burn | 231.66 | 145.82 |
| % Organics | 1.81 | 7.57 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|------------------------------------|--------------------------------|---------------|
| Project Name: | Brownsville Drive (West Tributary) | Water Source: | Water truck |
| Project Number: | 20150387 H008 | Meter: | 10-100 gpm |
| Date: | 10/4/2023 | Wetted Area (sq. feet): | 09:45 31 ft^2 |
| Weather: | Clear | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.04 |
| Performed By: | SNCF/EAP | Receptor Soils: | Filter Media |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | CB-1 (ft) | Wellpoint (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|-----------|----------------|---------------------|-------------------------|
| 8:00 | 15 | | 3.7 | Dry | | Water on |
| 8:01 | 23 | | | | | Pump on |
| 8:04 | 22 | | | | 88 | |
| 8:08 | 22.9 | | | | 175 | Increase flow to 25 gpm |
| 8:10 | 25.4 | | | | 246 | |
| 8:15 | 25 | | | | 370 | |
| 8:30 | 25.3 | 0.03 | 3.68 | | 736 | Moved SG to ponded area |
| 8:47 | 24.9 | 0.03 | 3.67 | | 1,172 | |
| 9:00 | 24.6 | 0.04 | | | 1,485 | |
| 9:16 | 24.9 | 0.04 | 3.65 | | 1,906 | |
| 9:30 | 24.4 | 0.04 | | | 2,232 | |
| 9:45 | 24.4 | 0.04 | 3.66 | | 2,617 | |
| 10:00 | 24.2 | 0.04 | | | 2,981 | |
| 10:15 | 24.4 | 0.04 | 3.65 | | 3,354 | |
| 10:27 | 24.4 | 0.04 | | | 3,635 | |
| 10:30 | 24.2 | 0.04 | 3.65 | | 3,701 | |
| 10:35 | 24.4 | 0.04 | | | 3,823 | |
| 10:38 | | 0 | 3.66 | Dry | 3,896 | Water off |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 76.0 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | - |

| | | | |
|------------------------|------------------------------------|--------------------------------|----------------|
| Project Name: | Brownsville Drive (West Tributary) | Water Source: | Water truck |
| Project Number: | 20150387 H008 | Meter: | 10-100 gpm |
| Date: | 10/4/2023 | Wetted Area (sq. feet): | 12:15 106 ft^2 |
| Weather: | Clear | Underdrain: | Yes |
| Test No.: | IT-2 | Test Depth (feet): | 0.14 |
| Performed By: | SNCF/EAP | Receptor Soils: | Filter Media |

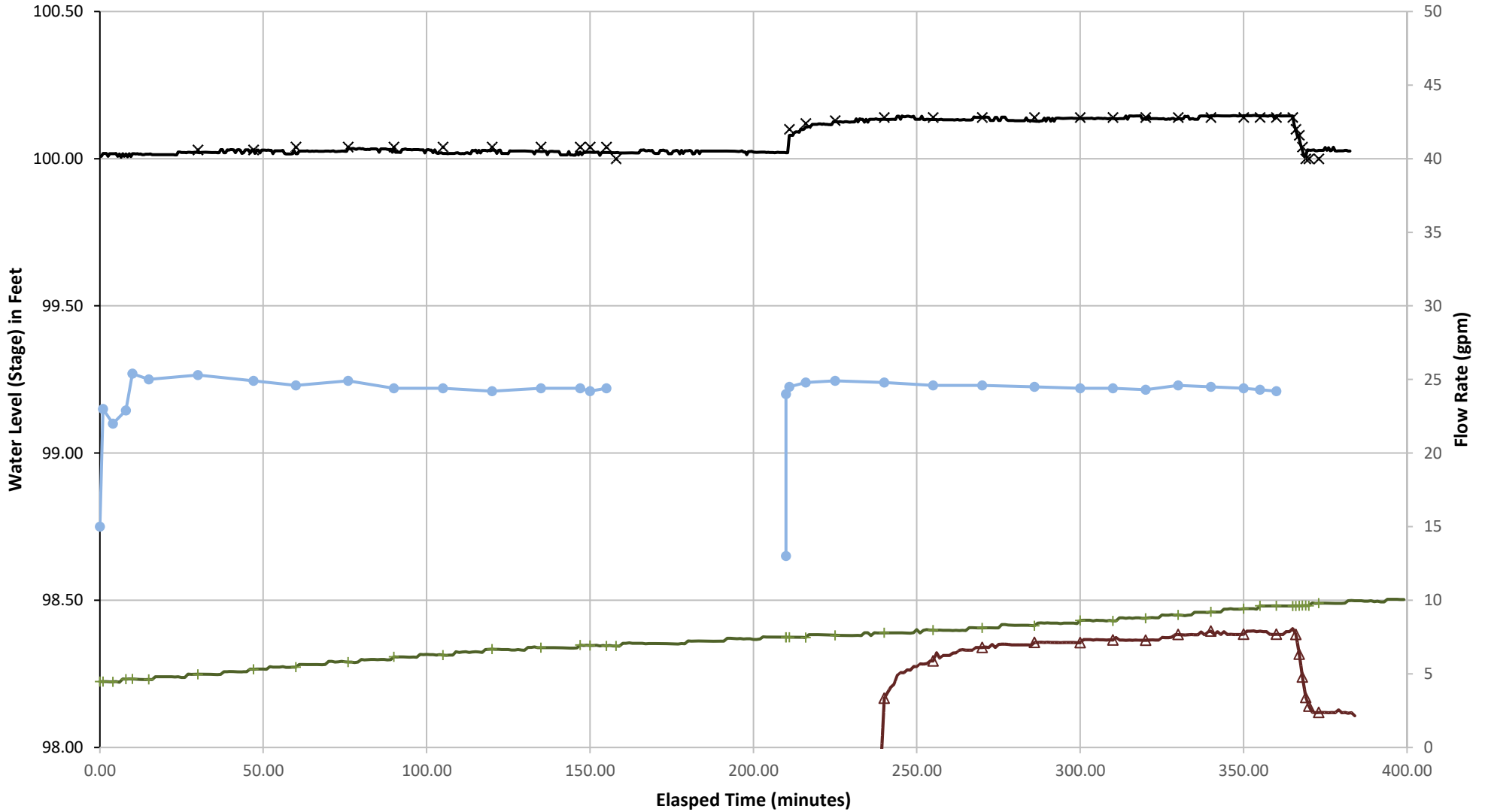
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | CB-1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|-----------|----------------------|---------------------|---|
| 11:30 | 13 | | 3.76 | | | Water on |
| 11:30 | 24 | | | | | Pump on |
| 11:31 | 24.5 | 0.1 | | | 41 | |
| 11:36 | 24.8 | 0.12 | | | 144 | |
| 11:45 | 24.9 | 0.13 | 3.75 | | 367 | |
| 12:00 | 24.8 | 0.14 | | 5.37 | 740 | Small hole near WP, water flowing into hole |
| 12:15 | 24.6 | 0.14 | 3.7 | 5.23 | 1,112 | |
| 12:30 | 24.6 | 0.14 | 3.69 | 5.18 | 1,487 | |
| 12:46 | 24.5 | 0.14 | | 5.17 | 1,900 | |
| 13:00 | 24.4 | 0.14 | 3.68 | 5.17 | 2,218 | |
| 13:10 | 24.4 | 0.14 | | 5.16 | 2,465 | |
| 13:20 | 24.3 | 0.14 | 3.65 | 5.16 | 2,705 | |
| 13:30 | 24.6 | 0.14 | | 5.14 | 2,962 | |
| 13:40 | 24.5 | 0.14 | 3.67 | 5.14 | 3,197 | |
| 13:50 | 24.4 | 0.14 | | 5.13 | 3,450 | |
| 13:55 | 24.3 | 0.14 | | | 3,572 | |
| 14:00 | 24.2 | 0.14 | 3.66 | 5.13 | 3,685 | |
| 14:05 | | 0.14 | | | 3,813 | Water off |
| 14:06 | | 0.1 | | 5.17 | | |
| 14:07 | | 0.08 | | 5.23 | | |
| 14:08 | | 0.04 | | 5.33 | | |
| 14:09 | | 0 | | 5.38 | | |
| 14:10 | | | 3.68 | 5.39 | | Endcap water |
| 14:13 | | | | 5.4 | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 22.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 24.0 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 22.7 |
| WP Average Infiltration Rate (in/hr) during falling head: | 57.6 |

Brownsville Drive (West Tributary) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used as relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ HA-1-WP Hand
- HA-1-WP Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 2 (Roof Cell)

Assessed On:
August 16, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested bioretention cell is the final cell in a series of underdrained bioretention cells constructed in 2009 which collect water directly from roof runoff from the adjacent building. Cells are constructed with 24" of raingarden soil mix in the base and tapers to 8" on the edges of the cell. Beneath the bioretention soil are underdrain gravels which surround a 6" diameter perforated pipe. The underlying soils were tilled a minimum of 12" deep before placement of the pea gravel underdrain. According to landscaping documents, the compost was mixed into the soil in 4" lifts during placement. No water is designed to infiltrate into the soil as the subgrade soils (Vashon Till) are unsuitable for infiltration.

BIORETENTION SOIL:

Thickness: 1.4'-1.7'

The apparent thickness of the bioretention soil in the cell base based on probe data and hand augers ranged from 1.4-1.6' below the ground surface with an average thickness of 1.5'. This is less than the 2' specified by the plans. The bioretention soil was observed to taper towards the edges of the cell to depths ranging from 0.2'-0.6'.

Composition: The design soil specifications were referenced in the design plans, but were not available for review. In comparison to the 2019 Ecology specification, the tested material fell within the recommended guidelines for sand gradation but barely fell below the specifications for fine gravel and barely exceeded the specifications for silt content. The organic matter content met the 2019 Ecology specifications.

Organic Matter Content (% by weight): 3.2

Percent passing #200 sieve: 5.3

Coefficient of Uniformity (Cu): 5.5

Coefficient of Curvature (Cc): 0.8

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A. Subgrade soil not encountered.

BUILT PER PLAN:

Soil at base of cell less than 2', otherwise built to plan.

GROUNDWATER CONDITIONS:

No groundwater was encountered during our explorations and the wellpoint, screened in the underdrain gravels from 1.6'-2.4' did not respond to infiltration testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 27.8

Subgrade Soil Rate (in/hr): N/A

The subgrade soil infiltration rate could not be measured due to the presence of the underdrain.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
 Cell: Type 2 (Roof Cell)

Assessed On:
 August 16, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Bioretention soil not placed to full 2' depth. Otherwise, the cell is in good condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|------------------|
| Weather | Clear, 80-90's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | Half Day: | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230816-154351.jpg

Site Photo: FA_SitePhotos-20230816-154410.jpg



Site Photo: FA_SitePhotos-20230816-162915.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
 Cell: Type 2 (Roof Cell)

Assessed On:
 August 16, 2023



Site Photo: FA_SitePhotos-20230816-162945.jpg

Cell Construction

| | |
|---|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Partial Width Width 3' 6" Perforated pipe down runs down the center of the cell and was observed in the catch basin. Based on probe measurements, the width of the underdrain was estimated to be 3' wide. The plans call for the underdrain gravels to consist of 6" minimum pea gravel above the pipe and 12" minimum pea gravel below the pipe. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments The tested cell is the final in a series of underdrained bioretention cells which collect roof runoff from the adjacent building. The adjacent roof has no gutter and water enters the cell under sheet flow like conditions. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 2 (Roof Cell)

Assessed On:
August 16, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230816-172444.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Water flows in sheet flow fashion from the roof approximately 15-20' above the base of the cell. No energy dissipation techniques are employed.


BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 2 (Roof Cell)

Assessed On:
August 16, 2023



Design Overflow/Outlet

| | |
|--|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2' Width: 1.5' |
| Additional Details: | |
| Stickup (ft) From Ground: 1.4 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 5% blocked Additional Details: Vegetation | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 5% blocked Additional Details: Vegetation hinders access, unable to gather relative stick up from staff gauge zero due to brambles | |
|  | |
| FA_DOPhoto-20230816-172738.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|--|--|--|--|--|------------------------------------|-------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | | | | | Depth (ft): |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Cell is densely vegetated. Natural mulch consists of cuttings from nettles in approximately 25% of the cell. Some scattered trash observed. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: Custodial staff report rats seen in the cell. Difficult to visually confirm due to dense vegetation. | | | | | | |
| Vegetation Description | | | | | | |
| Dense vegetation, thorny blackberry/salmon berry thicket, and stinging nettle. Limits work in about 30% of cell | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.4-1.6' of bioretention soil before encountering the underdrain gravels. This is less than the 2' specified by the plans. On the cell edges, less than 1 foot of soil was encountered above native soils. This is consistent with the cell design which shows a 3:1 slope with 8" of soil above the existing subgrade. No zones of compaction were observed. Some areas of the cell could not be probed due to thick, thorny vegetation. | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
 Cell: Type 2 (Roof Cell)

Assessed On:
 August 16, 2023



Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.5 |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown medium to fine SAND, with coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Underdrain encountered at 1.5' | |



IMG_0463.jpg

| | |
|---|---|
| HA-2-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.5 |
| Total Depth: | 2 |
| Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown medium to fine SAND, with coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: Loose, sl. moist, grey, fine rounded GRAVEL, trace sand, trace silt, moderate organics (GP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): | |
| Additional Details | |




IMG_0464.jpg

BIORETENTION CELL FIELD ASSESSMENT


Site: Bainbridge Island High School (BIHS)
Cell: Type 2 (Roof Cell)

Assessed On:
August 16, 2023



| | |
|--|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1 |
| Rain/Garden Mix Soil Texture: Loose, sl. moist, dark brown medium to fine SAND, with coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
|  | |
| IMG_0469.jpg | |
| Additional Details 0-0.2 Feet of dead blackberry canes 0.2-1.0 Bioretention soil mix Bottom of hole 1 foot, no returns, blackberries limited access, | |

Infiltration Test

| | |
|--|-------|
| IT-1 | |
| Water Supply | |
| <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM3-3-50 | |
| Wetted Pond Area (sq. ft) | 18.6 |
| Ponded Depth (ft) | 0.08 |
| Total Gallons | 1,885 |
| Steady State Flow Rate (GPM) | 5.5 |
| Additional Details: | |
| | |
|  | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)

Cell: Type 2 (Roof Cell)

Assessed On:

August 16, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)

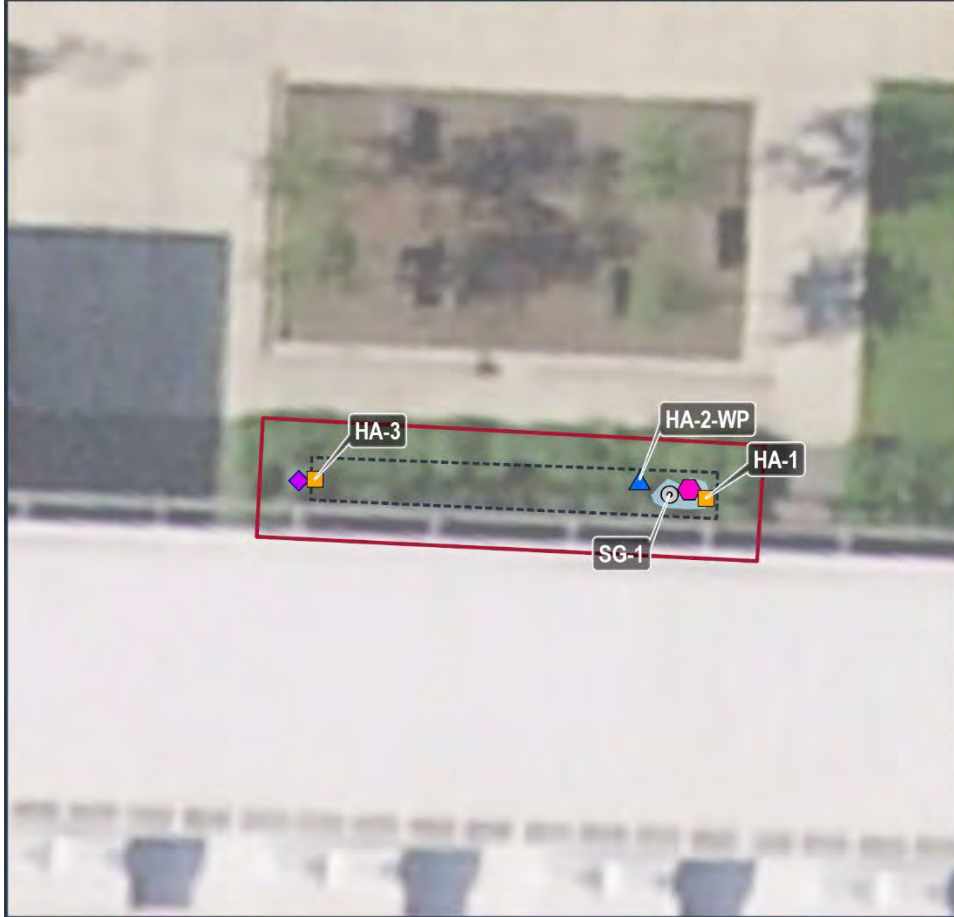
Cell: Type 2 (Roof Cell)

Assessed On:









August 16, 2023



SITE: BAINBRIDGE ISLAND HIGH SCHOOL (BIHS) CELL: ROOF CELL (TYP 2)



LEGEND

-  WELL POINT
-  HAND AUGER
-  TEMPORARY STAFF GAUGE
-  OVERFLOW STRUCTURE
-  DIFFUSER
-  TOP OF FACILITY
-  BASE OF FACILITY
-  WETTED AREA



1 in = 20 ft

LOCATION AND DISTANCES ARE APPROXIMATE.



associated
earth sciences
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Well Point

BIHS-2-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/15/23

Logged By: SNCF/APJ

20150387H008

Ending Date: 8/15/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 103.5

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

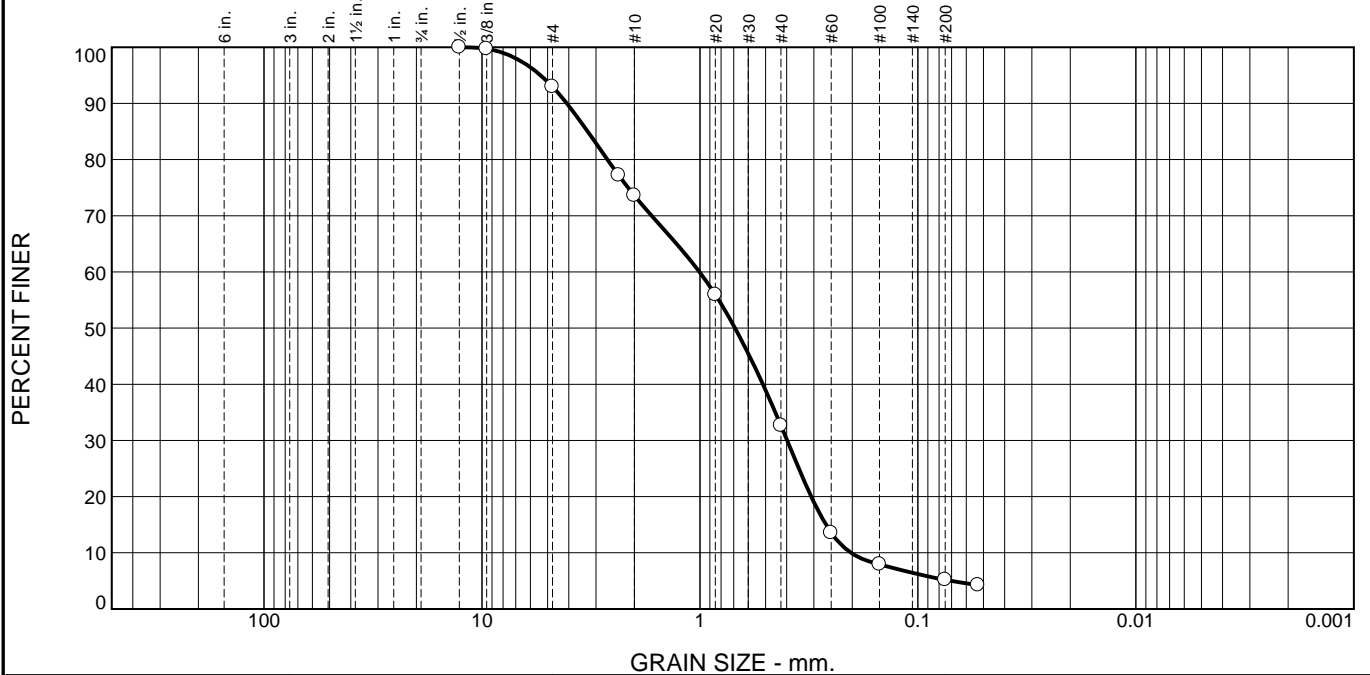
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some silt; abundant organics (SP-SM). | | | | | | | Stick up -3.5 to 0 feet Bioretention soil mix 0 to 1.3 feet 1.25-inch I.D. threaded galvanized steel casing -3.5 to 0 feet; duct tape covers screen 0 to 1.6 feet 3/8-inch bentonite chips 1.3 to 1.5 feet Existing gravel 1.5 to 1.7 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.6 to 2.4 feet Medium grain silica sand 1.7 to 2 feet Existing gravel 2 to 2.7 feet Cast iron drive endcap 2.4 to 2.7 feet Cast iron drivepoint 2.7 to 3 feet |
| 1 | | | | | | | | | | | |
| 2 | Hand | 2 3 | | Transition to Underdrain Gravel Loose, slightly moist, dark brown, fine to medium sandy, fine GRAVEL, some coarse sand, trace silt; abundant organics (GP). | | | | | | | |
| 3 | | | | Underdrain Gravel Loose, slightly moist, gray, fine GRAVEL, trace medium sand, trace silt; moderate organics (GP). No seepage. Moderate caving 1.5 to 2 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/23/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 7.0 | 19.4 | 40.9 | 27.5 | 5.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 93.0 | | |
| #8 | 77.2 | | |
| #10 | 73.6 | | |
| #20 | 56.0 | | |
| #40 | 32.7 | | |
| #60 | 13.6 | | |
| #100 | 7.9 | | |
| #200 | 5.2 | | |
| #270 | 4.3 | | |

Material Description
SAND some gravel some silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI= NP

Classification
 USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 4.0814 D₈₅= 3.2744 D₆₀= 1.0053
 D₅₀= 0.6900 D₃₀= 0.3979 D₁₅= 0.2643
 D₁₀= 0.2031 C_u= 4.95 C_c= 0.78

Remarks

Date Received: 8-16-2023 Date Tested: 10-23-2023

Tested By: FEW

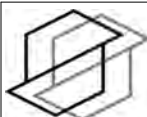
Checked By: SNCF/APJ

Title: _____

* (no specification provided)

Location: Onsite - BIHS-RC Bainbridge HS Roof Cell
Sample Number: HA-1 **Depth:** 0.0-1.5'

Date Sampled: 8-15-2023



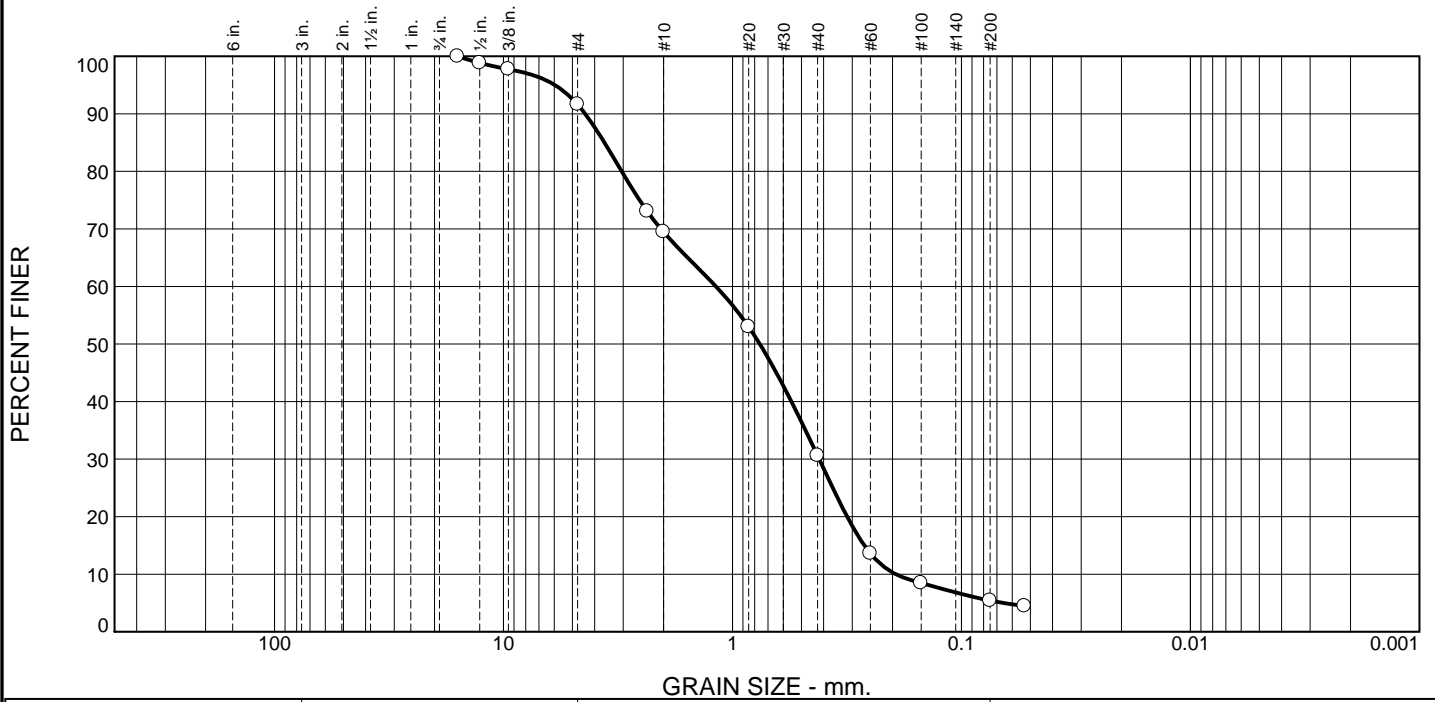
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 8.4 | 22.1 | 38.9 | 25.2 | 5.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 98.8 | | |
| 3/8" | 97.7 | | |
| #4 | 91.6 | | |
| #8 | 73.1 | | |
| #10 | 69.5 | | |
| #20 | 53.0 | | |
| #40 | 30.6 | | |
| #60 | 13.6 | | |
| #100 | 8.5 | | |
| #200 | 5.4 | | |
| #270 | 4.5 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 4.3991 | D ₈₅ = 3.6236 | D ₆₀ = 1.1804 |
| D ₅₀ = 0.7593 | D ₃₀ = 0.4181 | D ₁₅ = 0.2657 |
| D ₁₀ = 0.1936 | C _u = 6.10 | C _c = 0.76 |

Remarks

Date Received: 8-16-2023 Date Tested: 10-20-2023

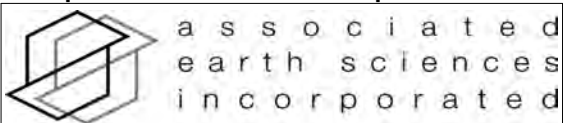
Tested By: FEW

Checked By: SNCF/CSI/JS

Title: _____

Location: Onsite - BIHS-RC Bainbridge HS Roof Cell
Sample Number: HA-3 **Depth:** 0.2-1.0'

Date Sampled: 8-15-2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 8/15/2023 | Project BIHS-RC | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bainbridge Island, WA | EB/EP No. BIHS-RC-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-1.5' | HA-3 @ 0.2-1' |
|--------------------|---------------|---------------|
| Wet Weight + Pan | 1548.23 | 1743.24 |
| Dry Weight + Pan | 1470.37 | 1665.98 |
| Weight of Pan | 391.97 | 392.04 |
| Weight of Moisture | 77.86 | 77.26 |
| Dry Weight of Soil | 1078.40 | 1273.94 |
| % Moisture | 7.22 | 6.06 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------|---------|
| Dry Soil Before Burn + Pan | 1470.37 | 1665.98 |
| Dry Soil After Burn + Pan | 1438.11 | 1623.53 |
| Weight of Pan | 391.97 | 392.04 |
| Wt. Loss Due to Ignition | 32.26 | 42.45 |
| Actual Wt. Of Soil After Burn | 1046.14 | 1231.49 |
| % Organics | 2.99 | 3.33 |

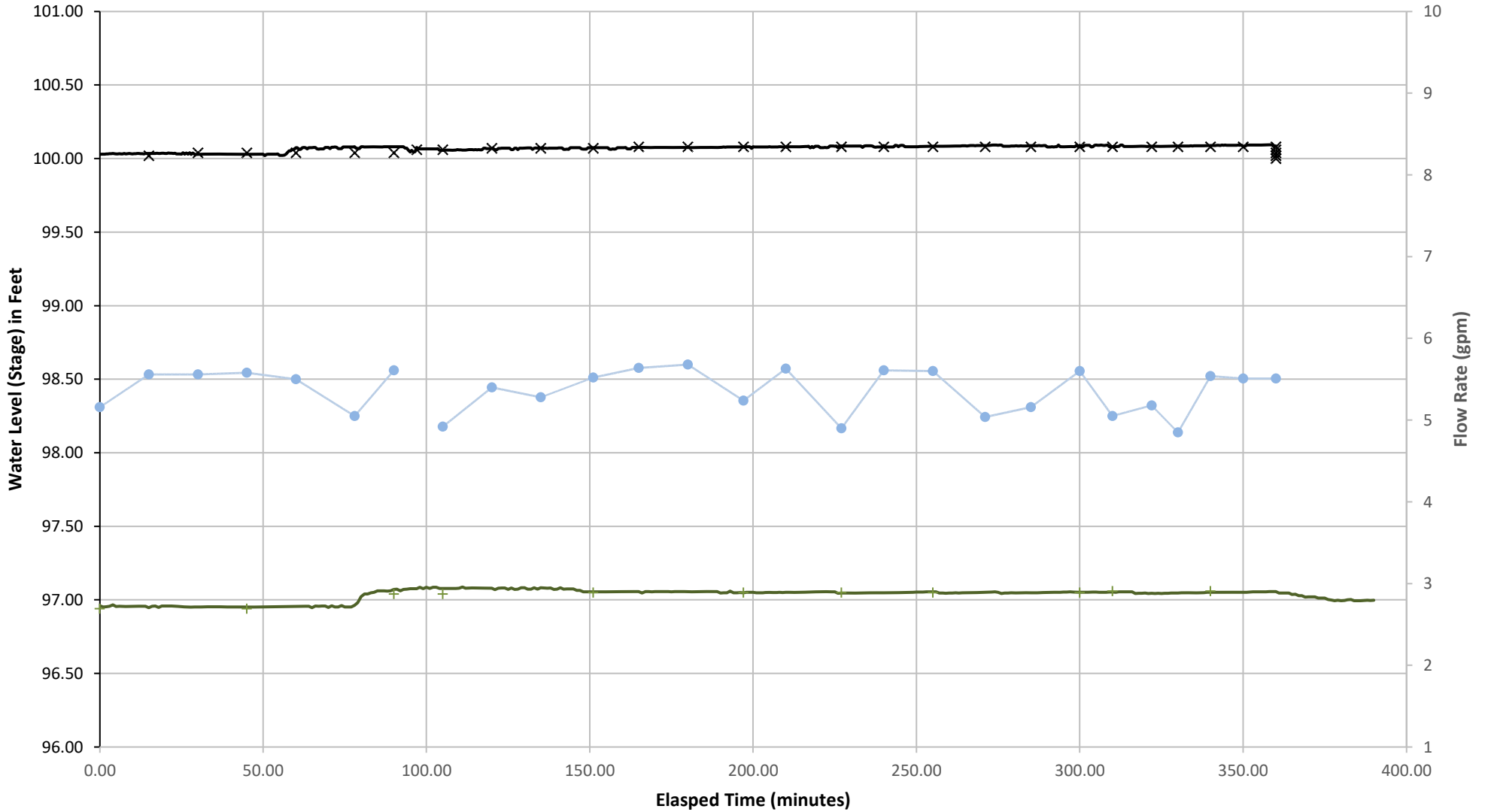
ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|---|--------------------------------|---|
| Project Name: | Bainbridge Island High School- Type 2 (Roof Cell) | Water Source: | Hosebib |
| Project Number: | 20150387H008 | Meter: | FM 4 3-50 |
| Date: | 8/16/2023 | Wetted Area (sq. feet): | (9am) 11.5ft / (10am) 16.9ft / (11:30am) 18.6ft |
| Weather: | Clear 70's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.08 |
| Performed By: | SNCF | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|--|
| 8:00 | 5.16 | | 4.06 | dry | 0 | Water On |
| 8:15 | 5.56 | 0.02 | | dry | 80 | |
| 8:30 | 5.56 | 0.04 | | | 160 | |
| 8:45 | 5.58 | 0.04 | 4.06 | dry | 241 | |
| 9:00 | 5.5 | 0.04 | | | 321 | Cleared SG-1 data logger of debris around base |
| 9:18 | 5.05 | 0.04 | | | 419 | |
| 9:30 | 5.61 | 0.04 | 3.96 | dry | 483 | Can see water flowing into CB |
| 9:37 | | 0.06 | | | | Staff gauge fell over 09:37 |
| 9:45 | 4.92 | 0.06 | 3.96 | dry | 563 | |
| 10:00 | 5.4 | 0.07 | | dry | 645 | |
| 10:15 | 5.28 | 0.07 | | | 724 | |
| 10:31 | 5.52 | 0.07 | 3.95 | dry | 813 | |
| 10:45 | 5.64 | 0.08 | | | 884 | |
| 11:00 | 5.68 | 0.08 | | dry | 965 | |
| 11:17 | 5.24 | 0.08 | 3.95 | | 1,061 | |
| 11:30 | 5.63 | 0.08 | | dry | 1,129 | |
| 11:47 | 4.9 | 0.08 | 3.95 | | 1,220 | |
| 12:00 | 5.61 | 0.08 | | | 1,289 | |
| 12:15 | 5.6 | 0.08 | 3.95 | dry | 1,374 | |
| 12:31 | 5.04 | 0.08 | | | 1,458 | |
| 12:45 | 5.16 | 0.08 | | dry | 1,537 | |
| 13:00 | 5.6 | 0.08 | 3.95 | | 1,613 | |
| 13:10 | 5.05 | 0.08 | 3.94 | dry | 1,669 | |
| 13:22 | 5.18 | 0.08 | | | 1,737 | |
| 13:30 | 4.85 | 0.08 | | | 1,775 | |
| 13:40 | 5.54 | 0.08 | 3.94 | dry | 1,833 | |
| 13:50 | 5.51 | 0.08 | | dry | 1,885 | |
| 14:00:00 | 5.51 | 0.08 | | | 1,937 | Water Off |
| 14:00:30 | | 0.06 | | | | |
| 14:00:45 | | 0.04 | | | | |
| 14:01:15 | | 0.02 | | | | |
| 14:02 | | 0 | | | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 27.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 34.6 |

Bainbridge High School-Typ 2 (Roof Cell) (IT-1) Infiltration Test Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface. The wellpoint did not respond to testing.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 5 (Tennis Cell)

Assessed On:
August 15, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested bioretention cell was constructed in 2009 and collects sheet flow from the adjacent parking lot and piped runoff from the adjacent tennis court. The cell is constructed with 24" of raingarden soil mix in the base which tapers to 8" on the edges of the cell. Beneath the bioretention soil are underdrain gravels which surround a 6" diameter perforated pipe. The underlying soils were tilled a minimum of 12" deep before placement of the pea gravel underdrain. According to landscaping documents, the compost was mixed into the soil in 4" lifts during placement. No water is designed to infiltrate into the soil as the subgrade soils (Vashon Till) are unsuitable for infiltration.

BIORETENTION SOIL:

Thickness: 0.3-1.8'

The apparent thickness of the bioretention soil in the cell base based on probe data and hand augers ranged from 0.3-1.8' and was highly variable throughout the cell. The thickness of the northern bioretention soils near the inlet was measured to be 0.4'. This soil was compacted and sat above fill soils, not underdrain gravels as specified by the plans. The soils in the central portion of the cell were measured to be 1.8' and sat above underdrain gravels. This portion of the cell is consistent with the design plans and the difference in soil thickness of 0.2' could be attributed to compaction over time. The soils in the southern portion of the cell near the overflow structure were measured to be 0.6' thick and not consistent in texture and color with the bioretention soils observed in the northern and central portions of the cell.

Composition: The design soil specifications were referenced in the design plans, but were not available for review. In comparison to the 2019 Ecology specification, the tested material fell within the recommended guidelines for sand gradation but barely fell below the specifications for fine gravel and barely exceeded the specifications for silt content. The organic matter content fell well below the 2019 Ecology specifications for the soil in the northern portion of the facility near the inlet but was within .5% of the minimum specification for the central portion. Since the compost was tilled into the soil during placement, it is possible that the northern portion of the facility did not receive same compost mix during placement as there were other irregularities with the observed conditions in that portion of the cell.

Organic Matter Content (% by weight): 3.7

Percent passing #200 sieve: 6.1

Coefficient of Uniformity (Cu): 6.2

Coefficient of Curvature (Cc): 0.9

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: Not Encountered

Fill soils encountered in HA-1 were found to be Stiff, slightly moist, tan, silty fine to medium SAND, some coarse sand (SM).

BUILT PER PLAN:

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 5 (Tennis Cell)

Assessed On:
August 15, 2023



Several observed conditions differed from the design plans:

- Northern 12' of the cell near IN-1 were constructed with 0.4' of bioretention soil above a silty fill material. Our interpretation is that the underdrain does not reach the full length of the cell as indicated on the plans.
- Approximately 25' from the inlet a 1 foot "berm" was observed sitting perpendicular to the long axis of the cell.
- Soil in the southernmost portion of the facility was of a different color and texture than the soil in the other parts of the facility.

GROUNDWATER CONDITIONS:

No groundwater was encountered in any of the hand augers. The temporary wellpoint installed was screened in the underdrain gravels from 2.1-2.9' below ground surface and did not respond to infiltration testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 85.7
Subgrade Soil Rate (in/hr): N/A

Two infiltration tests were performed. IT-1 was completed near the inlet where no underdrain gravels were interpreted to exist below the ground surface. This test measured an infiltration rate of 17.4 in/hr and is interpreted to represent the infiltration rate of the fill soils encountered below the surface. IT-2 was completed in the central portion of the cell where explorations found 1.8' of bioretention soil above underdrain gravels. This test measured a rate of 85.7 in/hr and is interpreted to represent the bioretention soil infiltration rate.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The observed cell conditions varied significantly from the plans in portions of the cell. Please see the 'built per plan' section above for specific details.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|-------------------------|
| Weather | Clear, 90s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Alex Johanson |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 5 (Tennis Cell)

Assessed On:
August 15, 2023



| | | | |
|----------------------------|---|--|--|
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |
|----------------------------|---|--|--|



Site Photo: FA_SitePhotos-20230815-212345.jpg



Site Photo: FA_SitePhotos-20230815-212605.jpg



Site Photo: FA_SitePhotos-20230815-212457.jpg



Site Photo: FA_SitePhotos-20230815-212644.jpg



Site Photo: FA_SitePhotos-20230815-212509.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
 Cell: Type 5 (Tennis Cell)

Assessed On:
 August 15, 2023



Cell Construction

| | |
|---|--|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width 3' Dense vegetation and steep side slopes obscures probes or hand augers to determine the trench width. Underdrain gravels do not extend the full length of the trench, stopping 13' feet short of tennis court inlet (IN-1). |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from sheet flow runoff from the adjacent parking lot and from an inlet which collects water from the nearby tennis court. Water is designed to infiltrate through the bioretention soil before reaching the underdrain pipe where it flows to a catch basin and out to the storm drain network. The underdrain gravels were not observed to extend to the full length of the trench and terminated 13' short of the tennis court inlet. | |

Inlets

| | |
|--|--|
| IN-1 <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: | |
| Pipe: Material <input checked="" type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.45' | |
| Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: If any dissipation method was implemented it has been deeply buried by sediment and organic debris. | |



FA_INphoto-20230815-220550.jpg

BIORETENTION CELL FIELD ASSESSMENT


Site: Bainbridge Island High School (BIHS)
 Cell: Type 5 (Tennis Cell)

Assessed On:
 August 15, 2023



| | | |
|---|---|--|
| IN-2 <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 152' Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230815-220406.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Angular rock lines the parking lot side of cell. | | |

Design Overflow/Outlet

| | | |
|---|--|--|
| DO - 1 Shape: <input type="checkbox"/> Round Dimensions: <input checked="" type="checkbox"/> Rectangular Length: 1.75' <input type="checkbox"/> Other Width: 1.4' Additional Details: | |  <p>FA_DOPhoto-20230815-215930.jpg</p> |
| Stickup (ft) From Ground: 0.28 Relative from staff gauge: | | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Vines within catch basin. Relative stick up difficult to measure due to thick vegetation between overflow structure and ponded area. | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 35% blocked Additional Details: Vines block trash rack on overflow structure. | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
 Cell: Type 5 (Tennis Cell)


Assessed On:
 August 15, 2023



Cell Surface and Geotech Probe Observations

| | | | | | |
|---|---|--------------------------------|--|-----------------------------------|---|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Cell bottom appears to increase once it becomes densely vegetated. Thin layer of calcrete on surface observed near IN-1 and further described in HA-1. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Additional Details: | | | | | |
| Vegetation Description | | | | | |
| Dense, prickly vegetation, blackberries, limited probing and cell exploration and excavation. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: | | | | | |
| The material within 12' of IN-1 was not underdrained and probe depths only reached 0.2' on average. At 25' from the inlet, there was an approximate 1' increase in surface elevation, labeled berm on the field map. The soils in the central portion of the cell were observed to be compacted and probe depths only reached 0.3-0.6'. The soil near the overflow structure did not resemble the same bioretention soil encountered at other portions of the cell and probed only 0.3-0.6'. Attempts to measure the cross-sectional depths of the cell were limited by dense, thorny vegetation. | | | | | |

Hand Auger


| | | |
|--|---|--|
| HA-1 | |  <p>IMG_0455.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | | |
| <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.06 | |
| to Native Soil: | 0.4 | |
| to Import/Underdrain: | | |
| Total Depth: | 0.5 | |
| Rain/Garden Mix Soil Texture: Med dense, slightly moist, dark brown, f-m SAND with coarse sand, some gravel, some silt, abundant organics (SP-SM)) | | |
| Native Soil Texture: Dense, slightly moist, tan, silty f-m SAND, some coarse sand (SM) | | |
| Liner Present: | Filter Fabric Present: | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details | | |
| 0-0.05': Natural mulch of blackberry canes | | |
| 0.05-0.06' : Stiff, dry, white, calcareous evaporite layer, vigorous reaction, source unknown. | | |
| 0.06-0.4 Bioretention Soil Mix | | |
| 0.4-0.5' Fill | | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 5 (Tennis Cell)

Assessed On:
August 15, 2023



| | |
|---|---|
| HA-2-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | 1.8 |
| Total Depth: | 2.1 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, f-m SAND with coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): | |
|  | |
| IMG_0457.jpg | |
| Additional Details | |
| Underdrain Gravels description: Loose, sl. moist brown sandy rounded fine GRAVEL, some coarse gravel, some silt, moderate organics (GP) | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | |
| to Native Soil: | 0.2 |
| to Import/Underdrain: | |
| Total Depth: | 0.8 |
| Rain/Garden Mix Soil Texture: N/A | |
| Native Soil Texture: Dense, sl. moist, brown, silty f-m SAND, some coarse sand, trace silt, moderate organics | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| IMG_0458.jpg | |
| Additional Details | |
| Surface soil more resembles fill soils encountered at HA-1. Soils increased in density at 0.8' and limited further excavation. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
Cell: Type 5 (Tennis Cell)

Assessed On:
August 15, 2023



Infiltration Test

| | |
|--|-------|
| IT-1/IT-2 | |
| Water Supply | |
| <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM4 (3-50) | |
| Wetted Pond Area (sq. ft) | 36 |
| Ponded Depth (ft) | 0.14 |
| Total Gallons | 1,158 |
| Steady State Flow Rate (GPM) | 6.5 |
| Additional Details: Two infiltration tests were performed. The first test was conducted near the inlet where underdrain gravels were not encountered beneath the bioretention soil. The second test was completed in the center of the cell where underdrain gravels were encountered. The above test statistics are for IT-1. Additional test details can be found in the executive summary. | |

Additional Comments

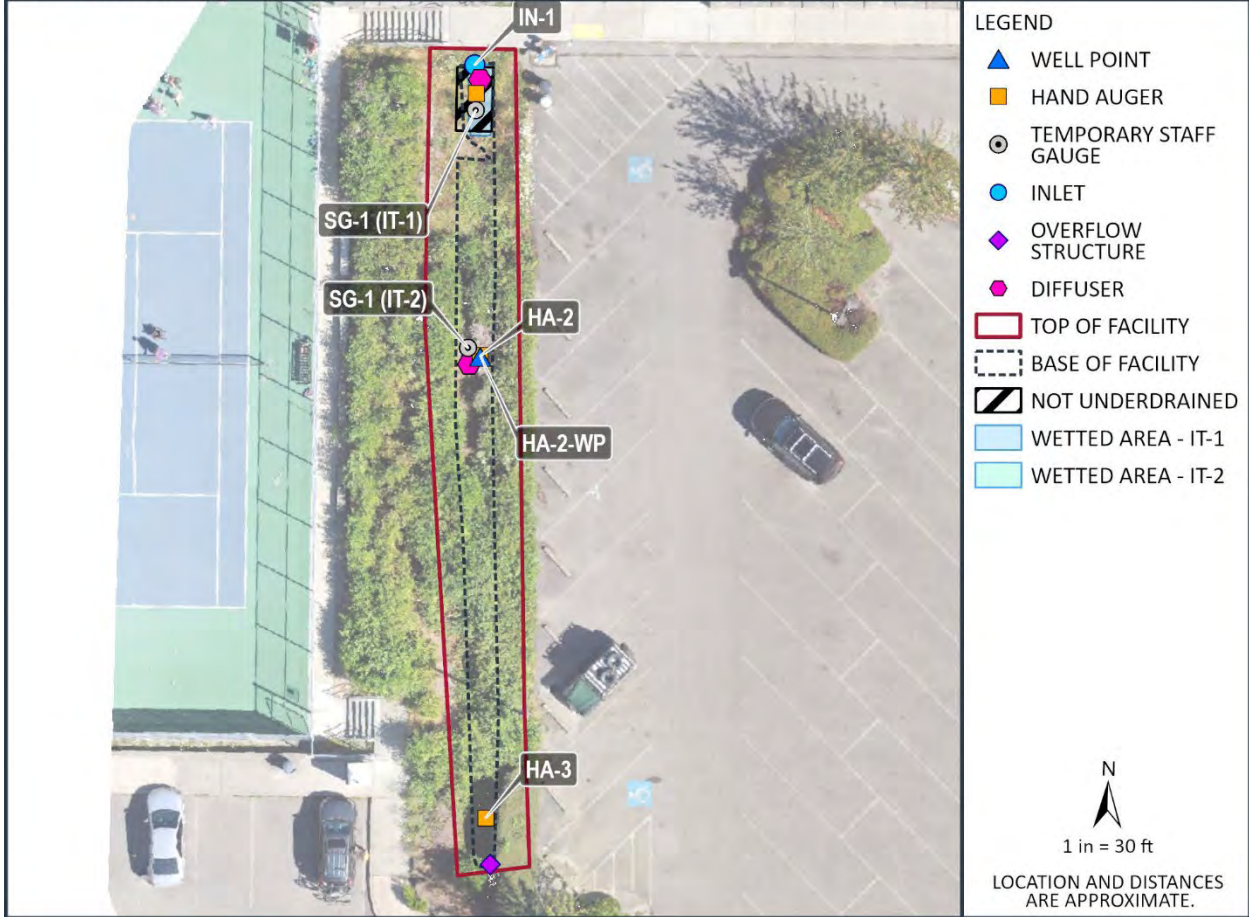
BIORETENTION CELL FIELD ASSESSMENT

Site: Bainbridge Island High School (BIHS)
 Cell: Type 5 (Tennis Cell)

Assessed On:
 August 15, 2023



SITE: BAINBRIDGE ISLAND HIGH SCHOOL (BIHS) CELL: TENNIS CELL (TYP 5)





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Exploration Boring

BIHS-5-HA-1

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 08/15/23

Logged By: SNLF

20150387H008

Ending Date: 08/15/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): .5

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

∇ Groundwater Depth ATD (ft): Not encountered

∇ Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|---|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | 1 | | | Natural Mulch Natural vegetation mulch (blackberry canes) | | | | | | | | | |
| | | 2 | | | Stiff, dry, white; calcareous evaporite layer; vigorous reaction with hydrochloric acid; source unknown. | | | | | | | | | |
| | | 3 | | | Bioretention Soil Mix Medium dense, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, trace silt; abundant organics (SP). | | | | | | | | | |
| 1 | | | | | Fill Medium dense, slightly moist, tan, silty, fine to medium SAND, some coarse sand (SM). | | | | | | | | | |
| 2 | | | | | No groundwater. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

1/19/2024

20150387H008



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Well Point

BIHS-5-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/15/23

Logged By: SNCF/APJ

20150387H008

Ending Date: 8/15/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.1

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.4

Water Level Elevation (ft): N/A

Datum: Project Datum

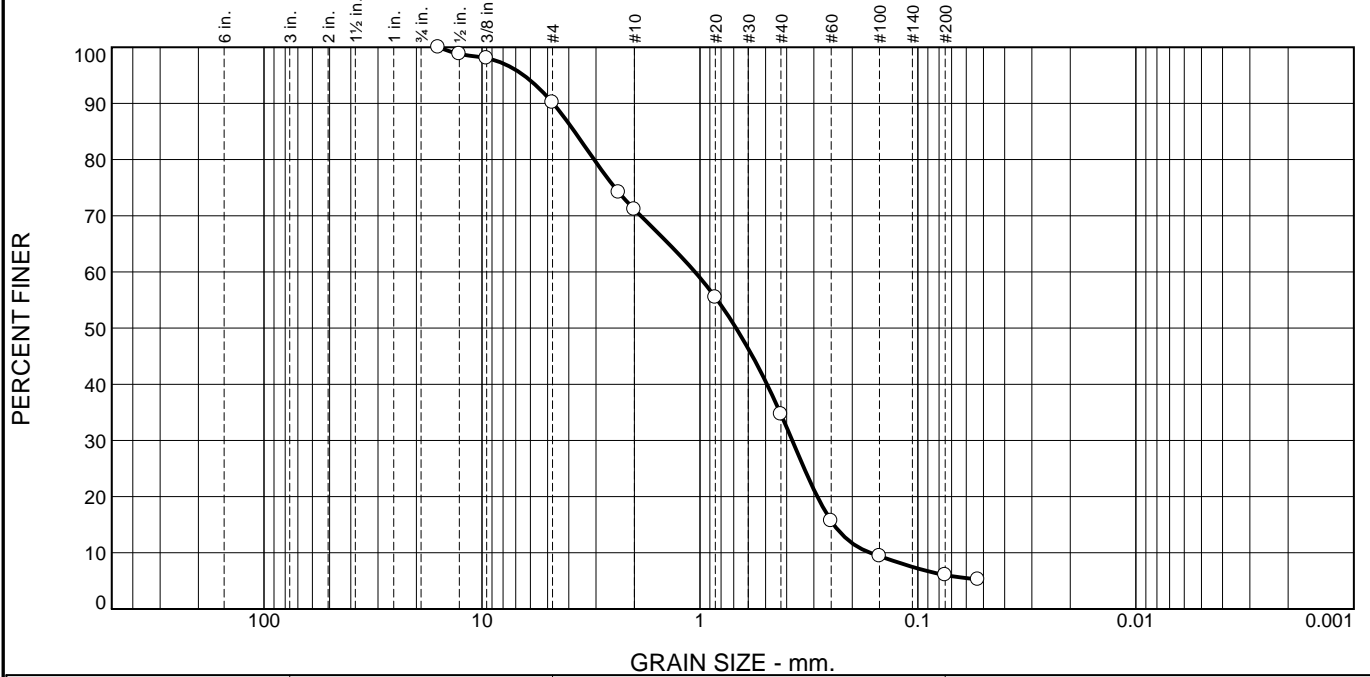
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | <p>Natural Mulch Natural mulch and moss.</p> | | | | | | | <p>Stickup -4.4 to 0 feet 1.25 inch I.D. threaded galvanized steel casing -4.4 to -0.02 feet Duct tape covered screen 0 to 2.1 feet Native-bioretention soil mix backfill 0 to 0.3 Medium grain silica sand .3 to 1 foot Native soil 1 to 1.5 feet 3/8 inch bentonite chips 1.5 to 1.8 feet Existing gravel 1.8 to 2.68 feet 1.25 in I.D. Stainless steel jacket over stainless steel #60 gauze welded to perforated steel 2.1 to 2.9 feet Cast iron drive endcap 2.9 to 3.2 feet Cast iron drive point 3.2 to 3.5 feet</p> |
| 1 | Hand | 2 | | <p>Bioretention Soil Mix Loose, dry, dark brown, fine to medium SAND, some coarse sand, some coarse rounded gravel, some silt; abundant organics (SP)</p> | | | | | | | |
| 2 | Hand | 3 | | <p>Underdrain Gravel Loose, slightly moist, brown, sandy, rounded fine GRAVEL, some coarse gravel, some silt; moderate organics (GP). No groundwater. Moderate caving 1.8 to 2.1 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

2/5/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.8 | 19.1 | 36.4 | 28.7 | 6.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 98.8 | | |
| 3/8" | 98.1 | | |
| #4 | 90.2 | | |
| #8 | 74.2 | | |
| #10 | 71.1 | | |
| #20 | 55.5 | | |
| #40 | 34.7 | | |
| #60 | 15.7 | | |
| #100 | 9.4 | | |
| #200 | 6.0 | | |
| #270 | 5.3 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 4.7130 | D ₈₅ = 3.7626 | D ₆₀ = 1.0536 |
| D ₅₀ = 0.6823 | D ₃₀ = 0.3771 | D ₁₅ = 0.2432 |
| D ₁₀ = 0.1654 | C _u = 6.37 | C _c = 0.82 |

Remarks

Date Received: 8-16-2023 Date Tested: 10-23-2023

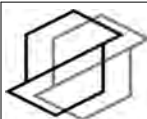
Tested By: FEW

Checked By: SNCF/APJ/JS

Title: _____

Location: Onsite - BIHS-TC Bainbridge HS Tennis Cell
Sample Number: HA-1 **Depth:** .05-.4'

Date Sampled: 8-15-2023



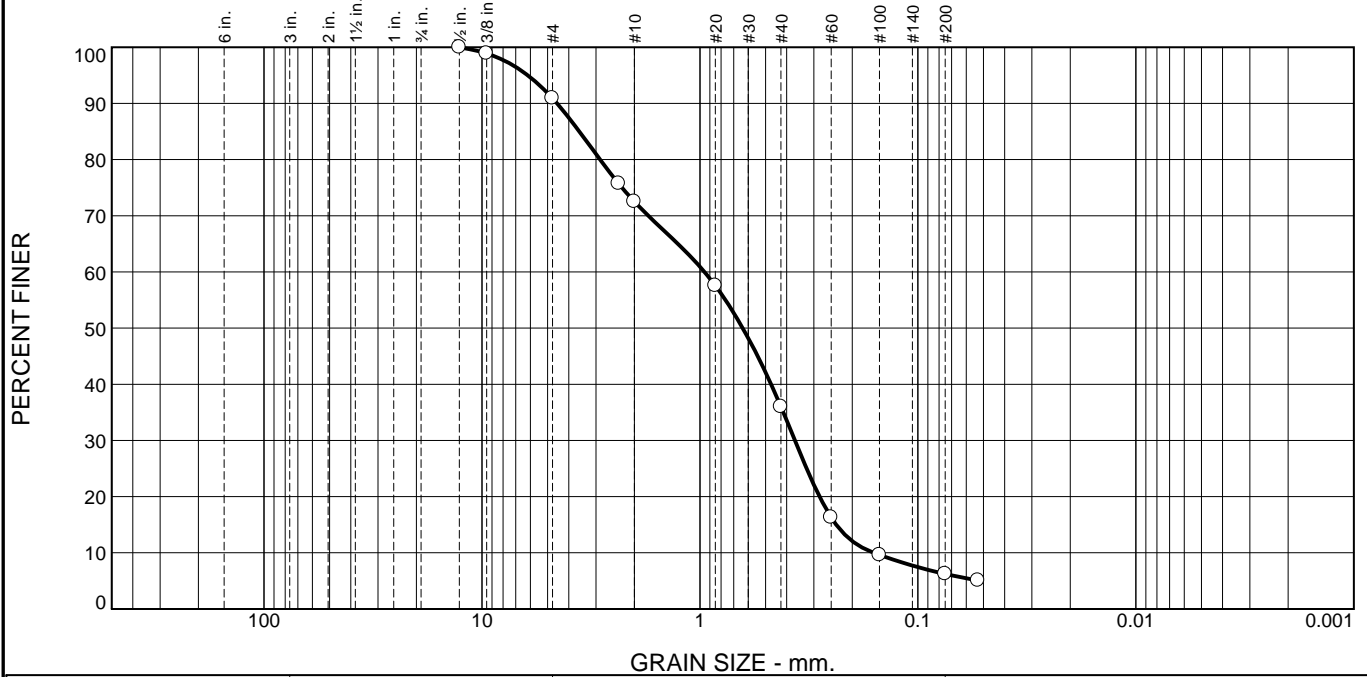
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.1 | 18.4 | 36.5 | 29.8 | 6.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 98.9 | | |
| #4 | 90.9 | | |
| #8 | 75.7 | | |
| #10 | 72.5 | | |
| #20 | 57.6 | | |
| #40 | 36.0 | | |
| #60 | 16.3 | | |
| #100 | 9.6 | | |
| #200 | 6.2 | | |
| #270 | 5.1 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 4.5247 D₈₅= 3.5756 D₆₀= 0.9535
D₅₀= 0.6365 D₃₀= 0.3665 D₁₅= 0.2370
D₁₀= 0.1594 C_u= 5.98 C_c= 0.88

Remarks

Date Received: 8-16-2023 Date Tested: 10-20-2023

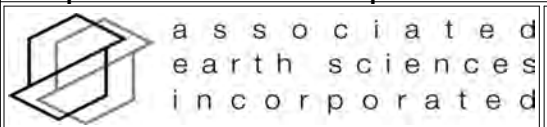
Tested By: FEW

Checked By: SNCF/CSI/JS

Title: _____

* (no specification provided)

Location: Onsite - BIHS-TC Bainbridge HS Tennis Cell Date Sampled: 8-15-2023
Sample Number: HA-2 Depth: 0.1-1.0'



Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 8/15/2023 | Project BIHS-TC | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bainbridge Island, WA | EB/EP No. BIHS-TC-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.05-.4' | HA-2 @ 0.1-1' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 1141.85 | 1087.29 |
| Dry Weight + Pan | 1122.99 | 1058.89 |
| Weight of Pan | 247.51 | 247.54 |
| Weight of Moisture | 18.86 | 28.40 |
| Dry Weight of Soil | 875.48 | 811.35 |
| % Moisture | 2.15 | 3.50 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------|---------|
| Dry Soil Before Burn + Pan | 1122.99 | 1058.89 |
| Dry Soil After Burn + Pan | 1098.33 | 1022.26 |
| Weight of Pan | 247.51 | 247.54 |
| Wt. Loss Due to Ignition | 24.66 | 36.63 |
| Actual Wt. Of Soil After Burn | 850.82 | 774.72 |
| % Organics | 2.82 | 4.51 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|--|--------------------------------|----------------|
| Project Name: | Bainbridge Island High School-Type 5 (Tennis Cell) | Water Source: | Hosebib |
| Project Number: | 20150387H008 | Meter: | FM 4 3-50 |
| Date: | 8/15/2023 | Wetted Area (sq. feet): | 11:40: 36 ft^2 |
| Weather: | Clear, 80s | Underdrain: | Partial |
| Test No.: | IT-1 | Test Depth (feet): | 0.14 |
| Performed By: | SNCF | Receptor Soils: | Fill |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|---|
| 10:00 | 5.5 | Dry | Dry | Dry | 0 | Water On |
| 10:02 | | | | | 8 | 6.64 Flow rate |
| 10:03 | | | | | | Water reached staff gauge |
| 10:05 | 6.36 | 0.08 | | | 28 | |
| 10:10 | 6.72 | 0.09 | | | 60 | |
| 10:15 | 5.87 | 0.1 | | | 93 | |
| 10:33 | 6.06 | 0.1 | | | 206 | Water turned off twice for 11 min as tennis campers drank water from fountain |
| 10:45 | 6.4 | 0.11 | | | 282 | |
| 11:00 | 6.48 | 0.12 | | | 380 | Water briefly off |
| 11:17 | 6.74 | 0.13 | Dry | Dry | 487 | |
| 11:30 | 6.67 | 0.13 | | | 573 | |
| 11:45 | 6.7 | 0.14 | | | 672 | |
| 12:00 | 6.7 | 0.14 | | | 768 | |
| 12:10 | 6.76 | 0.14 | | | 837 | |
| 12:20 | 6.8 | 0.14 | | | 902 | |
| 12:30 | 6.82 | 0.14 | | | 967 | |
| 12:40 | 6.76 | 0.14 | | | 1029 | |
| 12:52 | 6.3 | 0.14 | 5.55 | Dry | 1107 | Water flowing in Cb |
| 13:00 | 6.09 | 0.14 | | | 1158 | Water Off |
| 13:02 | | 0.1 | | | | |
| 13:03 | | 0.09 | | | | |
| 13:04 | | 0.08 | | | | |
| 13:05 | | 0.06 | | | | |
| 13:06 | | 0.05 | | | | |
| 13:07 | | 0.04 | | | | |
| 13:09 | | 0.03 | | | | |
| 13:10 | | 0 | | | | |

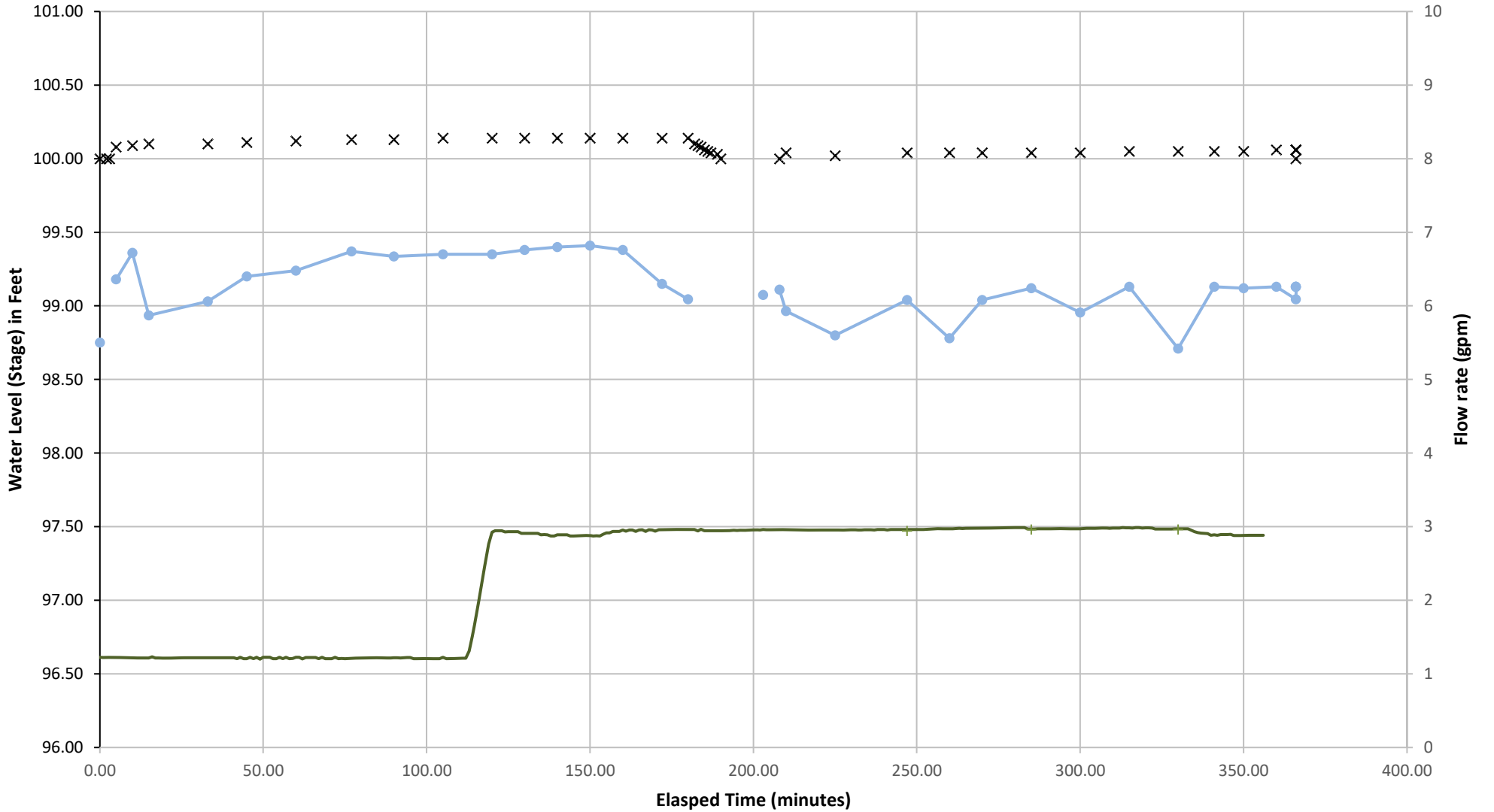
| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 17.4 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 8.8 |

| | | | |
|------------------------|--|--------------------------------|--------------------|
| Project Name: | Bainbridge Island High School-Type 5 (Tennis Cell) | Water Source: | Hosebib |
| Project Number: | 20150387H008 | Meter: | FM 4 3-50 |
| Date: | 8/15/2023 | Wetted Area (sq. feet): | 15:15: 6.8 ft^2 |
| Weather: | Clear, 80's | Underdrain: | Yes |
| Test No.: | IT-2 | Test Depth (feet): | 0.06 |
| Performed By: | SNCF | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|--------------------|
| 13:23 | 6.15 | dry | 5.47 | DRY | 0 | Water On |
| 13:25 | | | | | | Adjust SG location |
| 13:28 | 6.22 | | | | 31 | |
| 13:30 | 5.93 | 0.04 | | | 42 | |
| 13:45 | 5.6 | 0.02 | | | 131 | |
| 14:07 | 6.08 | 0.04 | 4.53 | DRY | 264 | |
| 14:20 | 5.56 | 0.04 | | | 340 | |
| 14:30 | 6.08 | 0.04 | | | 400 | |
| 14:45 | 6.24 | 0.04 | 4.52 | | 489 | |
| 15:00 | 5.91 | 0.04 | | | 585 | |
| 15:15 | 6.26 | 0.05 | | | 672 | |
| 15:30 | 5.42 | 0.05 | 4.52 | DRY | 758 | |
| 15:41 | 6.26 | 0.05 | | | 825 | |
| 15:50 | 6.24 | 0.05 | | | 885 | |
| 16:00 | 6.26 | 0.06 | | | 940 | |
| 16:10 | 6.09 | 0.06 | | DRY | 1001 | |
| 16:20 | 6.26 | 0.06 | | | 1059 | |
| 16:30 | 6.26 | 0.06 | | | 1122 | Water Off |
| 16:31 | | 0 | | | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 85.7 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 43.2 |

Bainbridge Island High School-Type 5 (Tennis Cell) Infiltration Test Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations not surveyed and should be used as a relative reference. Elevation 100 represents ground surface. Catch Basin logger pulled immediately after test, falling head response not recorded.

x Staff Gauge #1 Hand Data
+ Catch Basin Hand
— Catch Basin Logger
● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)
Cell: Site 7A

Assessed On:
September 14, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2011 and collects residential road runoff from the adjacent street and cul-de-sac through three curb cut inlets. The western half of the cell is built at a 6:1 slope with two sets of weirs which are designed to slow flow downgradient. The cell base is constructed with 3" of mulch set above 1.5' of bioretention soil atop native soils. An overflow structure sits in the northwest corner of the cell and is designed to allow 0.5' of maximum ponding. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 0.6-2.3'

The apparent thickness of the loose bioretention soil ranged from 0.6-2.3' with an average depth of 1.4', slightly less than the design specification. The variability in probe measurements may be due to soil compaction over time. Explorations and probes were limited to the central basin of the cell due to thick vegetation and utilities in the upper weir zones.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications the tested material met the standard for sand gradation and silt content. The organic matter content was below the minimum specification.

Organic Matter Content (% by weight): 3.8

Percent passing #200 sieve: 4.4

Coefficient of Uniformity (Cu): 7.7

Coefficient of Curvature (Cc): 0.8

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Loose, slightly moist to moist, brown to light brown, very sandy, GRAVEL (SP)

BUILT PER PLAN:

Water was observed seeping into the catch basin through cracks in the cement structure. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell. The temporary wellpoint was screened from 1.4-1.9' below ground surface and responded to testing immediately. Within 3.5 hours the water in the wellpoint was at the same elevation as the surface water.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >40.1

Subgrade Soil Rate (in/hr): 40.1

No bioretention soil infiltration rate can be determined from the collected data. The storage in the bioretention soil was quickly filled during infiltration testing and we interpret the underlying subgrade to be controlling the rate of infiltration.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)
 Cell: Site 7A

Assessed On:
 September 14, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Besides the leaky catch basin, the cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------|---------------|--------------------|
| Weather | Clear, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: EAP | | Half Day: APJ, MJP |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 3 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230914-165901.jpg



Site Photo: FA_SitePhotos-20230914-170925.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)

Cell: Site 7A

Assessed On:
September 14, 2023



Site Photo: FA_SitePhotos-20230914-170948.jpg



Site Photo: FA_SitePhotos-20230914-171019.jpg

Cell Construction

| | |
|---|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| <p>Additional Comments Water is conveyed from the adjacent cul-de-sac and roadway through curb cuts, and over stream bed cobbles into the cell. Water is designed to infiltrate through the bioretention soil before infiltrating into the native subgrade. Two overflow weirs are located along the 6:1 slope to slow water flow and encourage infiltration before overflowing to the lower pond area, each with a ponded depth of 6" before finally overflowing into the catch basin and connecting to the storm drain network.</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)

Cell: Site 7A

Assessed On:

September 14, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230914-180816.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)

Cell: Site 7A

Assessed On:

September 14, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230914-181321.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)

Cell: Site 7A

Assessed On:
September 14, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Vegetation overhanging inlet was observed.



FA_INBLPhoto-20230914-181727.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)
Cell: Site 7A

Assessed On:
September 14, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.1'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230914-182242.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 75% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Blackberry brambles were observed overhanging the curb.



FA_INBLPhoto-20230914-182145.jpg

Additional Details: No energy dissipation was observed.

BIORETENTION CELL FIELD ASSESSMENT


Site: Bothell 25th (BO25)
Cell: Site 7A

Assessed On:
September 14, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.2' Width: 1.7' |
| Additional Details: | |
| Stickup (ft) From Ground: 0 Relative from staff gauge: 0.67 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 20% blocked Additional Details: Overflow was blocked by stream cobbles and mulch. | |



FA_DOPhoto-20230914-183348.jpg

Cell Surface and Geotech Probe Observations

| | | |
|---|--|-----------------|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input checked="" type="checkbox"/> Coarse Mulch | | Depth (ft): 0.2 |
| Cell Coverage | | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Natural mulch of dead leaves and vegetation cover upper tier of cell. Minimal garbage was observed in the cell. | | |
| Pest Evidence | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | | |
| Vegetation Description | | |
| Vegetation covers approximately 70% of the cell, and 100% of the upper tier of the cell. The vegetation in the upper tier was very thick, which negated our ability to conduct the infiltration test in the upper portion of the cell. | | |
| Additional Details | | |
| Geotech Probe Observations: At the cell base, probe measurements found 0.6-2.3' of bioretention soil, with an average of 1.4', before encountering the native soil. This high variability is inconsistent with the 1.5' specified by the plans. The cell design shows a long gradual 6:1 slope in the eastern half of the cell, and a 0% grade in the | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)
Cell: Site 7A

Assessed On:
September 14, 2023



western half. Some zones of compaction were observed which may explain some of the variability in probe depths. Some areas of the cell could not be probed due to thick vegetation.

Hand Auger

| | |
|--|---|
| HA-2-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.25 |
| to Native Soil: | 1.6 |
| to Import/Underdrain: | |
| Total Depth: | 2.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, trace silt, scattered fine rootlets, abundant fine organics (SP) Native Soil Texture: Vashon Recessional Outwash: Very loose, slightly moist to moist, light brown, very sandy GRAVEL, trace silt, few organics (GW) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details | |
| Native sediment had moderate caving and some oxidation. Wellpoint water level rose to same elevation as surface water. | |



FA_FPhoto-20230914-185128.jpg


| | |
|---|------------------------|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.25 |
| to Native Soil: | 1.6 |
| to Import/Underdrain: | |
| Total Depth: | 2.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, fine organics, scattered rootlets with occasional roots (SP) Native Soil Texture: Vashon Recessional Outwash: Very loose, slightly moist to moist, light brown, very sandy GRAVEL, trace silt, few organics (GW) | |
| Liner Present: | Filter Fabric Present: |
| | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)
 Cell: Site 7A

Assessed On:
 September 14, 2023



| | |
|--|---|
| HA-1 | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
|  | |
| Additional Details roots absent, severe caving from 1.6-2.5' samples mixed with above organics | |

FA_FPhoto-20230914-185357.jpg

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.25 |
| to Native Soil: | 0.75 |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, grayish-brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant fine rootlets (SP) Native Soil Texture: Vashon Recessional Outwash: Very loose, slightly moist to moist, light brown, very sandy GRAVEL, trace silt, few organics (GW) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)

Cell: Site 7A

Assessed On:
September 14, 2023



HA-3



FA_FPhoto-20230914-185449.jpg

Additional Details

Slight oxidation on gravels was observed in the native soil.

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-4 (3-50)

| | |
|---------------------------|------|
| Wetted Pond Area (sq. ft) | 49.5 |
|---------------------------|------|

| | |
|-------------------|-----|
| Ponded Depth (ft) | 0.7 |
|-------------------|-----|

| | |
|---------------|--------|
| Total Gallons | 10,766 |
|---------------|--------|

| | |
|------------------------------|----|
| Steady State Flow Rate (GPM) | 21 |
|------------------------------|----|

Additional Details:

Wetted pond and ponded depth are based on max values. Field infiltration rate is based on steady state flow rate and a ponded area of 46.5 ft². Additional test details can be found in the executive summary.



IT_Photo-20230914-215700.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 25th (BO25)

Cell: Site 7A

Assessed On:
September 14, 2023



SITE: BOTHELL 25TH (BO25) CELL: SITE 7A





associated
earth sciences
incorporated

Well Point

BO25-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations
20150387H008

Start Date: 9/14/23
Ending Date: 9/14/23

Logged By: MJP
Approved By: JHS

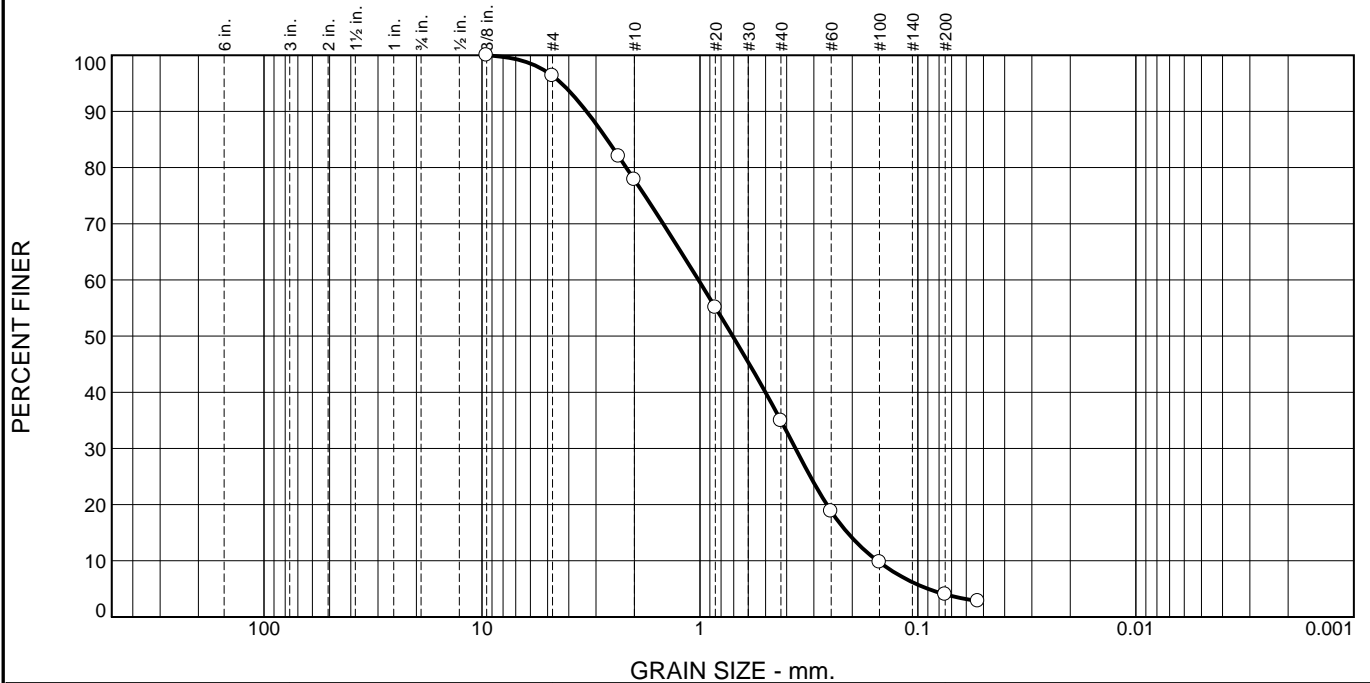
Driller/Equipment: Hand Auger
Hammer Weight/Drop: N/A
Hole Diameter (in): 4
Ground Surface Elevation (ft): 100
Water Level Elevation (ft): N/A
Total Depth (ft): 2.5
Well Completion Depth (ft): 2.5
Well Tag No.: N/A
Top of Well Casing Elevation (ft): 103.3
Datum: Project Datum
Groundwater Depth ATD (ft): Not encountered
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Bark mulch and wood chips. | | | | | | | Stick up 3.3 to 0 feet Existing bioretention soils 0 to 0.7 feet 3/8-inch bentonite chips 0.7 to 1.1 feet Medium grain silica sand 1.1 to 2.5 feet 1.25-inch I.D. threaded galvanized steel casing -3.3 to 0.2 feet; duct tape covers screen 0.2 to 1.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.4 to 1.9 feet Cast iron end cap 1.9 to 2.2 feet Cast iron drivepoint 2.2 to 2.5 feet |
| 1 | | | | Bioretention Soil Mix Loose, slightly moist, dark brown, medium to fine SAND, trace coarse sand, trace silt; abundant fine organics; scattered fine rootlets with occasional roots (SP). Increasing gravel content with depth. | | | | | | | |
| 2 | | | | Vashon Recessional Outwash Loose, slightly moist to moist, brown to light brown, very sandy, GRAVEL, trace silt; roots absent; severe caving; samples mixed with above organics (GP). | | | | | | | |
| 3 | | | | Refusal at 2.5 feet on hard sediment No seepage. Severe caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/21/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 3.6 | 18.5 | 43.0 | 30.9 | 4.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 96.4 | | |
| #8 | 82.0 | | |
| #10 | 77.9 | | |
| #20 | 55.1 | | |
| #40 | 34.9 | | |
| #60 | 18.8 | | |
| #100 | 9.7 | | |
| #200 | 4.0 | | |
| #270 | 2.8 | | |

Material Description
SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 3.3123 D₈₅= 2.6670 D₆₀= 1.0162
 D₅₀= 0.7072 D₃₀= 0.3646 D₁₅= 0.2105
 D₁₀= 0.1532 C_u= 6.63 C_c= 0.85

Remarks

Date Received: 9-15-2023 Date Tested: 11-28-2023

Tested By: FEW

Checked By: CSI/JHS

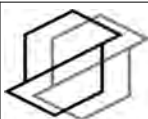
Title: _____

* (no specification provided)

Location: Onsite - BHPS-BO25
 Sample Number: HA-1

Depth: 0.5

Date Sampled: 9-14-2023



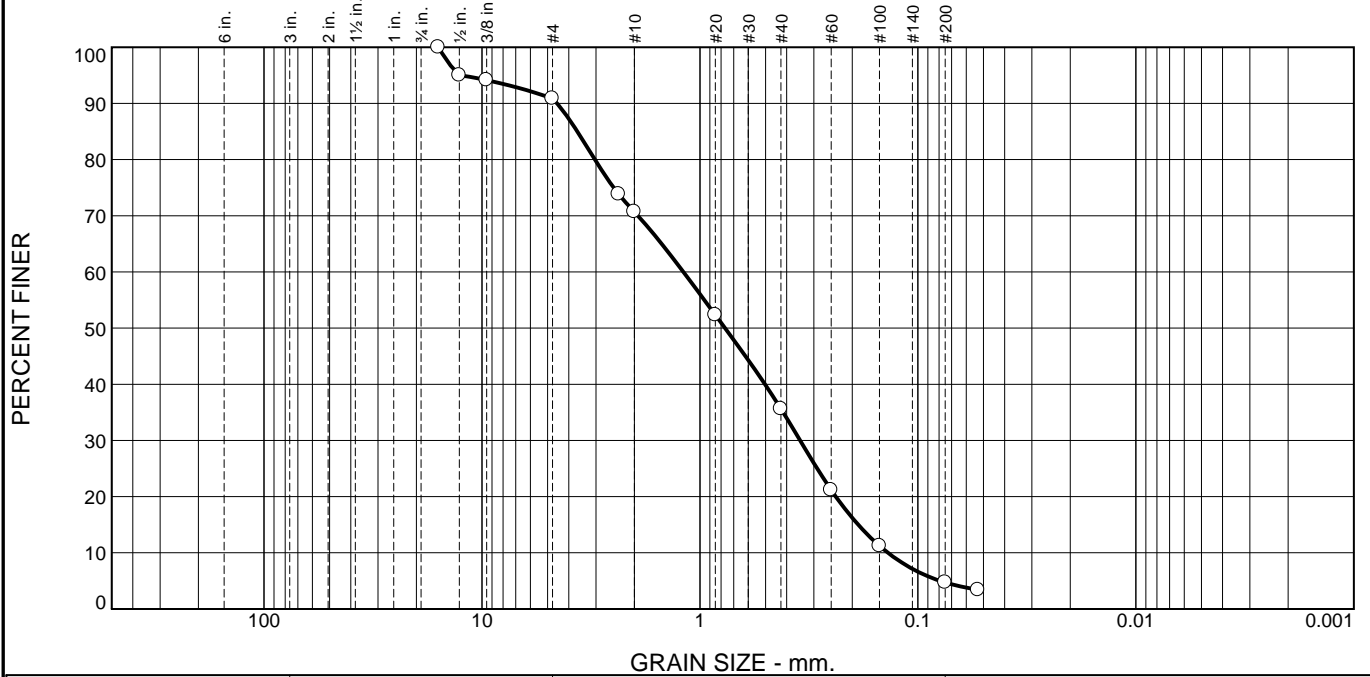
associated
 earth sciences
 incorporated

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.1 | 20.2 | 35.1 | 30.9 | 4.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 95.0 | | |
| 3/8" | 94.1 | | |
| #4 | 90.9 | | |
| #8 | 73.8 | | |
| #10 | 70.7 | | |
| #20 | 52.3 | | |
| #40 | 35.6 | | |
| #60 | 21.2 | | |
| #100 | 11.2 | | |
| #200 | 4.7 | | |
| #270 | 3.4 | | |

Material Description

SAND some gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 4.5261 D₈₅= 3.6521 D₆₀= 1.1910
D₅₀= 0.7675 D₃₀= 0.3470 D₁₅= 0.1880
D₁₀= 0.1372 C_u= 8.68 C_c= 0.74

Remarks

Date Received: 9-15-2023 Date Tested: 11-27-2023

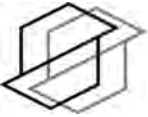
Tested By: FEW

Checked By: CSI/JHS

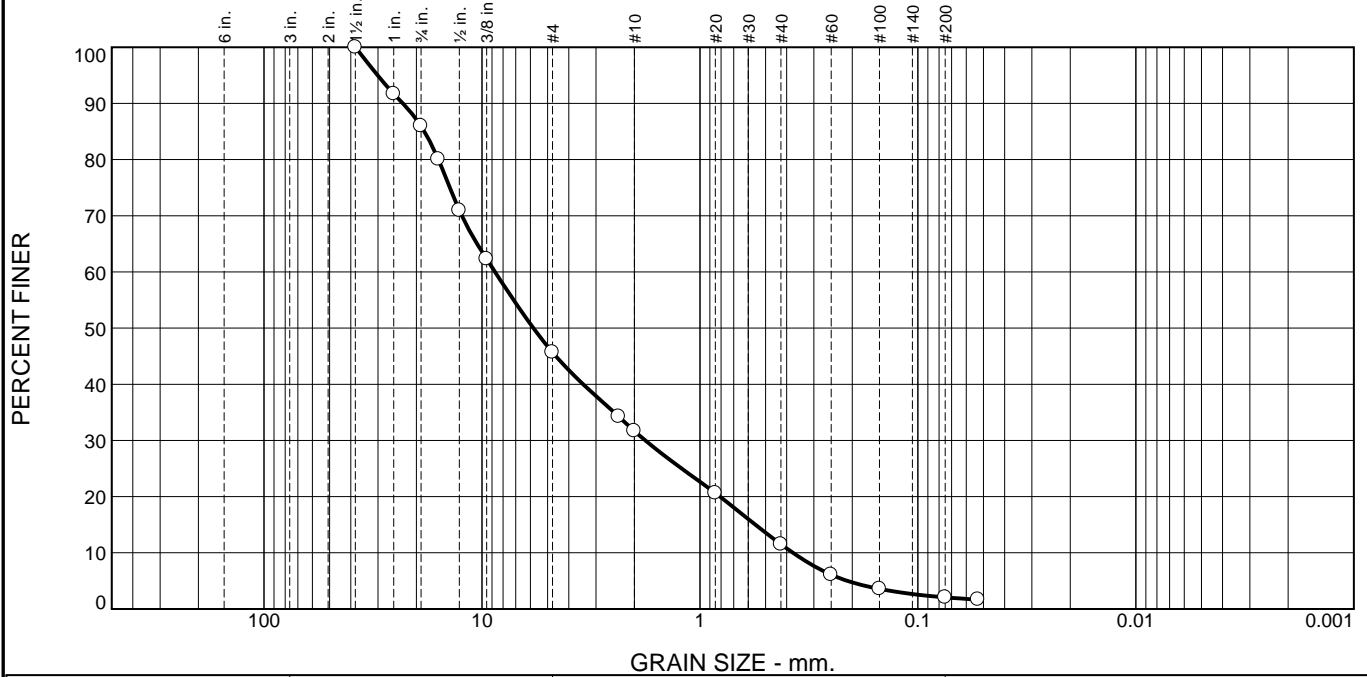
Title: _____

* (no specification provided)

Location: Onsite - BHPS-BO25 Date Sampled: 9-14-2023
Sample Number: HA-2 Depth: 0.5'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 |
|---|--|--|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 14.0 | 40.3 | 14.0 | 20.2 | 9.4 | 2.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 91.7 | | |
| 3/4" | 86.0 | | |
| 5/8" | 80.1 | | |
| 1/2" | 71.0 | | |
| 3/8" | 62.3 | | |
| #4 | 45.7 | | |
| #8 | 34.3 | | |
| #10 | 31.7 | | |
| #20 | 20.6 | | |
| #40 | 11.5 | | |
| #60 | 6.1 | | |
| #100 | 3.6 | | |
| #200 | 2.1 | | |
| #270 | 1.7 | | |

Material Description

very sandy Gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 23.0762 D₈₅= 18.3716 D₆₀= 8.7130
D₅₀= 5.8110 D₃₀= 1.7828 D₁₅= 0.5567
D₁₀= 0.3745 C_u= 23.27 C_c= 0.97

Remarks

Date Received: 9-15-2023 Date Tested: 11-29-2023

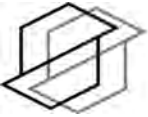
Tested By: FEW

Checked By: CSI/JHS

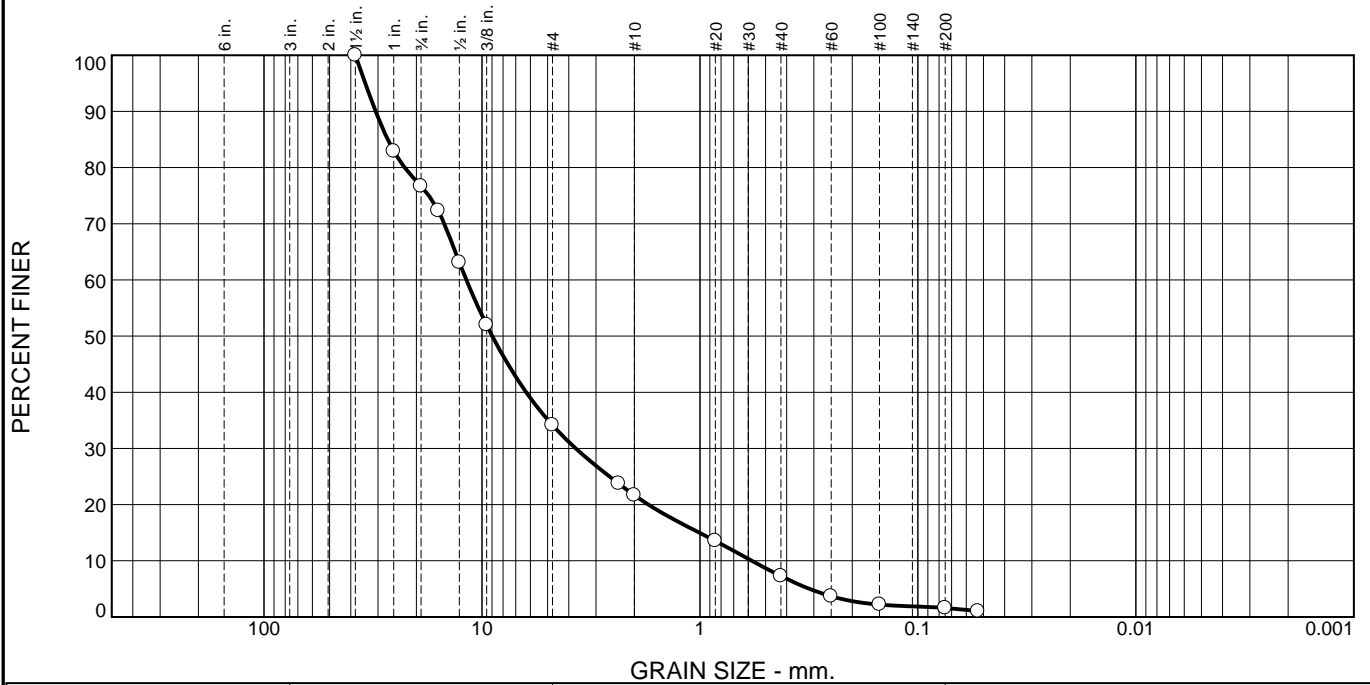
Title: _____

* (no specification provided)

Location: Onsite - BO25 Date Sampled: 9-14-2023
Sample Number: HA-2-WP Depth: 2'

| | | |
|---|--|---------------|
|  | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 | Figure |
|---|--|---------------|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 23.3 | 42.6 | 12.4 | 14.4 | 5.7 | 1.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 82.9 | | |
| 3/4" | 76.7 | | |
| 5/8" | 72.3 | | |
| 1/2" | 63.1 | | |
| 3/8" | 52.0 | | |
| #4 | 34.1 | | |
| #8 | 23.8 | | |
| #10 | 21.7 | | |
| #20 | 13.5 | | |
| #40 | 7.3 | | |
| #60 | 3.7 | | |
| #100 | 2.2 | | |
| #200 | 1.6 | | |
| #270 | 1.0 | | |

* (no specification provided)

Material Description

very sandy GRAVEL trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GW AASHTO (M 145)= A-1-a

Coefficients

| | | |
|---------------------------|---------------------------|---------------------------|
| D ₉₀ = 30.7563 | D ₈₅ = 27.0980 | D ₆₀ = 11.7955 |
| D ₅₀ = 8.9704 | D ₃₀ = 3.7160 | D ₁₅ = 1.0063 |
| D ₁₀ = 0.5779 | C _u = 20.41 | C _c = 2.03 |

Remarks

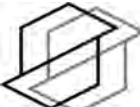
Date Received: 9-15-2023 Date Tested: 11-29-2023

Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - BO25 Date Sampled: 9-14-2023
 Sample Number: HA-2-WP Depth: 2.5'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 |
|---|--|--|

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|-----------------------------------|--------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 10/28/2023 | Project BHPS-BO25 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bothell, WA | EB/EP No. BO25-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.5' | HA-2 @ 0.5' |
|--------------------|-------------|-------------|
| Wet Weight + Pan | 602.46 | 552.67 |
| Dry Weight + Pan | 588.54 | 536.46 |
| Weight of Pan | 260.05 | 257.97 |
| Weight of Moisture | 13.92 | 16.21 |
| Dry Weight of Soil | 328.49 | 278.49 |
| % Moisture | 4.24 | 5.82 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 588.54 | 536.46 |
| Dry Soil After Burn + Pan | 578.64 | 523.87 |
| Weight of Pan | 260.05 | 257.97 |
| Wt. Loss Due to Ignition | 9.90 | 12.59 |
| Actual Wt. Of Soil After Burn | 318.59 | 265.90 |
| % Organics | 3.01 | 4.52 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|-----------------------|--------------------------------|--|
| Project Name: | 25th Avenue (Site 7A) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) |
| Date: | 9/14/2023 | Wetted Area (sq. feet): | 09:42: 45 ft^2 / 12:05: 52.5 ft^2 / 12:33 46.5 ft^2 / 13:32: 43.5 ft^2 / 15:47 49.5 ft^2 |
| Weather: | Clear, 70s | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.7 |
| Performed By: | EAP | Receptor Soils: | Qvr |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|--|
| 9:00 | | | | | Water on |
| 9:02 | 25.07 | 0.2 | 5.24 | 48 | |
| 9:04 | 25.05 | 0.24 | 5.27 | 98 | |
| 9:06 | 25.2 | 0.25 | 5.3 | 149 | |
| 9:10 | 48.18 | | | | Increase flow; catch basin dry |
| 9:15 | 48.38 | 0.37 | 4.8 | 350 | |
| 9:20 | 48.18 | 0.49 | 4.07 | 730 | |
| 9:30 | 34.22 | | | | Decrease flow |
| 9:32 | 34.24 | 0.6 | 3.75 | 1,294 | |
| 9:40 | 36.19 | | | | |
| 9:45 | 36.1 | 0.6 | 3.68 | 1,752 | |
| 10:00 | 36.12 | 0.65 | 3.59 | 2,292 | Observed leaky CB, small cracks in cement - 71 gpm |
| 10:02 | 35.12 | | | | |
| 10:15 | 35.42 | 0.68 | 3.55 | 2,825 | |
| 10:23 | | | | | Water off; flow entering beehive |
| 10:24 | 30.25 | 0.61 | | | Water on; water receded |
| 10:32 | 30.29 | 0.61 | 3.58 | 3,330 | |
| 10:45 | 30.46 | 0.65 | 3.55 | 3,727 | |
| 10:51 | 26.12 | | | | Decrease flow |
| 11:00 | 26.14 | 0.64 | 3.56 | 4,144 | |
| 11:15 | 26.21 | 0.63 | 3.56 | 4,541 | |
| 11:30 | 26.16 | 0.65 | 3.55 | 4,932 | |
| 11:45 | 26.17 | 0.66 | 3.47 | 5,323 | |
| 12:00 | 26.24 | 0.67 | 3.55 | 5,720 | |
| 12:02 | 22.55 | | | | Decrease flow to stop water flowing into overdrain |
| 12:15 | 22.44 | 0.64 | 3.49 | 6,063 | |
| 12:30 | 22.36 | 0.63 | 3.5 | 6,400 | |
| 12:45 | 22.5 | 0.63 | 3.5 | 6,736 | |
| 13:05 | 22.4 | 0.64 | 3.46 | 7,189 | |
| 13:08 | | 0.64 | | | Falling head test |
| 13:08 | | 0.63 | | | |
| 13:09 | | 0.62 | | | |
| 13:10 | | 0.58 | | | |
| 13:10 | | 0.56 | | | |
| 13:11 | | 0.54 | | | |
| 13:11 | 20.73 | | | | Water on |
| 13:30 | 20.72 | 0.55 | 3.54 | 7,642 | |

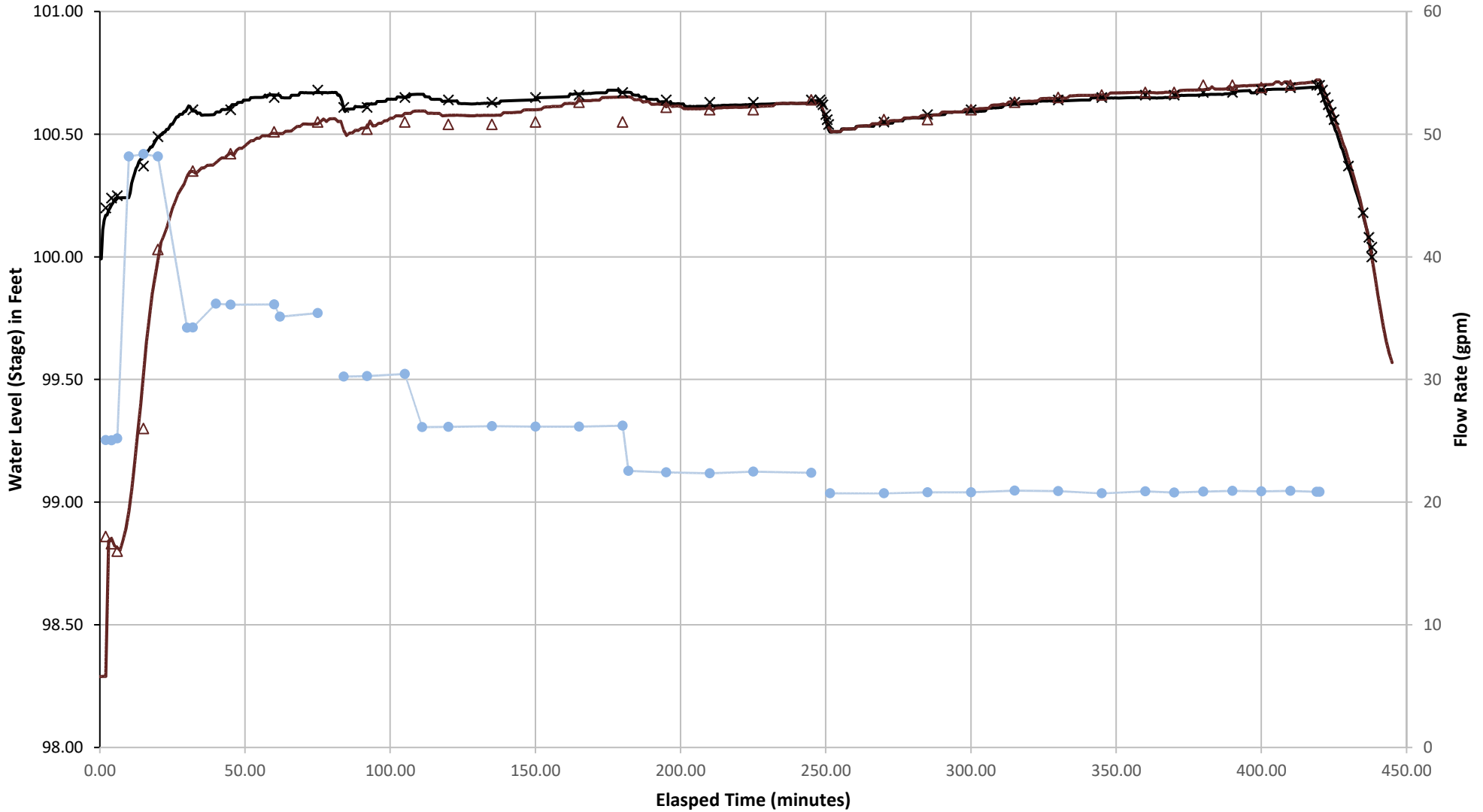
| | | | | | |
|-------|-------|------|------|--------|----------------------------------|
| 13:45 | 20.8 | 0.58 | 3.54 | 7,953 | Catch basin wet <0.3 ft |
| 14:00 | 20.8 | 0.6 | 3.5 | 8,275 | |
| 14:15 | 20.94 | 0.63 | 3.47 | 8,578 | Catch basin wet <0.3 ft |
| 14:30 | 20.9 | 0.64 | 3.45 | 8,891 | Very slow leakage observed in CB |
| 14:45 | 20.72 | 0.65 | 3.44 | 9,205 | |
| 15:00 | 20.88 | 0.66 | 3.43 | 9,514 | |
| 15:10 | 20.78 | 0.66 | 3.43 | 9,722 | |
| 15:20 | 20.86 | 0.67 | 3.4 | 9,946 | |
| 15:30 | 20.92 | 0.67 | 3.4 | 10,143 | |
| 15:40 | 20.88 | 0.68 | 3.41 | 10,349 | |
| 15:50 | 20.92 | 0.69 | 3.4 | 10,557 | |
| 15:59 | 20.84 | 0.7 | | 10,744 | |
| 16:00 | 20.84 | 0.7 | | 10,766 | Water off |
| 16:01 | | 0.68 | | | |
| 16:02 | | 0.65 | | | |
| 16:03 | | 0.62 | | | |
| 16:04 | | 0.59 | | | |
| 16:05 | | 0.56 | | | |
| 16:10 | | 0.37 | | | |
| 16:15 | | 0.18 | | | |
| 16:17 | | 0.08 | | | |
| 16:18 | | 0.04 | | | |
| 16:19 | | 0 | | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 40.1 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 26.4 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 54.6 |
| WP Average Infiltration Rate (in/hr) during falling head: | - |

25th Avenue (Site 7A) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (B035G)
Cell: Raingarden #2

Assessed On:
September 15, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and collects road runoff from the adjacent roadway through two piped inlets. The cell is constructed below the adjacent road grade and the sidewalls are set at 3:1 slopes with no bioretention soil placed atop the sidewalls. The base of the cell is constructed with 1.5' of bioretention soil set above the native subgrade. An outflow pipe sits at the cell base on the western edge of the cell which conveys water to the storm drainage network. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 0.5-1.5'

The apparent thickness of the loose bioretention soil ranged from 0.5-1.5' with an average depth of 1.4'. This is slightly less than the 1.5' specified by the plans. The thickness of the bioretention soil decreased towards the western end of the cell near the outlet. Zones of compaction were observed between HA-1-WP and HA-2.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications, the sand gradation and silt content exceeded the standard. The organic matter content fell within the specified range.

Organic Matter Content (% by weight): 6.1

Percent passing #200 sieve: 6.5

Coefficient of Uniformity (Cu): 4.0

Coefficient of Curvature (Cc): 1.3

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense to dense, moist, light brown, very gravelly, silty, fine SAND (SM)

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was observed in hand auger explorations conducted in the test cell. The temporary wellpoint was screened from 2.2-1.7' below ground surface and responded to testing immediately once the pool expanded to western half of the cell where the wellpoint was placed. The water in the wellpoint was at the same elevation as the surface water for the remainder of the test.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 27.7

Subgrade Soil Rate (in/hr): 2.7

The bioretention soil infiltration rate was calculated from test results during the first hour of the test before the storage in the bioretention soil became full and the slower draining subgrade soils controlled the facility infiltration rates.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)

Cell: Raingarden #2

Assessed On:
September 15, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:
The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------|---------------|------------------|
| Weather | Clear, 80s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: EAP | | Half Day: MJP |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230915-191057.jpg

Site Photo: FA_SitePhotos-20230915-191116.jpg



Site Photo: FA_SitePhotos-20230915-191136.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)

Cell: Raingarden #2

Assessed On:
September 15, 2023



Site Photo: FA_SitePhotos-20230915-191213.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments The cell is 95% covered by thick vegetation. The cell is contained by elevated land surface on all sides. The down-gradient portion (west) of the cell contains a catchbasin with debris collector. There are two 12-inch black corrugated plastic pipes that serve as inlets on the up-gradient portion (east) of the cell. Water is designed to infiltrate through the bioretention soil then infiltrate into the native subgrade. The east side of the cell is very steep with a 3:1 slope (about 8 feet below road grade). The west side of cell is less steep with a 2:1 slope (about 2 feet below road grade). | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)

Cell: Raingarden #2

Assessed On:

September 15, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Other: Other

Diameter: 1'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230915-195107.jpg

Erosion Present? Yes No

Blockage Present? Yes No


Additional Details: Some leaf debris was observed on angular rocks.

BIORETENTION CELL FIELD ASSESSMENT


Site: Bothell 35th & Grannis (BO35G)
 Cell: Raingarden #2

Assessed On:
 September 15, 2023



| | |
|--|--|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: |  <p>FA_INphoto-20230915-195209.jpg</p> |
| Pipe: Material <input type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input checked="" type="checkbox"/> Other Other: Other Diameter: 1' | |
| Energy Dissipation Angular Rock: Functioning Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Additional Details: | |

Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input checked="" type="checkbox"/> Round Dimensions: <input type="checkbox"/> Rectangular Diameter: 1' <input type="checkbox"/> Other |  <p>FA_DOPhoto-20230915-201005.jpg</p> |
| Additional Details: Stickup (ft) From Ground: 0.2 Relative from staff gauge: 0.95 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 40% blocked Additional Details: Leaf debris and sticks were observed in the bottom of the catch basin. | |

Cell Surface and Geotech Probe Observations

| |
|--|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.1 Cell Coverage |
|--|

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)
 Cell: Raingarden #2

Assessed On:
 September 15, 2023



| | | | | | |
|-------------|-------------------------------|---|--|-----------------------------------|------------------------------------|
| Mulch | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |

95% of the cell is covered in dense vegetation. Dead leaves make up 25-50% of the cell coverage. Mulch coverage is only 10% of cell area. There was some trash observed in the cell.

Pest Evidence

| | | |
|---------------------------|------------------------------|--|
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No |

Additional Details:

Vegetation Description

Vegetation covers 95% of the cell. Dense vegetation made it very difficult to measure ponded area and take staff gauge measurements.

Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 0.5-1.5' of bioretention soil before encountering the underlying subgrade. This is slightly less than the 1.5' specified by the plans. Zones of compaction were observed between HA-1-WP and HA-2.

Hand Auger

HA-1-WP

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|------|
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | |
| Total Depth: | 2.75 |

Rain/Garden Mix Soil Texture: Loose to medium dense (compacted*), dark brown, fine to medium SAND, some coarse sand, some silt, trace gravel, abundant fine organics, few woodchips (SP-SM)
 Native Soil Texture: Vashon Advance Outwash: Medium dense to dense, moist, light brown, very gravelly silty fine to medium SAND, some coarse sand (SM)

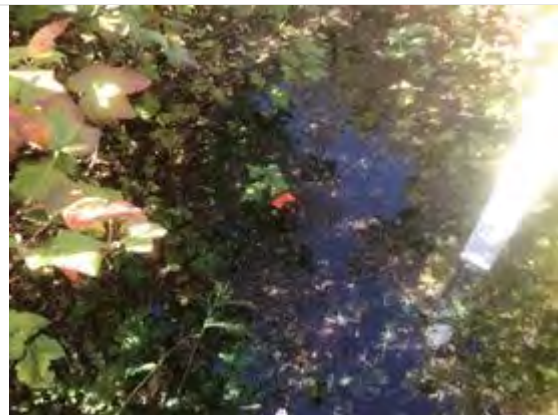
| | |
|---|---|
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Well Point Detail

Is the well point dry? Yes No
 Depth to water from TOC (ft):
 Respond to Testing: Yes No
 Shallowest Depth to water during testing from Ground Surface (ft): 0

Additional Details

*see MJP field logs notebook



FA_FPhoto-20230915-203435.jpg

HA-2


Zone 1 Zone 2 Zone 3


BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)
Cell: Raingarden #2

Assessed On:
September 15, 2023



| | | |
|--|---|---|
| HA-2 | |  <p>FA_FPhoto-20230915-203619.jpg</p> |
| <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0 | |
| to Native Soil: | 1.5 | |
| to Import/Underdrain: | | |
| Total Depth: | 2 | |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some silt, abundant fine organics, few rootlets (SP-SM) | | |
| Native Soil Texture: Vashon Advance Outwash: Medium dense to dense, moist, light brown, very gravelly silty fine to medium SAND, some coarse sand (SM) | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |

| | | |
|---|---|--|
| HA-3 | |  <p>FA_FPhoto-20230915-204004.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | | |
| <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0 | |
| to Native Soil: | 1 | |
| to Import/Underdrain: | | |
| Total Depth: | 2.5 | |
| Rain/Garden Mix Soil Texture: V. loose-loose, moist, dark brown, silty, f SAND, abundant organics, few woodchips and fine rootlets - buttercup plant species on ground surface (SM) | | |
| Native Soil Texture: Vashon Advance Outwash: Loose to medium dense, moist, slightly olive to brown, slightly oxidized, very gravelly, silty, fine to medium SAND, some coarse sand (SM) | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |
| Native unit changes with depth. | | |
| 1.5-2.5': Medium dense-dense, moist, light brown, fine SAND, some medium sand, some gravel, trace coarse sand, some silt to silty, gravel is fine (SP-SM) | | |
| 2.5': Same as above, becomes silty to very silty | | |

Infiltration Test

| |
|------|
| IT-1 |
|------|

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)

Cell: Raingarden #2

Assessed On:
September 15, 2023



| | |
|--|-------|
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-4 (3-50) | |
| Wetted Pond Area (sq. ft) | 375 |
| Ponded Depth (ft) | 0.94 |
| Total Gallons | 9,091 |
| Steady State Flow Rate (GPM) | 11.5 |

Additional Details:
Ponded depth is at the maximum value. Steady state ponded depth is approximately 0.89 feet. Additional test details can be found in the executive summary.



IT_Photo-20230915-222729.jpg



IT_Photo-20230915-222857.jpg



IT_Photo-20230915-222947.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell 35th & Grannis (BO35G)

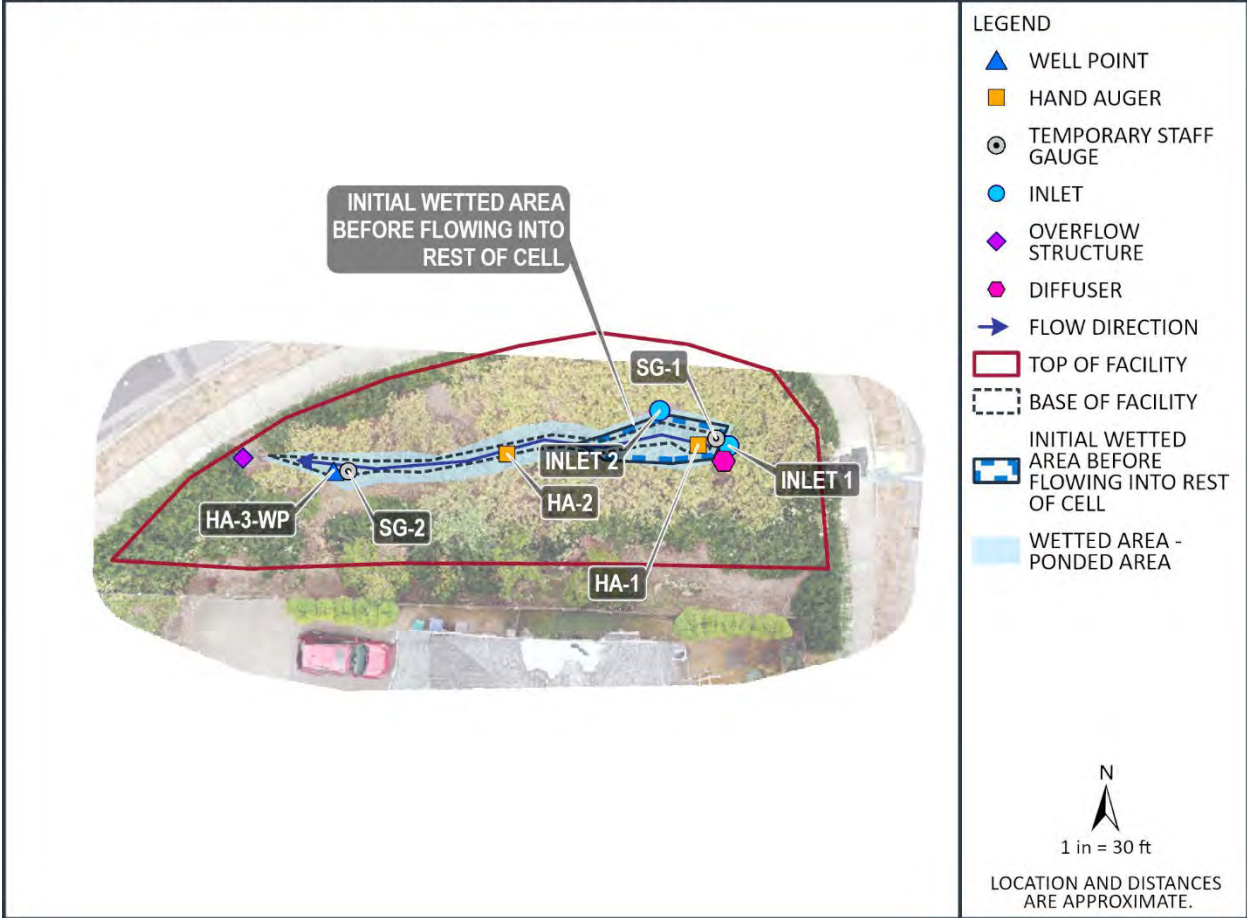
Cell: Raingarden #2

Assessed On:

September 15, 2023



SITE: BOTHELL 35TH & GRANNIS (BO35G) CELL: RAINGARDEN #2





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Well Point

BO35G-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/14/23

Logged By: MJP

20150387H008

Ending Date: 9/14/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.8

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.8

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

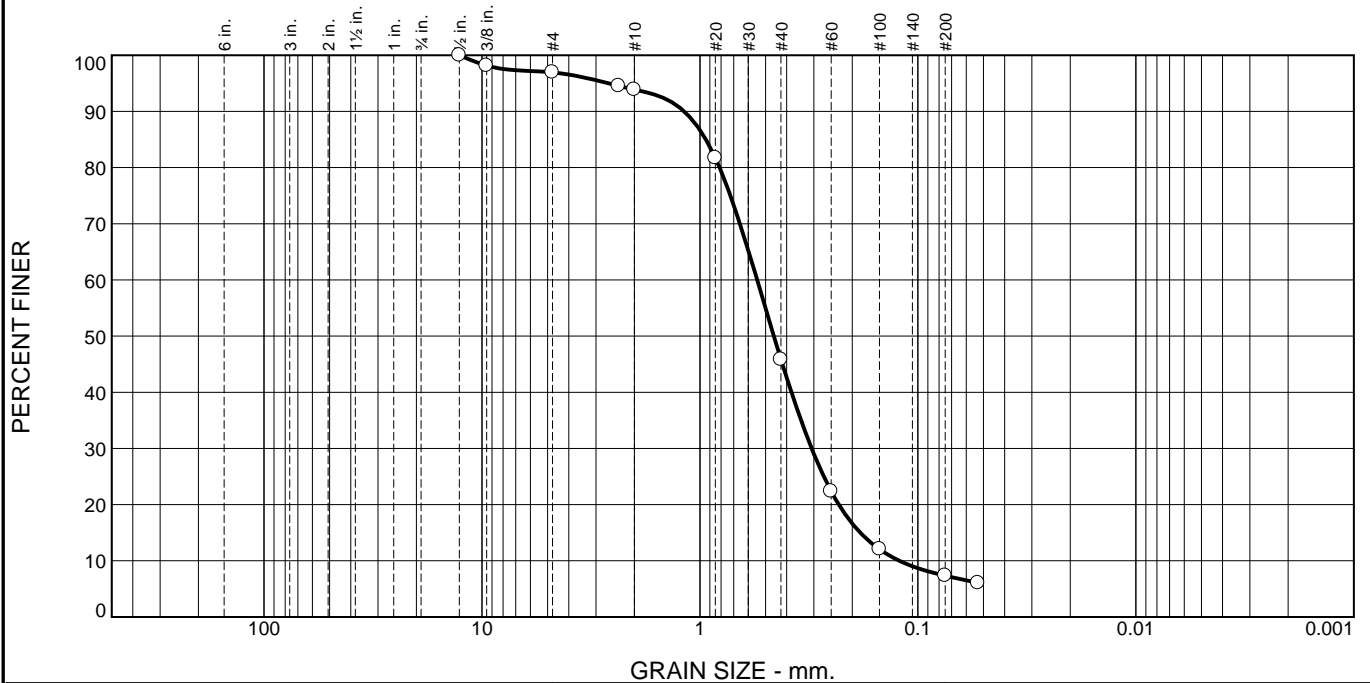
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | <p>Bioretention Soil Mix Loose to medium dense (compacted), dark brown, fine to medium SAND, some silt; abundant fine organics; few wood chips (SP-SM).</p> | | | | | | | <p>Stick up -5 to 0 feet Bioretention backfill 0 to 0.5 feet 3/8-inch bentonite chips 0.5 to 1.5 feet</p> <p>1.25-inch I.D. threaded galvanized steel casing -5 to -1 feet; duct tape covers screen -1 to 1.7 feet Medium grain silica sand 1.5 to 2.8 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.7 to 2.2 feet Cast iron end cap 2.2 to 2.5 feet Cast iron drivepoint 2.5 to 2.8 feet</p> |
| 1 | | | | <p>Vashon Advance Outwash Medium dense to dense, moist, light brown, very gravelly, silty, fine SAND (SM).</p> | | | | | | | |
| 2 | | | | <p>Becomes dense, grayish brown (SM).</p> | | | | | | | |
| 3 | | | | <p>No groundwater encountered. No caving. Refusal at 2.8 feet Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/21/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 0.0 | 3.0 | 3.1 | 48.1 | 38.4 | 7.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 98.2 | | |
| #4 | 97.0 | | |
| #8 | 94.5 | | |
| #10 | 93.9 | | |
| #20 | 81.7 | | |
| #40 | 45.8 | | |
| #60 | 22.4 | | |
| #100 | 12.1 | | |
| #200 | 7.4 | | |
| #270 | 6.1 | | |

* (no specification provided)

Material Description

SAND some silt trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 1.1806 | D ₈₅ = 0.9391 | D ₆₀ = 0.5464 |
| D ₅₀ = 0.4582 | D ₃₀ = 0.3071 | D ₁₅ = 0.1839 |
| D ₁₀ = 0.1217 | C _u = 4.49 | C _c = 1.42 |

Remarks

Date Received: 9-15-2023 Date Tested: 11-30-2023

Tested By: FEW

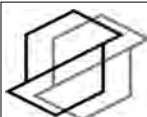
Checked By: CSI/JHS

Title: _____

Location: Onsite - BHPS-BO35G
 Sample Number: HA-1

Depth: 0.5'

Date Sampled: 9-14-2023



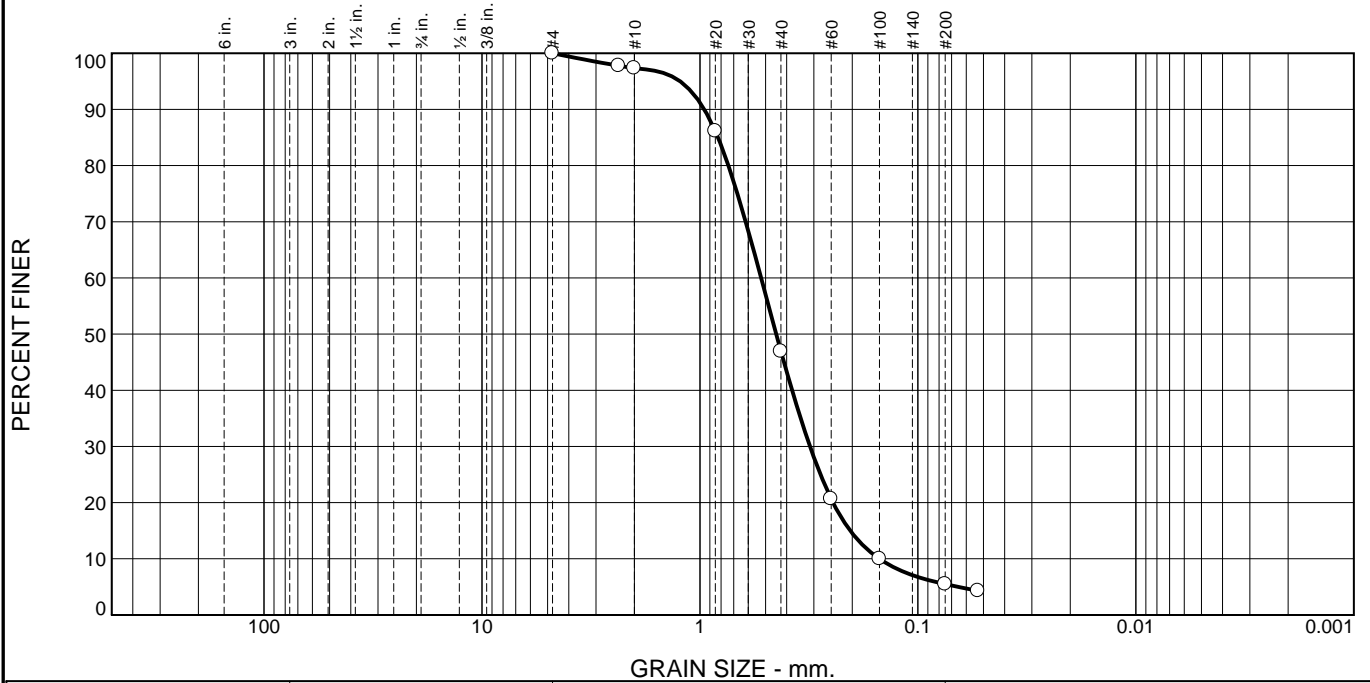
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.0 | 2.6 | 50.5 | 41.4 | 5.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #4 | 100.0 | | |
| #8 | 97.8 | | |
| #10 | 97.4 | | |
| #20 | 86.1 | | |
| #40 | 46.9 | | |
| #60 | 20.7 | | |
| #100 | 10.0 | | |
| #200 | 5.5 | | |
| #270 | 4.3 | | |

Material Description

SAND some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 0.9552 | D ₈₅ = 0.8265 | D ₆₀ = 0.5241 |
| D ₅₀ = 0.4469 | D ₃₀ = 0.3126 | D ₁₅ = 0.2045 |
| D ₁₀ = 0.1501 | C _u = 3.49 | C _c = 1.24 |

Remarks

Date Received: 9-15-2023 Date Tested: 11-30-2023

Tested By: FEW

Checked By: CSI/JHS

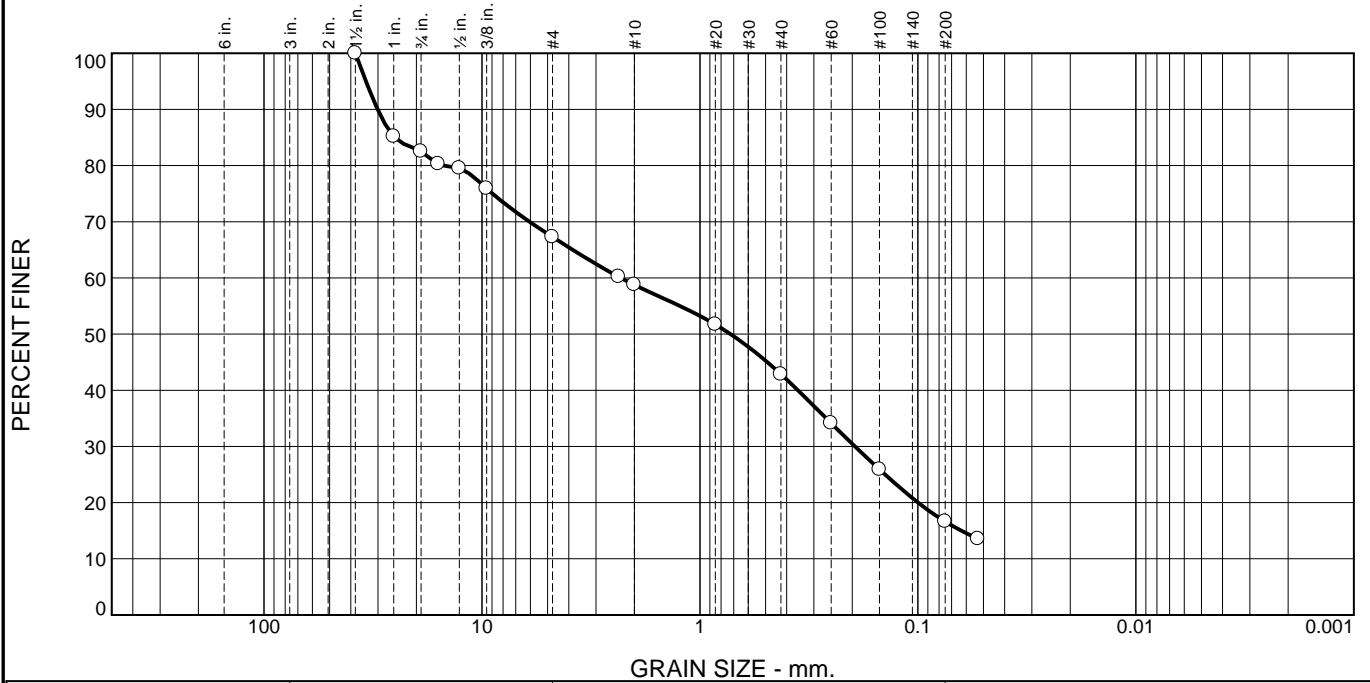
Title: _____

* (no specification provided)

Location: Onsite - BHPS-BO35G Date Sampled: 9-14-2023
 Sample Number: HA-2 Depth: 0.5'

| | | |
|---------------------------|---|--------|
| | Client: City of Olympia | Figure |
| | Project: Bioretention Hydrologic Performance Monitoring Study | |
| Project No: 20150387 H008 | | |

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 17.5 | 15.2 | 8.5 | 15.9 | 26.3 | 16.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 85.2 | | |
| 3/4" | 82.5 | | |
| 5/8" | 80.3 | | |
| 1/2" | 79.5 | | |
| 3/8" | 75.9 | | |
| #4 | 67.3 | | |
| #8 | 60.2 | | |
| #10 | 58.8 | | |
| #20 | 51.7 | | |
| #40 | 42.9 | | |
| #60 | 34.1 | | |
| #100 | 25.9 | | |
| #200 | 16.6 | | |
| #270 | 13.5 | | |

* (no specification provided)

Material Description

very gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 30.1213 D₈₅= 25.1256 D₆₀= 2.3062
D₅₀= 0.7239 D₃₀= 0.1944 D₁₅= 0.0631
D₁₀= C_u= C_c=

Remarks

Date Received: 9-15-2023 Date Tested: 11-29-2023

Tested By: FEW

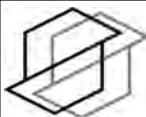
Checked By: CSI/JHS

Title: _____

Location: Onsite - BO35G
Sample Number: HA-2

Depth: 1.75'

Date Sampled: 9-14-2023



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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/15/2023 | Project BHPS-BO35G | Project No. 20150387 H008 | | Soil Description Bioretention Soil |
| Tested By FEW | Location Bothell, WA | EB/EP No. BO35G-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.5' | HA-2 @ 0.5' |
|--------------------|-------------|-------------|
| Wet Weight + Pan | 514.7 | 459.5 |
| Dry Weight + Pan | 497.4 | 447.9 |
| Weight of Pan | 258.0 | 259.5 |
| Weight of Moisture | 17.2 | 11.6 |
| Dry Weight of Soil | 239.4 | 188.4 |
| % Moisture | 7.2 | 6.2 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 497.4 | 447.9 |
| Dry Soil After Burn + Pan | 480.5 | 438.0 |
| Weight of Pan | 258.0 | 259.5 |
| Wt. Loss Due to Ignition | 16.9 | 9.9 |
| Actual Wt. Of Soil After Burn | 222.5 | 178.5 |
| % Organics | 7.1 | 5.2 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|----------------------------------|--------------------------------|--|
| Project Name: | 35th and Grannis (Raingarden #2) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-4 |
| Date: | 9/15/2023 | Wetted Area (sq. feet): | 10:44 125 ft^2 / 11:30: 330.5 ft^2 / 13:50: 369 ft^2 |
| Weather: | Clear, 80s | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.94 |
| Performed By: | EAP | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|--|
| 10:12 | 32.88 | | | | | Water on |
| 10:13 | 32.88 | | | | 31 | |
| 10:14 | 32.92 | 0.11 | | | | |
| 10:17 | 32.72 | 0.16 | | | 160 | |
| 10:20 | 45.96 | | | | | Increase flow |
| 10:27 | 45.84 | 0.31 | | | 578 | |
| 10:44 | 45.94 | 0.49 | | | 1,358 | Localized pooling |
| 10:58 | 45.78 | 0.53 | | | 2,000 | |
| 11:15 | 45.99 | 0.61 | 0.44 | 4.73 | 2,781 | |
| 11:30 | 45.97 | 0.7 | | | 2,470 | |
| 11:31 | 45.97 | | 0.56 | 4.5 | | |
| 11:45 | 46 | 0.8 | | | 4,177 | |
| 11:46 | 46 | | 0.66 | 4.42 | 4,850 | |
| 12:00 | 46.1 | 0.88 | | | | |
| 12:01 | 46.1 | | 0.74 | 4.34 | | Entire cell ponded up to overdrain |
| 12:04 | 37.8 | | | | | Decrease flow |
| 12:15 | 38.02 | 0.93 | | | 5,454 | |
| 12:16 | | | 0.8 | 4.3 | | |
| 12:18 | 24.76 | | | | | Decrease flow; water approaching overdrain |
| 12:20 | | 0.94 | | | | Water off (falling head test) |
| 12:24 | | 0.93 | | | | |
| 12:28 | | 0.91 | | | | |
| 12:29 | | | 0.78 | 4.31 | | |
| 12:32 | | 0.89 | | | | |
| 12:34 | 9.42 | | | | | Water on |
| 12:45 | 9.42 | 0.87 | | | 5,719 | |
| 12:46 | 9.42 | | 0.73 | 4.36 | | |
| 12:48 | 16.23 | | | | | Increase flow |
| 13:00 | 15.99 | 0.87 | | | 5,941 | |
| 13:01 | 15.99 | | 0.74 | 4.35 | | |
| 13:16 | 16.03 | 0.88 | | | 6,200 | |
| 13:17 | 16.03 | | 0.74 | 4.33 | | |
| 13:30 | 15.99 | 0.89 | | | 6,425 | |
| 13:31 | 15.99 | | 0.76 | 4.32 | | |
| 13:33 | 11.91 | | | | | Decrease flow |
| 13:45 | 11.84 | 0.89 | | | 6,615 | |

| | | | | | | |
|-------|-------|------|------|------|-------|-----------|
| 13:46 | 11.84 | | 0.76 | 4.32 | | |
| 14:00 | 11.81 | 0.89 | | | 6,794 | |
| 14:01 | 11.81 | | 0.76 | 4.32 | | |
| 14:15 | 11.81 | 0.89 | | | 6,973 | |
| 14:16 | 11.81 | | 0.76 | 4.32 | | |
| 14:32 | 11.93 | 0.89 | | | 7,175 | |
| 14:33 | 11.93 | | 0.76 | 4.32 | | |
| 14:47 | 11.96 | 0.89 | | | 7,354 | |
| 14:48 | 11.96 | | 0.76 | 4.32 | | |
| 15:00 | 11.89 | 0.89 | | | 7,509 | |
| 15:01 | 11.89 | | 0.76 | 4.31 | | |
| 15:15 | 11.91 | 0.9 | | | 7,689 | |
| 15:16 | 11.91 | | 0.76 | 4.31 | | |
| 15:31 | 11.93 | 0.9 | | | 7,879 | |
| 15:32 | 11.93 | | 0.76 | 4.31 | | |
| 15:45 | 12 | 0.9 | | | 8,047 | |
| 15:46 | 12 | | 0.77 | 4.3 | | |
| 16:00 | 11.98 | 0.91 | 0.77 | 4.3 | 8,227 | |
| 16:12 | 12 | 0.91 | | | 8,371 | |
| 16:13 | 12 | | 0.78 | 4.29 | 8,431 | |
| 16:22 | 11.98 | 0.91 | | | 8,491 | |
| 16:23 | 11.98 | | 0.78 | 4.29 | | |
| 16:32 | 12 | 0.92 | | | 8,611 | |
| 16:33 | 12 | | 0.78 | 4.29 | | |
| 16:42 | 12 | 0.92 | | | 8,731 | |
| 16:43 | 12 | | 0.79 | 4.29 | | |
| 16:52 | 11.96 | 0.93 | | | 8,851 | |
| 16:53 | 11.96 | | 0.79 | 4.28 | | |
| 17:02 | 12.02 | 0.93 | | | 8,971 | |
| 17:03 | 12.02 | | 0.79 | 4.28 | | |
| 17:11 | 12 | 0.94 | | | 9,079 | |
| 17:12 | 12 | 0.94 | 0.8 | 4.28 | 9,092 | Water off |
| 17:13 | | 0.94 | | | | |
| 17:14 | | 0.93 | | | | |
| 17:15 | | 0.93 | 0.79 | | | |
| 17:16 | | 0.93 | | | | |
| 17:20 | | 0.92 | | | | |
| 17:21 | | | 0.78 | 4.28 | | |
| 17:25 | | 0.9 | | | | |
| 17:26 | | | 0.76 | 4.29 | | |
| 17:30 | | 0.89 | | | | |
| 17:31 | | | 0.75 | 4.29 | | |
| 17:35 | | 0.88 | | | | |
| 17:36 | | | 0.74 | 4.31 | | |
| 17:40 | | 0.87 | | | | |
| 17:41 | | | 0.73 | 4.32 | | |
| 17:45 | | 0.86 | | | | |
| 17:46 | | | 0.72 | 4.33 | | |

| | | | | | | |
|-------|--|------|------|------|--|-------------|
| 17:52 | | 0.84 | | | | |
| 17:53 | | | 0.7 | 4.36 | | |
| 17:55 | | 0.83 | | | | |
| 17:56 | | | 0.7 | 4.35 | | |
| 18:00 | | 0.83 | | | | |
| 18:01 | | | 0.69 | 4.37 | | |
| 18:05 | | 0.82 | | | | |
| 18:06 | | | 0.69 | 4.38 | | |
| 18:11 | | 0.8 | | | | |
| 18:12 | | | 0.68 | 4.39 | | End of test |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.7 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 1.7 |

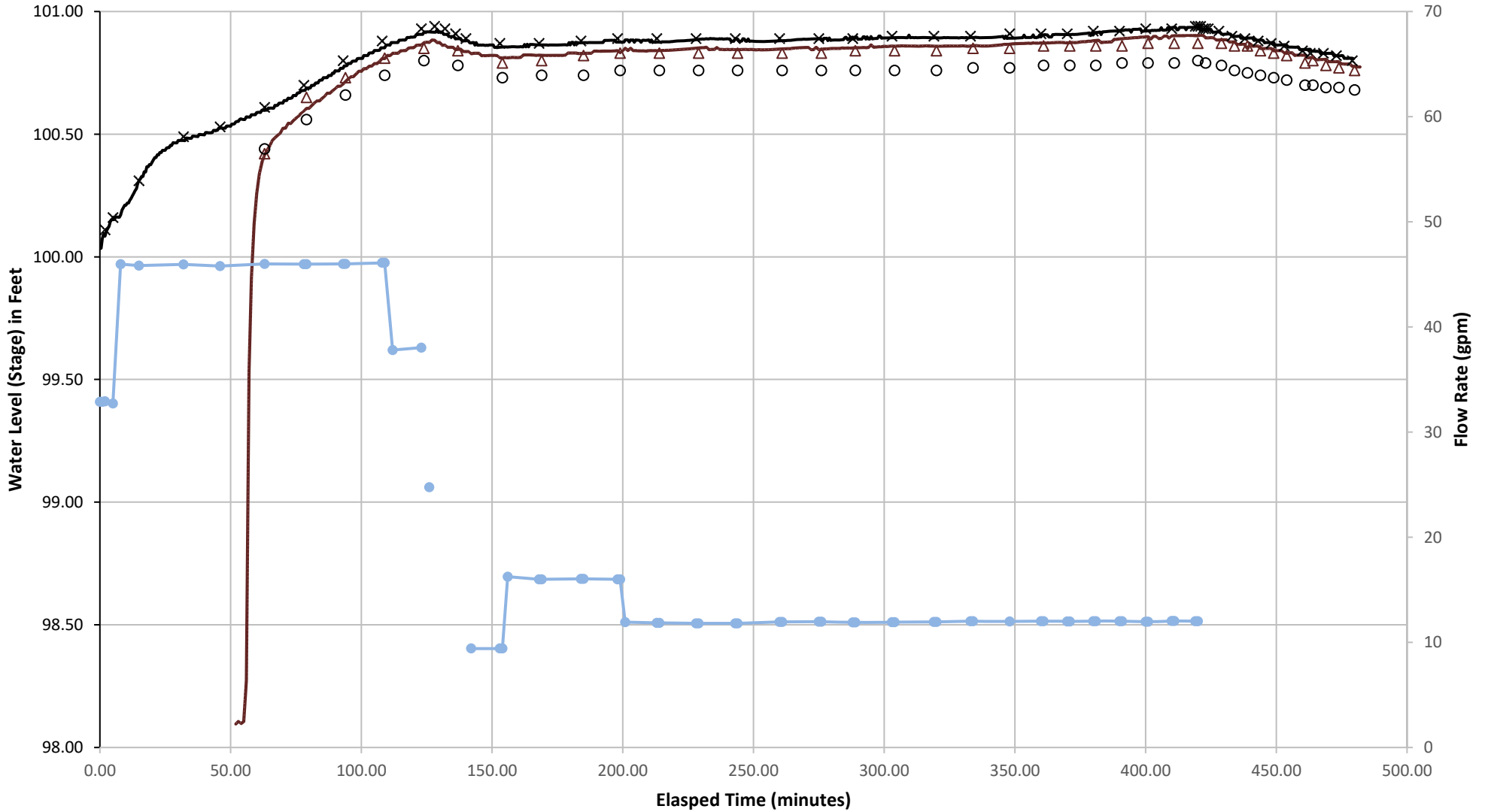
| | |
|--|-----|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.7 |
| Average Infiltration Rate (in/hr) during falling head: | 1.4 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 3.0 |
| WP Average Infiltration Rate (in/hr) during falling head: | 1.8 |

| | |
|---|------|
| SG-1 Average Infiltration Rate during first hour of inflow (prior to filing storage): | 27.7 |
|---|------|

35th & Grannis Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used for relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
 - Staff Gauge #1 Logger
 - △ Wellpoint Hand
-
- Wellpoint Logger
 - Staff Gauge #2 Hand Data
 - Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)
Cell: Site 2E

Assessed On:
September 18, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and collects runoff from the adjacent road and residential cul-de-sac through 2 curb cut inlets. The cell is constructed with 3" of mulch atop 2.5' of bioretention soil. Beneath the soil is a 2' wide, 1.5' deep underdrain trench composed of type 26 aggregate with a perforated pipe connecting to the overflow structure, which allows 8" of ponding, and the catch basin. A PVC liner sits against the curb side of the cell and extends 1' beneath the bioretention soil. Water is designed to infiltrate through the bioretention soil and enter the underdrain pipe which conveys flow to the storm drainage network.

BIORETENTION SOIL:

Thickness: >1.8'

Due to the presence of PSE utilities beneath the cell and heavy caving in the one hand auger conducted in the cell, the thickness of the bioretention soil could not be measured. The plans call for 2.5' of bioretention soil mix.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications the tested material met the standard for sand gradation and silt content. The organic matter content was below the minimum specification.

Organic Matter Content (% by weight): 3.8

Percent passing #200 sieve: 4.1

Coefficient of Uniformity (Cu): 7.4

Coefficient of Curvature (Cc): 1

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Hand auger explorations did not penetrate the gravel drain rock underneath the bioretention soil.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was observed in the hand auger exploration conducted in the test cell. The temporary wellpoint was screened from 0.9-1.4' and did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 32.8

Subgrade Soil Rate (in/hr): N/A

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)
 Cell: Site 2E

Assessed On:
 September 18, 2023



The subgrade soil infiltration rate cannot be determined from our infiltration test due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:
 The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------------------|-------------------------|------------------|
| Weather | Sunny, 80's | | |
| Recent Rainfall | Today: 0.02" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Catherine Ikeda | Half Day: Sarah Faubion | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 1 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: IMG_1800.JPG



Site Photo: IMG_1801.JPG

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)
 Cell: Site 2E

Assessed On:
 September 18, 2023



Cell Construction

| | |
|---|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Partial Width Width 2' The underdrain is a 6" slotted storm drain pipe set within a trench of mineral aggregate type 26 that is 2 feet wide by 1.5 feet thick underlying the base of the rain garden. Slots are to be 0.069 inches wide on 45 degree centers by 1.0 inches long and spaced 0.125inches apart. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed through two curb cuts that allow run off from the adjacent cul-de-sac and roadway into the cell. Water is designed to infiltrate through the bioretention soil before reaching the underdrain pipe where it flows to a catch basin and out to the storm drain network. | |

Inlets

| | |
|--|---|
| IN-1 <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.1' Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Some stream cobbles were partially buried at the base of the inlet. | IMG_1783.JPG Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Stream cobbles were observed scattered at the base of the curb cut. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)

Cell: Site 2E

Assessed On:
September 18, 2023



BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)

Cell: Site 2E

Assessed On:

September 18, 2023



IN-2

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Pipe:

Material

- PVC Metal Concrete Other

Other: Other

Diameter: 0.4'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Eroded

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



IMG_1798.JPG

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)

Cell: Site 2E

Assessed On:
September 18, 2023



Erosion Present? Yes No

Severity: Minor

Minor to moderate erosion around stream cobbles was observed, some cobbles are more buried than others.

Blockage Present? Yes No

Approximately 15% blocked

Types:

Sediment Organic Rock

Trash Vegetation

Additional Details: Leaf litter and other vegetation covers the base of the inlet pipe



IMG_1797.JPG

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)
 Cell: Site 2E

Assessed On:
 September 18, 2023



Design Overflow/Outlet

| | |
|--|--------------------------------|
| DO - 1 | |
| Shape: <input checked="" type="checkbox"/> Round <input type="checkbox"/> Rectangular <input type="checkbox"/> Other Additional Details: | Dimensions: Diameter: 0.55' |
| Stickup (ft) From Ground: 0 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 20% blocked Additional Details: Overflow trash rack is blocked by leaves and leaf litter. Water can still enter, but leaf litter slows flow. | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 20% blocked Additional Details: Overflow trash rack is blocked by leaves and leaf litter. Water can still enter, but leaf litter slows flow. | |
| IMG_1789.JPG | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|--|-------------------------------|---|-----------------------------------|--|------------------------------------|
| Mulch: <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.2 | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Natural mulch and leaf litter cover cell. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Additional Details: | | | | | |
| Vegetation Description | | | | | |
| Shrubs and trees on the west side of the cell limit observation of ponded area width. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: No probe measurements were conducted due to the PSE utilities running along the length of the cell. | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)
Cell: Site 2E

Assessed On:
September 18, 2023



Hand Auger

| | |
|--|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.8 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): | |
|  <p>FA_FPhoto-20230918-154404.jpg</p>  <p>FA_FPhoto-20230918-162759.jpg</p> | |
| Additional Details | |
| Due to PSE utilities, only one hand auger was completed at this site. HA-1 was terminated at 1.8' due to excessive caving. | |

Infiltration Test

| | |
|--|----------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 205 |
| Ponded Depth (ft) | 0.58 |
| Total Gallons | 24,214.3 |
| Steady State Flow Rate (GPM) | 69.5 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)

Cell: Site 2E

Assessed On:

September 18, 2023



Additional Details:

Additional test details can be found in the executive summary.



IMG_1802.JPG

Additional Comments

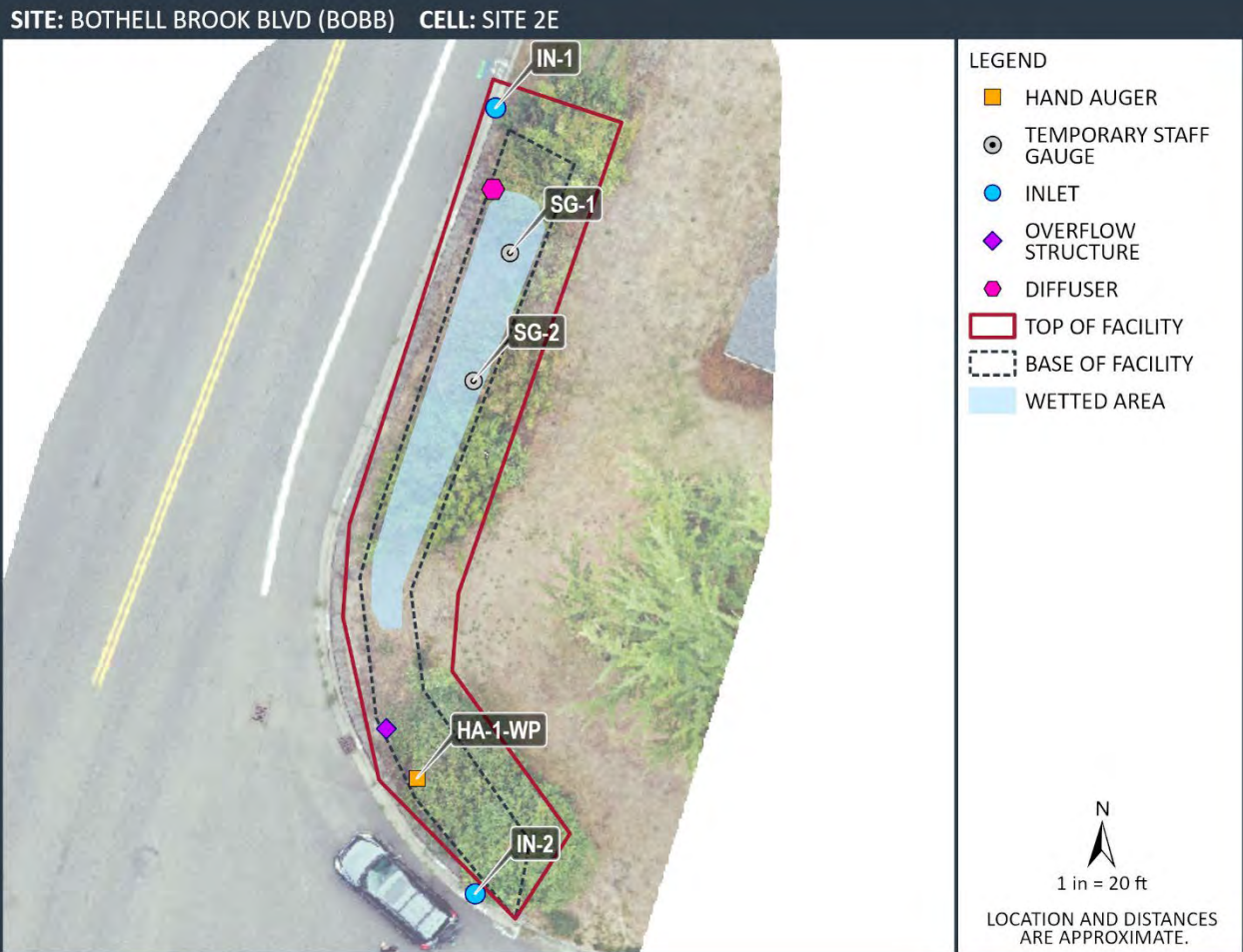
PSE utilities limited the Wellpoint installation, hand augers at the site, and probe measurements.

BIORETENTION CELL FIELD ASSESSMENT

Site: Bothell Brook Blvd (BOBB)

Cell: Site 2E

Assessed On:
September 18, 2023





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Well Point

BOBB-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/18/23

Logged By: CSI/SNCF

20150387H008

Ending Date: 9/18/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.8

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.4

Water Level Elevation (ft): N/A

Datum: Project Datum

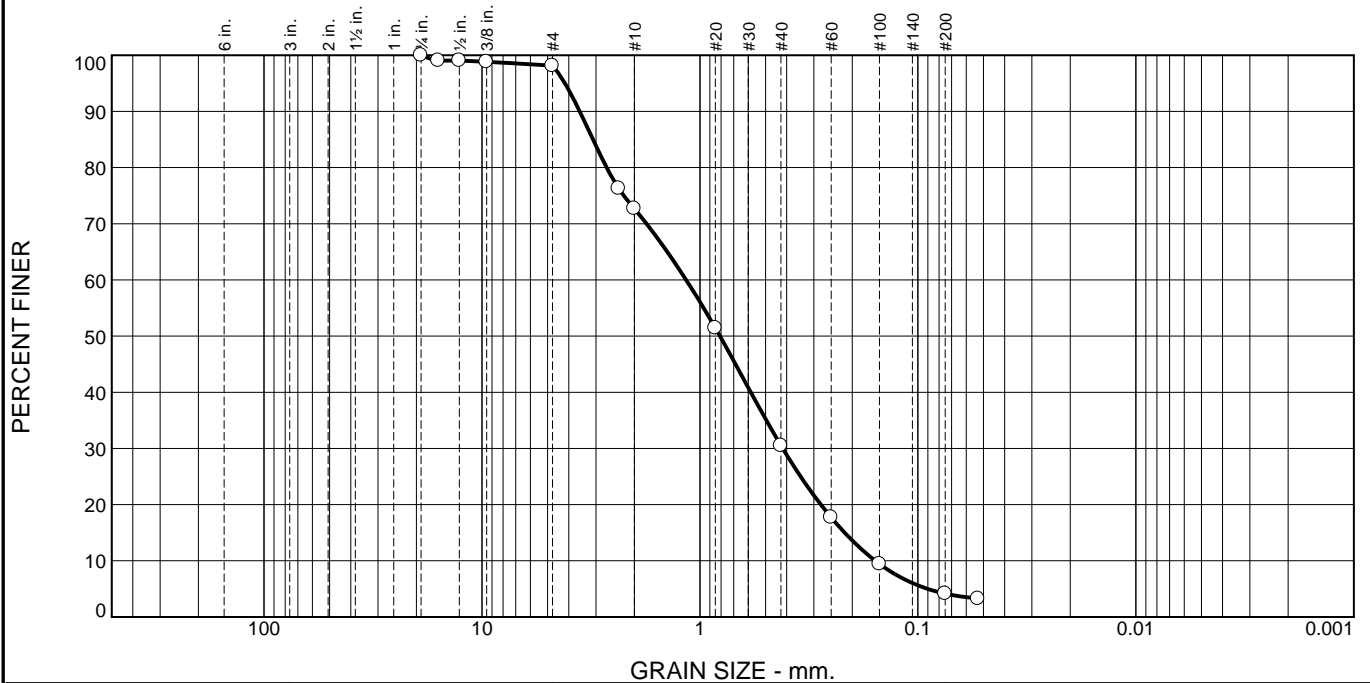
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Natural Mulch Fibrous grasses, organic debris. | | | | | | | <p>Stickup -4.4 to 0 feet. 3/8-inch bentonite chips 0 to 0.9 feet 1.25-inch I.D. threaded galvanized steel casing -4.4 to 0.1 feet; duct tape covers screen 0.1 to 0.9 feet Medium grained silica sand 0.9 to 1.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 0.9 to 1.4 feet Cast iron end cap 1.4 to 1.7 feet Cast iron drivepoint 1.7 to 2.0 feet</p> |
| 1 | | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, trace silt; abundant organics; wood chips (SP). As above; wood chip frequency decreases. | | | | | | | |
| 2 | | 2 | | As above, becomes brown; trace organics. | | | | | | | |
| 3 | | 3 | | As above, becomes brown; trace to no organics; sand becomes very coarse. | | | | | | | |
| 4 | | 4 | | No seepage. Excessive caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/21/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.9 | 25.4 | 42.2 | 26.4 | 4.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 99.0 | | |
| 1/2" | 99.0 | | |
| 3/8" | 98.8 | | |
| #4 | 98.1 | | |
| #8 | 76.3 | | |
| #10 | 72.7 | | |
| #20 | 51.4 | | |
| #40 | 30.5 | | |
| #60 | 17.7 | | |
| #100 | 9.4 | | |
| #200 | 4.1 | | |
| #270 | 3.3 | | |

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.5593 D₈₅= 3.0960 D₆₀= 1.1568
D₅₀= 0.8096 D₃₀= 0.4173 D₁₅= 0.2168
D₁₀= 0.1569 C_u= 7.37 C_c= 0.96

Remarks

Date Received: 9-18-2023 Date Tested: 12-14-2023

Tested By: FEW

Checked By: CSI/SNCF/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-BOBB
Sample Number: HA-1WP

Depth: 0.5-1'

Date Sampled: 9-18-2023



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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--------------------------------|-------------------------------------|------------------------|--|
| Date Sampled 9/18/2023 | Project BHPS-BOBB | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bothell, WA | EB/EP No. BOBB-HA | Depth 0.5-1" | |

Moisture Content

| | |
|--------------------|------------------------|
| Sample ID | HA-1WP @ 0.5-1' |
| Wet Weight + Pan | 1395.4 |
| Dry Weight + Pan | 1346.7 |
| Weight of Pan | 358.0 |
| Weight of Moisture | 48.6 |
| Dry Weight of Soil | 988.8 |
| % Moisture | 4.9 |

Organic Matter and Ash Content

| | |
|-------------------------------|---------------|
| Dry Soil Before Burn + Pan | 1346.7 |
| Dry Soil After Burn + Pan | 1308.7 |
| Weight of Pan | 358.0 |
| Wt. Loss Due to Ignition | 38.1 |
| Actual Wt. Of Soil After Burn | 950.7 |
| % Organics | 3.8 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------------------|--------------------------------|---|
| Project Name: | Brook Boulevard (Site 2E) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 9/18/2023 | Wetted Area (sq. feet): | 10:32: 170 ft^2 / 11:45 194 ft^2 / 13:30 205 ft^2 |
| Weather: | Partly Cloudy, 60s | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.58 |
| Performed By: | CSI/SNCF | Receptor Soils: | Underdrain Gravels / Qvt |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|------------------|----------------------|---------------------|---|
| 8:10 | | | | | | | Water on |
| 8:12 | 40.68 | 0.18 | | 3.29 | | 70 | |
| 8:16 | 40.8 | 0.18 | 0.2 | | | 238 | |
| 8:18 | 40.7 | 0.2 | 0.14 | | | 354 | Water flowing between rock wall; moved diffuser |
| 8:20 | 40.8 | 0.2 | 0.1 | | | | |
| 8:25 | 40.8 | 0.2 | 0.17 | | | 586 | |
| 8:30 | 40.4 | 0.2 | 0.12 | | | 788 | |
| 8:48 | 40.46 | 0.2 | 0.2 | 3.09 | | 1,535 | |
| 8:52 | 69 | 0.27 | 0.38 | | | 1,744 | Increase flow to 70 gpm |
| 9:00 | 69.3 | 0.27 | 0.44 | 3.07 | | 2,265 | |
| 9:15 | 9:36 | 0.28 | 0.48 | 3.05 | | 3,316 | |
| 9:33 | 69.5 | 0.29 | 0.52 | 3.04 | Dry | 4,607 | Added WP |
| 9:45 | 69.6 | 0.29 | 0.53 | | | 5,394 | |
| 10:00 | 69.5 | 0.3 | 0.54 | 3 | | 6,450 | |
| 10:16 | 69.7 | 0.31 | 0.55 | | | 7,542 | |
| 10:32 | 69.42 | 0.31 | 0.56 | 3 | | 8,670 | Ponded area = 170 ft^2 |
| 10:45 | 69.65 | 0.31 | 0.56 | 2.99 | | 9,590 | |
| 11:00 | 69.3 | 0.31 | 0.56 | 2.99 | | 10,601 | |
| 11:15 | 69.1 | 0.32 | 0.56 | 2.98 | | 11,667 | |
| 11:30 | 69.5 | 0.32 | 0.56 | 3 | | 12,684 | |
| 11:45 | 69.6 | 0.32 | 0.56 | 3 | | 13,727 | Ponded area = 194 ft^2 |
| 12:00 | 69.8 | 0.32 | 0.57 | 3 | | 14,767 | |
| 12:15 | 69.7 | 0.32 | 0.57 | 2.99 | | 15,808 | |
| 12:30 | 69.4 | 0.32 | 0.57 | 3.01 | | 16,854 | |
| 12:45 | 69.9 | 0.32 | 0.57 | 3.01 | | 17,896 | |
| 13:00 | 69.65 | 0.32 | 0.57 | 3.01 | | 18,940 | |
| 13:15 | 69.75 | 0.32 | 0.57 | 3 | | 19,985 | |
| 13:30 | 69.8 | 0.32 | 0.58 | 2.98 | | 21,030 | Ponded area = 205 ft^2 |
| 13:45 | 69.75 | 0.32 | 0.58 | 3 | | 22,076 | |
| 14:00 | 69.15 | 0.32 | 0.58 | 3 | | 23,117 | |
| 14:15 | 69.4 | 0.32 | 0.58 | 3 | | 24,159 | |
| 14:15 | | 0.32 | 0.58 | 3 | | 24,214 | Water off |
| 14:16 | | 0.22 | 0.54 | | | | |
| 14:17 | | 0.17 | 0.5 | | | | |
| 14:17 | | 0.14 | 0.47 | | | | |
| 14:18 | | 0.1 | 0.44 | | | | |
| 14:18 | | 0 | 0.41 | | | | SG#1 sunk 0.04' |
| 14:19 | | | 0.38 | | | | |
| 14:20 | | | 0.33 | | | | |

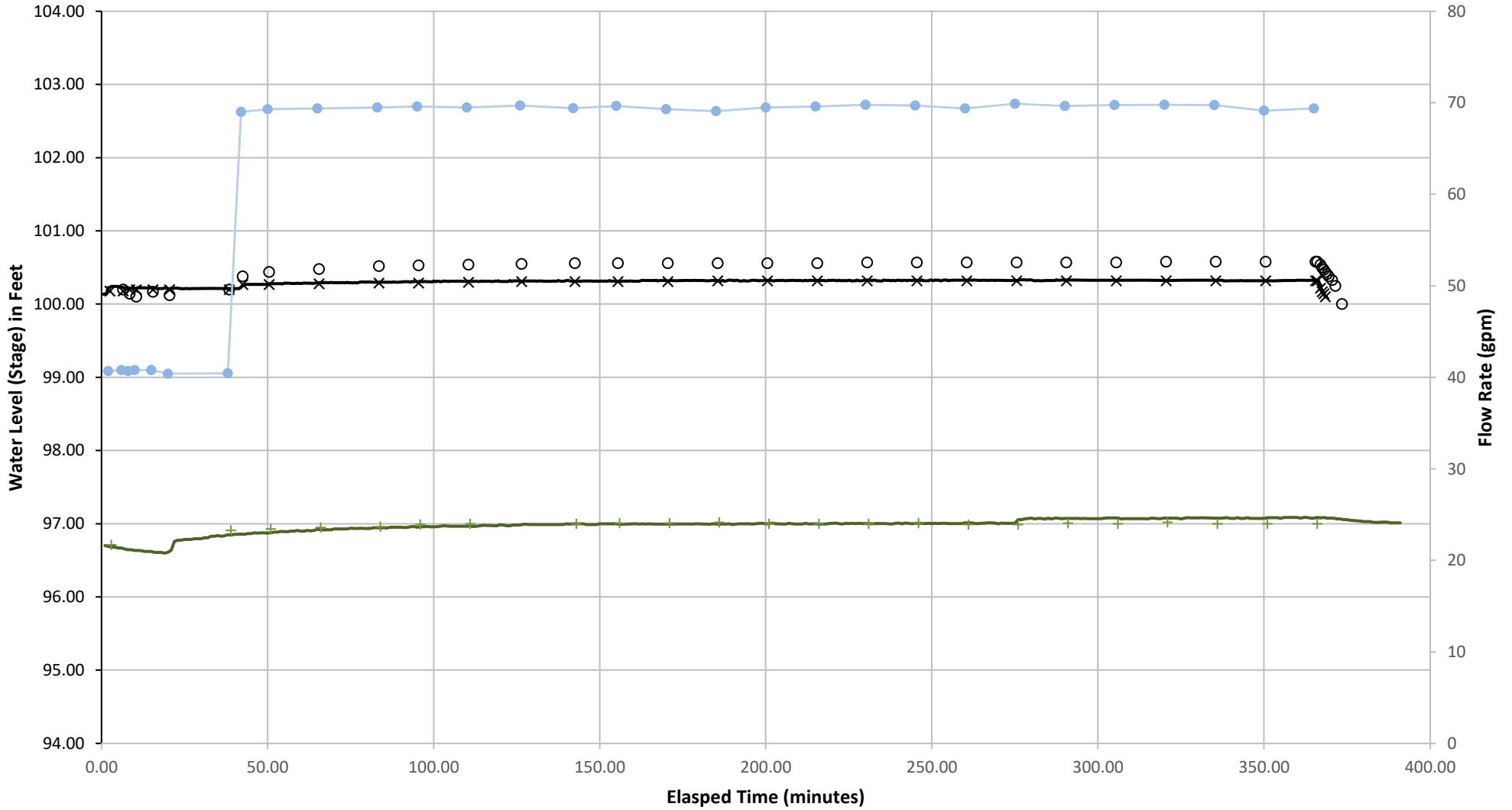
| | | | | | | | |
|-------|--|--|------|--|-----|--|-----------------|
| 14:21 | | | 0.25 | | | | |
| 14:23 | | | 0 | | | | Water Off |
| 14:25 | | | | | Dry | | Ponded area dry |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 32.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | - |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 32.7 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 43.2 |

Brook Boulevard (Site 2E) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- + Catch Basin Hand
- Catch Basin Logger
- Staff Gauge #2 Hand Data
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th PI (BV145)
Cell: Raingarden #2

Assessed On:
June 28, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell (Raingarden #2) was constructed in 2011 as one of a series of stormwater upgrades completed on 145th Avenue. This cell collects road runoff directly from 145th Ave and overflow runoff from a series of upgradient bioretention swales. The cell is constructed with 24" of bioretention soil above an 8" import sand blanket above native soils. Embedded in native soils beneath the sand blanket is a 6" perforated underdrain pipe surrounded by an 18"x24" gravel trench. These gravels only sit immediately around the pipe and are not a full width underdrain.

BIORETENTION SOIL:

Thickness: 1.9-2.4'

The apparent thickness of the bioretention soils ranged from 1.9-2.4' with an average depth of 2.1'.

Composition: The plans call for the city of Bellevue's 2010 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation and silt content from the tested material met the specifications for the 2019 Ecology specifications. The organic matter content fell just below the 2019 specifications. A second bioretention soil sample was taken near the inlet of the cell. This sample found much higher silt fractions (17.2%) and organic matter content (6.84%) in comparison with the representative sample from the center of the cell.

Organic Matter Content (% by weight): 3.3

Percent passing #200 sieve: 4.4

Coefficient of Uniformity (Cu): 5.6

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense, moist, tannish brown, fine gravelly, fine to medium SAND, trace silt; tannish oxidation (SP)

The site is mapped as Vashon Till by Troost and the drainage report notes the presence of Till in a pre-construction test boring. AESI interprets the subgrade material as Vashon Advance Outwash.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered during excavations of hand augers. The temporary wellpoint, screened from 2.6-2.1' below ground surface responded to testing and once the storage in the bioretention soil filled, the wellpoint water level was at or above the surface for the remainder of the test.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 40.5

Subgrade Soil Rate (in/hr): N/A

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th PI (BV145)
 Cell: Raingarden #2

Assessed On:
 June 28, 2023



Due to the presence of the underdrain pipe, no subgrade soil infiltration rate could be determined from this infiltration test.

A separate raingarden (Raingarden #1) in the same series of stormwater installations completed in 2011 was tested in phase one of this study. The infiltration rate of the bioretention soils was measured to be 43 in/hr near the outlet and 18 in/hr near the inlet.

MAINTENECE OBSERVATIONS/CONDITIONS

The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------|---------------|------------------|
| Weather | Clear, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: APJ | | Half Day: |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230628-181723.jpg



Site Photo: FA_SitePhotos-20230628-181754.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th PI (BV145)
 Cell: Raingarden #2

Assessed On:
 June 28, 2023



Site Photo: FA_SitePhotos-20230628-181821.jpg



Site Photo: FA_SitePhotos-20230628-181849.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation lines running down street side and private residence sides of cell. Droplets of water observed on some leaves in morning. Plants appear very healthy and irrigated. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Cell is a teardrop shape with an inlet to the SE and overflow catch basin in the NW. Water enters the cell from a piped inlet which collects runoff from the adjacent arterial road and upgradient bioretention swales. The cell is constructed with bioretention soil above a filter sand media which blankets a 6" perforated pipe which conveys water to a catch basin outside the cell. No underdrain gravels are present. Evidence of scour to the NW away from the inlet in the low, less vegetated portion of the cell. Siltation and deposition present near inlet. Catch basin slightly leaky, trickle of water flowing into outfall. | |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th Pl (BV145)
Cell: Raingarden #2

Assessed On:
June 28, 2023



IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230628-193323.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: 0.2' of debris at base of inlet pipe.
Consists of silt, pine needles, organic material.



FA_INBLPhoto-20230628-193628.jpg

Additional Details: Stream cobble has been partially buried by sediment and organic debris. Deposition of sediment is dominant over erosion. Street catch basin which inlet connects to is filled with debris.


BIORETENTION CELL FIELD ASSESSMENT

Site: 145th PI (BV145)
 Cell: Raingarden #2

Assessed On:
 June 28, 2023



Design Overflow/Outlet

| | | |
|---|--------------|--|
| DO - 1 | |  |
| Shape: | | |
| <input type="checkbox"/> Round | Dimensions: | |
| <input checked="" type="checkbox"/> Rectangular | Length: 1.8' | |
| <input type="checkbox"/> Other | Width: 1.45' | |
| Additional Details: | | |
| Stickup (ft) | | |
| From Ground: 0.81 | | |
| Relative from staff gauge: 0.28 | | |
| Damage Indicators: | | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: | | |
| <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |
| Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

FA_DOPhoto-20230628-192801.jpg

Cell Surface and Geotech Probe Observations

| | | | | | | |
|--|--|--|--|-----------------------------------|------------------------------------|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | | |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| No mulch present, bare bioretention soil covered by pine needles, vegetative debris especially in side closest to road where vegetation is dominant. Handful of pieces of trash (dog toy, Starbucks lid). Evidence of scour to the NW away from the inlet in the low, less vegetated portion of the cell. Siltation and deposition present near inlet. Catch basin slightly leaky, trickle of water flowing into outfall. Both monitoring points clogged with sediment and unusable. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: No pest evidence, but abundance of worms observed once flow was on for several hours. | | | | | | |
| Vegetation Description | | | | | | |
| Thick grasses and vegetation cover ~ 70% of cell. Vegetation is primarily located in zones 2-3 and cell above the cell base. Vegetation acts to channelize flow downgradient and prevents water from ponding on surface in vegetated quadrant of cell until head rises significantly. Plants placed in true cell base where scour is observed are performing more poorly than vegetation on the side slopes. Center plants also furthest from irrigation line. | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observations: Soil probes in the cell base ranged in thickness from 1.9-2.4' with an average depth of 2.1'. The sideslopes of the cell averaged 1' of bioretention soil. The soil was found to be loose and no areas of compaction were observed. | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th PI (BV145)
 Cell: Raingarden #2

Assessed On:
 June 28, 2023



Hand Auger

| | |
|--|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 2.3 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace coarse sand, some silt, abundant organics, scattered rootlets (SP). Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| FA_FPhoto-20230628-115507.jpg | |
| Additional Details At 2.3' encountered import sand blanked: Medium dense, moist light brownish gray, medium to fine SAND, trace silt (SP). Native soils not encountered in this exploration. | |

| | |
|---|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.5 |
| to Native Soil: | 2.3 |
| to Import/Underdrain: | |
| Total Depth: | 2.5 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, silty, fine to medium SAND, trace gravel, scattered rootlets, abundant organics Native Soil Texture: Medium dense, moist, tannish brown, fine gravelly, fine to medium SAND, trace silt; light oxidation (SP). | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th PI (BV145)
 Cell: Raingarden #2

Assessed On:
 June 28, 2023



HA-2



FA_FPhoto-20230628-115627.jpg

Additional Details

HA-2 located near the inlet. Bioretention soil, particularly the uppermost 0.5' significantly siltier than hand augers scattered throughout cell base away from inlet.

HA-3-WP

- Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|---|---|
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 2.1 |
| to Import/Underdrain: | |
| Total Depth: | 2.8 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics, scattered rootlets (SP) | |
| Native Soil Texture: Medium dense, moist, tannish brown, fine gravelly, fine to medium SAND, trace silt; light oxidation (SP). | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th Pl (BV145)
 Cell: Raingarden #2

Assessed On:
 June 28, 2023



HA-3-WP

Well Point Detail

Is the well point dry? Yes No
 Depth to water from TOC (ft):
 Respond to Testing: Yes No
 Shallowest Depth to water during testing from Ground Surface (ft): 0



FA_FPhoto-20230628-115816.jpg

Additional Details

Water in the wellpoint reached the surface.
 Import sand blanket encountered from 1.8-2.1': Medium dense, moist light brownish gray, medium to fine SAND, trace silt (SP).

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-7 (50-300)

Wetted Pond Area (sq. ft) 294

Ponded Depth (ft) 0.6

Total Gallons 46,948.3

Steady State Flow Rate (GPM) 125

Additional Details:

Trace water entering catch basin through joints in concrete.



BIORETENTION CELL FIELD ASSESSMENT

Site: 145th Pl (BV145)

Cell: Raingarden #2

Assessed On:

June 28, 2023



IT_Photo-20230628-190334.jpg



IT_Photo-20230628-190410.jpg



IT_Photo-20230628-190435.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: 145th Pl (BV145)

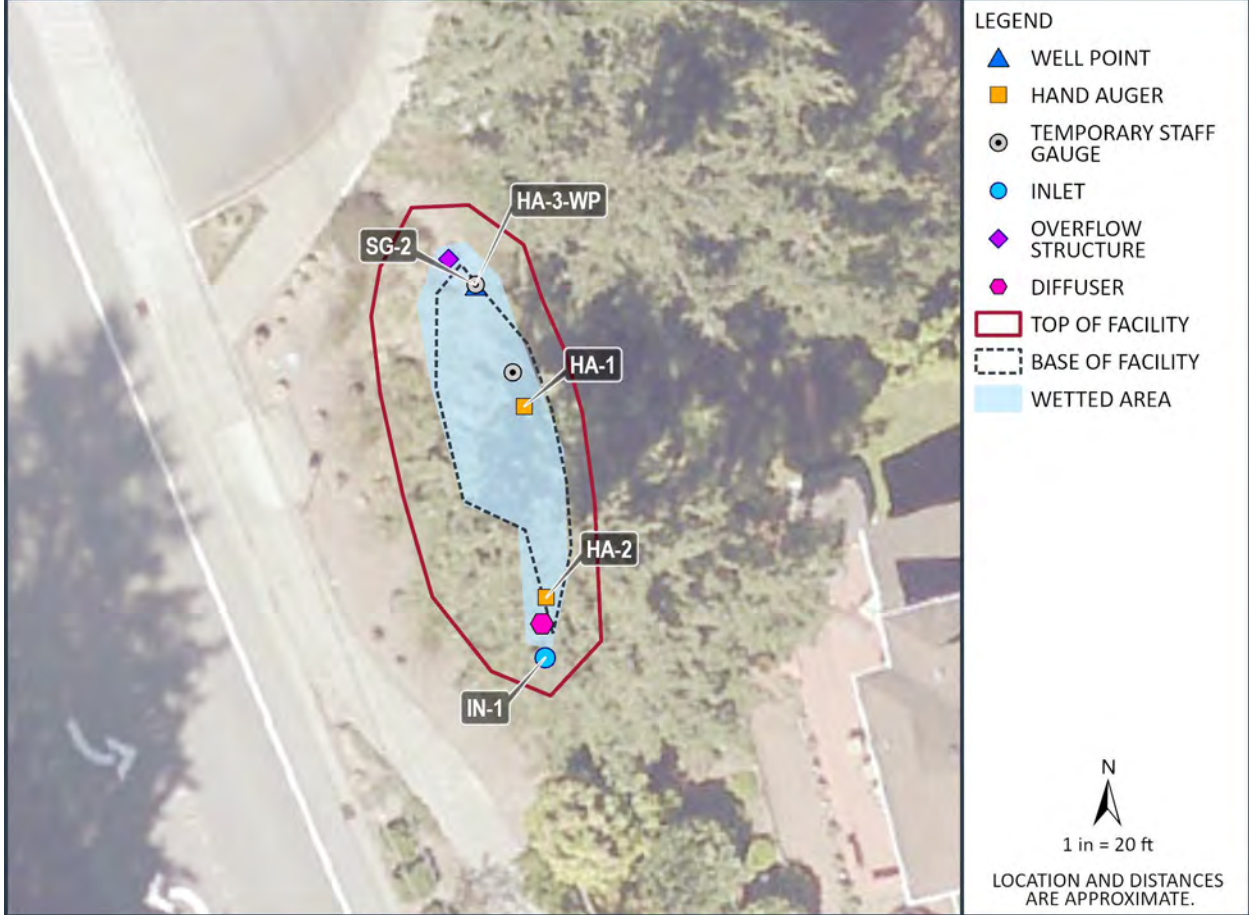
Cell: Raingarden #2

Assessed On:

June 28, 2023



SITE: 145TH PL (BV145) CELL: BIOCELL 2





associated
earth sciences
incorporated

Well Point

BV145-HA-3-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/26/23

Logged By: APJ

20150387H008

Ending Date: 6/26/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.8

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.2

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.4

Water Level Elevation (ft):

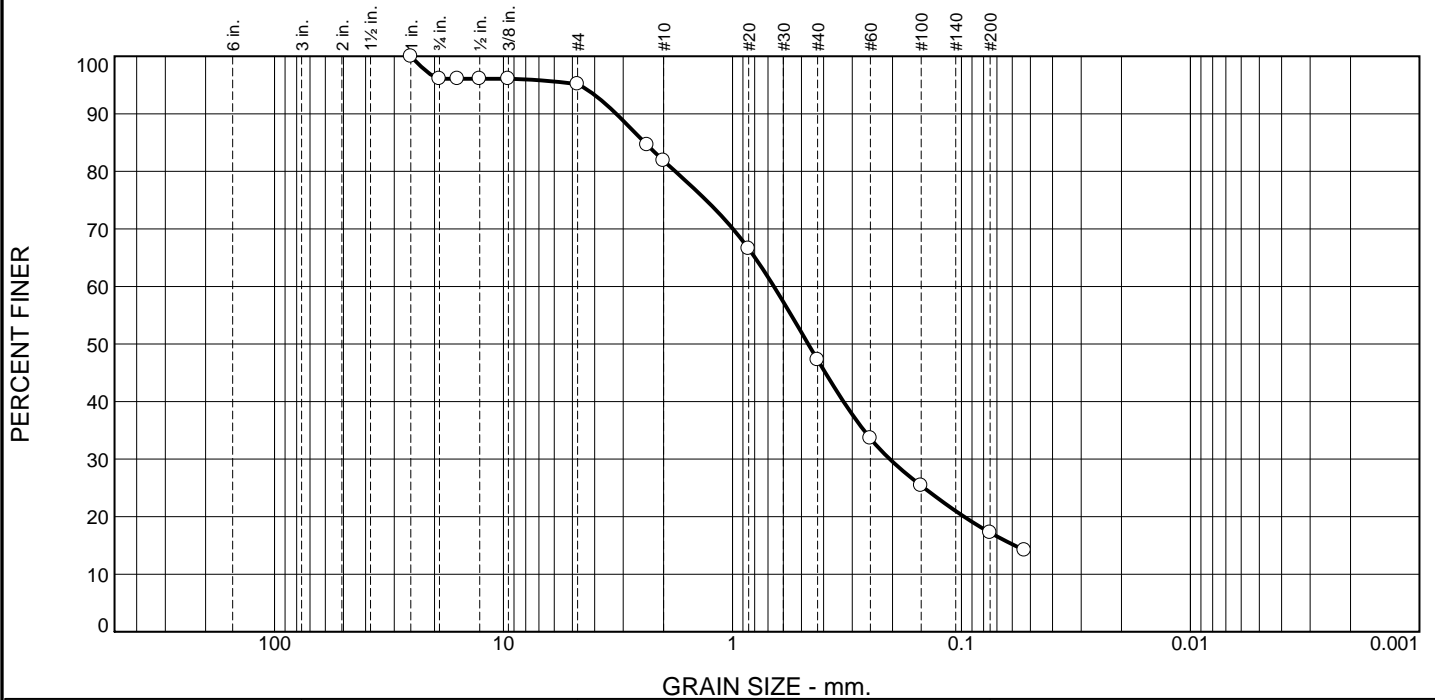
Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, some coarse SAND, trace gravel, trace silt; abundant fine organics; scattered rootlets (SP). | | | | | | | Stick up -4.4 to 0 feet Existing bioretention soils 0 to 0.8 feet |
| 1 | Hand | 1 | | | | | | | | | 3/8-inch bentonite chips 0.8 to 1.8 feet 1.25-inch I.D. threaded galvanized steel casing -4.4 to 0.1 feet; duct tape covers screen 0.1 to 2.1 feet |
| 2 | Hand | 2 | | | | | | | | | Medium grained silica sand 1.8 to 3.2 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 2.1 to 2.6 feet |
| 3 | Hand | 3 | | Import Sand Medium dense, moist, light brownish gray, medium to fine SAND, trace silt (SP). | | | | | | | Cast iron drive endcap 2.6 to 2.9 feet |
| 4 | Hand | 4 | | Vashon Advance Outwash Medium dense, moist, tannish brown, fine gravelly, fine to medium SAND, trace silt; light oxidation (SP). | | | | | | | Cast iron drivepoint 2.9 to 3.2 feet |
| 5 | Hand | 5 | | Medium dense, moist, tannish brown, fine gravelly, medium to fine SAND, trace silt (SP). | | | | | | | |
| 6 | Hand | 6 | | No seepage. No caving. Refusal due to gravel at 2.8 feet; wellpoint advanced to 3.2 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |

1/23/2024
20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 3.9 | 1.0 | 13.2 | 34.6 | 30.1 | 17.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 96.1 | | |
| 5/8" | 96.1 | | |
| 1/2" | 96.1 | | |
| 3/8" | 96.1 | | |
| #4 | 95.1 | | |
| #8 | 84.6 | | |
| #10 | 81.9 | | |
| #20 | 66.6 | | |
| #40 | 47.3 | | |
| #60 | 33.6 | | |
| #100 | 25.4 | | |
| #200 | 17.2 | | |
| #270 | 14.2 | | |

* (no specification provided)

Material Description

BSM
silty SAND, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.2184 D₈₅= 2.4141 D₆₀= 0.6592
D₅₀= 0.4668 D₃₀= 0.2057 D₁₅= 0.0585
D₁₀= C_u= C_c=

Remarks

Date Received: 7/15/2023 Date Tested: 9/7/2023

Tested By: FEW

Checked By: APJ/JHS

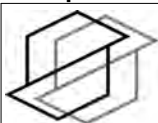
Title: _____

Location: Onsite - BV145

Sample Number: HA-2

Depth: 0-0.5'

Date Sampled: 7/15/2023



associated
earth sciences
incorporated

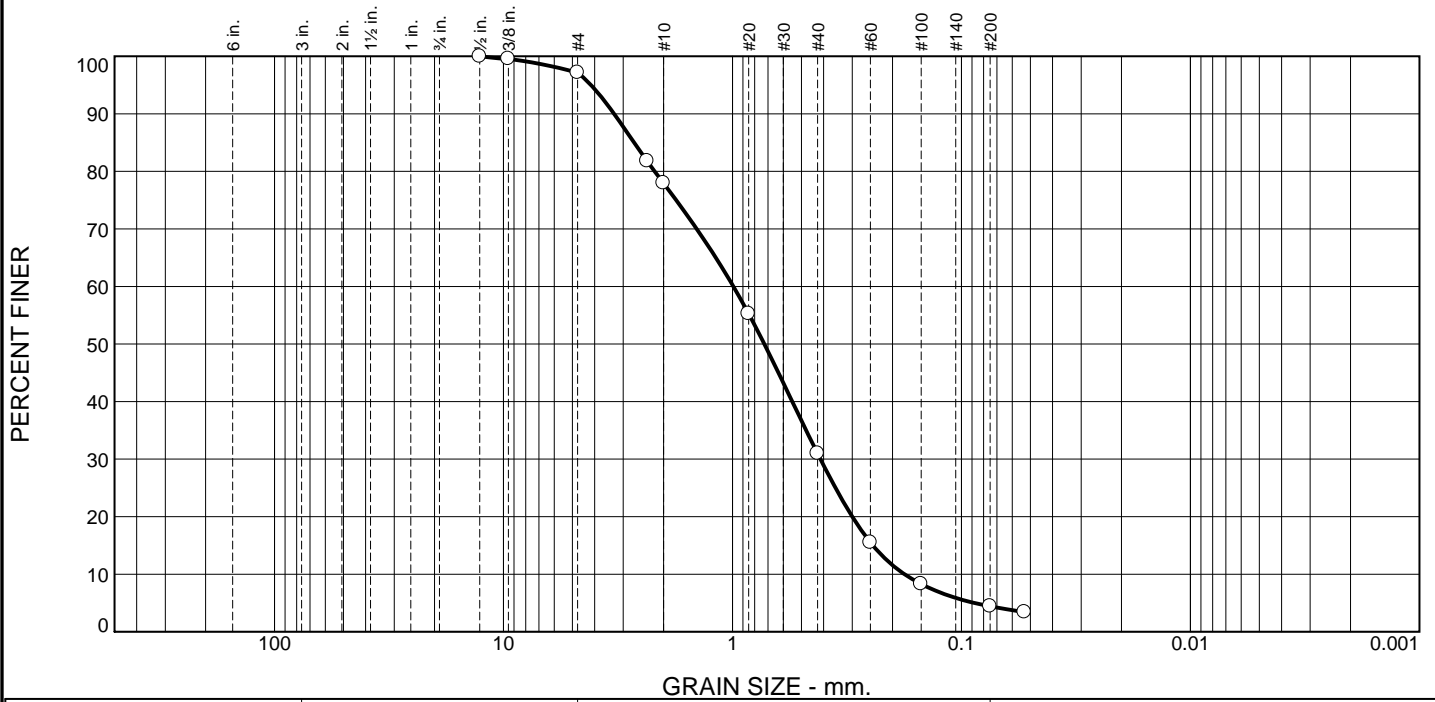
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.8 | 19.2 | 47.0 | 26.6 | 4.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.5 | | |
| #4 | 97.2 | | |
| #8 | 81.8 | | |
| #10 | 78.0 | | |
| #20 | 55.3 | | |
| #40 | 31.0 | | |
| #60 | 15.5 | | |
| #100 | 8.3 | | |
| #200 | 4.4 | | |
| #270 | 3.4 | | |

* (no specification provided)

Material Description

SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.2875 D₈₅= 2.6881 D₆₀= 0.9907
D₅₀= 0.7259 D₃₀= 0.4130 D₁₅= 0.2439
D₁₀= 0.1774 C_u= 5.59 C_c= 0.97

Remarks

Date Received: 7/15/2023 Date Tested: 9/05/2023

Tested By: FEW

Checked By: APJ/JHS

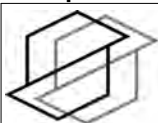
Title: _____

Location: Onsite - BV145

Sample Number: HA-3

Depth: 0.5'

Date Sampled: 7/15/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|---------------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 6/26/2023 | Project BHPS - Bellevue 145 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Bellevue, WA | EB/EP No. BV145-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0-0.5' | HA-3 @ 0.5' |
|--------------------|---------------|-------------|
| Wet Weight + Pan | 514.70 | 1307.95 |
| Dry Weight + Pan | 479.74 | 1222.65 |
| Weight of Pan | 100.80 | 357.97 |
| Weight of Moisture | 34.96 | 85.30 |
| Dry Weight of Soil | 378.94 | 864.68 |
| % Moisture | 9.23 | 9.86 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|---------|
| Dry Soil Before Burn + Pan | 821.70 | 1222.65 |
| Dry Soil After Burn + Pan | 790.00 | 1193.97 |
| Weight of Pan | 357.95 | 357.97 |
| Wt. Loss Due to Ignition | 31.70 | 28.68 |
| Actual Wt. Of Soil After Burn | 432.05 | 836.00 |
| % Organics | 6.84 | 3.32 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|--------------------------|--------------------------------|---|
| Project Name: | 145th PI (Raingarden #2) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) / FM-7 (50-300) |
| Date: | 6/28/2023 | Wetted Area (sq. feet): | 10:20: 142 ft ² / 13:40: 294 ft ² |
| Weather: | Clear, 80's | Underdrain: | Partial |
| Test No.: | IT-1 | Test Depth (feet): | 0.63 |
| Performed By: | APJ | Receptor Soils: | Vashon Advance Outwash |

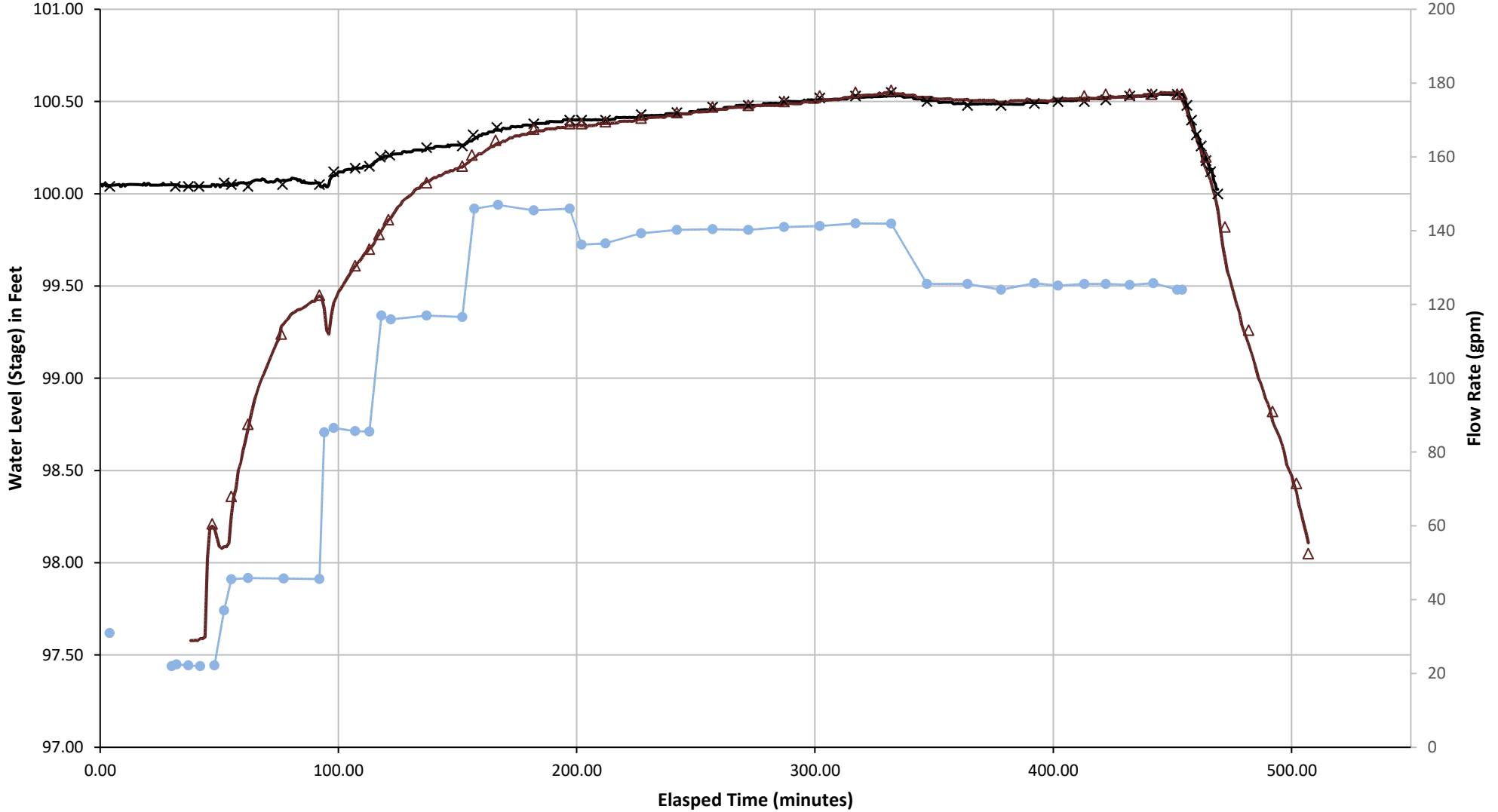
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|---|
| 8:58 | | | | | | Water on, wellpoint dry. |
| 9:02 | 31 | 0.04 | | | 100 | Leaky non-collapse hose |
| 9:03 | | | | | 130 | Water off |
| 9:10 | | | | | | Re-adjusting set up |
| 9:13 | | | | | | Water on, leaky non-collapse hose, water off again. |
| 9:28 | 22 | | | | 155 | Water on again |
| 9:30 | 22.48 | 0.04 | | | 187 | |
| 9:35 | 22.2 | 0.04 | 0.08 | | 298 | |
| 9:40 | 22 | 0.04 | 0.02 | | 410 | SG #2 some hydrocompaction, tape floating above ground surface |
| 9:43 | | | | | | Ponded area dried up |
| 9:45 | | | | 6.65 | | |
| 9:46 | 22.2 | | | | 554 | Increase flow to 37 gpm |
| 9:50 | 37.13 | 0.06 | 0.08 | | 683 | Increase flow to 44 gpm |
| 9:53 | 45.54 | 0.05 | 0.12 | 6.5 | 809 | |
| 10:00 | 45.86 | 0.04 | 0.14 | 6.11 | 1134 | Sediment accumulating behind SG1 |
| 10:15 | 45.72 | 0.05 | 0.13 | 5.62 | 1810 | |
| 10:30 | 45.64 | 0.05 | 0.14 | 5.41 | 2497 | Water off, switch to FM-7 |
| 10:32 | 85.36 | | | | | Water on |
| 10:36 | 86.58 | 0.12 | 0.2 | | 2802 | Water filling behind CB |
| 10:45 | 85.72 | 0.14 | 0.22 | 5.25 | 3597 | |
| 10:51 | 85.55 | 0.15 | 0.23 | 5.16 | 4091 | Increase flow to 116 gpm |
| 10:56 | 117.02 | 0.2 | 0.28 | 5.08 | 4646 | |
| 11:00 | 116 | 0.21 | 0.3 | 5 | 5120 | Abundant floating leaf litter observed |
| 11:15 | 117 | 0.25 | 0.33 | 4.8 | 6941 | |
| 11:30 | 116.6 | 0.26 | 0.36 | 4.71 | 8658 | Increase flow to 147 gpm |
| 11:35 | 146 | 0.32 | 0.4 | 4.65 | 9399 | Water flowing into P-1 |
| 11:45 | 147 | 0.36 | 0.44 | 4.57 | 10895 | |
| 12:00 | 145.55 | 0.38 | 0.47 | 4.51 | 13046 | |
| 12:15 | 146 | 0.4 | 0.49 | 4.48 | 15214 | CB=3.48 - some leakage in catch basin; decrease flow to 135 gpm |
| 12:20 | 136.24 | 0.4 | 0.49 | 4.48 | 15893 | |
| 12:30 | 136.6 | 0.4 | 0.48 | 4.47 | 17257 | Increase flow to 140 gpm |
| 12:45 | 139.3 | 0.43 | 0.51 | 4.45 | 19461 | |
| 13:00 | 140.25 | 0.44 | 0.53 | 4.42 | 21461 | |
| 13:15 | 140.42 | 0.47 | 0.55 | 4.39 | 23727 | |
| 13:30 | 140.25 | 0.48 | 0.56 | 4.38 | 25675 | |
| 13:45 | 141 | 0.5 | 0.59 | 4.36 | 27877 | CB=4.50 - trickle in catch basin |
| 14:00 | 141.25 | 0.52 | 0.6 | 4.33 | 29934 | |
| 14:15 | 142 | 0.53 | 0.62 | 4.31 | 32161 | |

| | | | | | | |
|-------|--------|------|------|------|---------|--|
| 14:30 | 141.9 | 0.55 | 0.63 | 4.3 | 34146 | Decrease flow to 125 gpm |
| 14:45 | 125.6 | 0.5 | 0.58 | 4.33 | 36032 | |
| 15:02 | 125.6 | 0.48 | 0.57 | 4.34 | 38161 | |
| 15:16 | 124 | 0.48 | 0.57 | 4.34 | 39927 | |
| 15:30 | 125.76 | 0.49 | 0.58 | 4.35 | 41675 | |
| 15:40 | 125.11 | 0.5 | 0.58 | 4.35 | 42920 | |
| 15:51 | 125.6 | 0.5 | 0.59 | 4.33 | 44297 | |
| 16:00 | 125.6 | 0.51 | 0.6 | 4.32 | 45427 | |
| 16:10 | 125.3 | 0.53 | 0.62 | 4.32 | 46685 | |
| 16:20 | 125.76 | 0.54 | 0.62 | 4.32 | 47939 | Observed outfall to street through non-design pipe. |
| 16:30 | 124 | 0.54 | 0.62 | 4.32 | 49197 | |
| 16:32 | 124 | 0.54 | 0.62 | 4.32 | 49445.3 | Water off |
| 16:34 | | 0.48 | 0.55 | | | |
| 16:36 | | 0.4 | 0.48 | | | |
| 16:38 | | 0.32 | 0.42 | | | |
| 16:40 | | 0.26 | 0.34 | | | |
| 16:42 | | 0.18 | 0.26 | 4.66 | | |
| 16:44 | | 0.12 | 0.18 | | | |
| 16:47 | | 0 | 0.1 | | | |
| 16:48 | | | 0.08 | | | |
| 16:50 | | | 0 | 5.04 | | |
| 17:00 | | | | 5.6 | | |
| 17:10 | | | | 6.04 | | flow in outfall about half as strong as flow during test |
| 17:20 | | | | 6.43 | | |
| 17:30 | | | | 6.81 | | flow in outfall a trickle |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 40.5 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 25.9 |
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 40.6 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 26.4 |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 41.4 |
| WP Average Infiltration Rate (in/hr) during falling head: | 30.9 |

Bellevue 145th PI (Raingarden #2) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

× Staff Gauge #1 Hand Data
— Staff Gauge #1 Logger
△ Wellpoint Hand
— Wellpoint Logger
● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and collects roof runoff from the adjacent Elementary school building. The cell is constructed with 3" of mulch above 1.5' of bioretention soil. The bioretention soil is underlain by the existing native subgrade, which was scarified prior to soil placement. The cell has an emergency overflow structure which sits 1' above the cell base. In addition to the overflow structure, a rock lined weir also sits 1' above the cell base which during overflow events is designed to convey water offsite to the neighboring wetland. All water conveyed to the cell is designed to infiltrate into the ground.

BIORETENTION SOIL

Thickness: 0.8-1.9'

The thickness of the loose bioretention soil based on hand augers and probe results ranged from 0.8-1.9' with an average thickness of 1.4'. This is nearly consistent with the 1.5' specified by the plans.

Composition: The plans call for the city of Bellevue's 2012 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation for the tested material was finer than the specification for the 2019 Ecology specification but the silt content was within the specified range. The organic matter content met the specifications for the 2019 standards.

Organic Matter Content (% by weight): 5.1

Percent passing #200 sieve: 4.8

Coefficient of Uniformity (Cu): 3.5

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense, moist, tan, gravelly, medium to fine SAND, trace silt (SP)

BUILT PER PLAN:

A non-engineered outlet pipe exists just south of the designed rock weir overflow. This is a 0.3' diameter crushed corrugated plastic pipe which sits underneath a tree log. The presence of the pipe allows for only 0.2' of ponded depth in the base of the cell before water enters the pipe. Because of the pipe's existence the designed overflow structures (beehive overflow and rock weir) are not used and the infiltrating area of the raingarden is limited to the southern half of the cell since ponded water will flow out the pipe instead of pooling in the slightly higher cell elevation to the north.

GROUNDWATER CONDITIONS:

No groundwater was observed during excavations of hand augers. The temporary wellpoint was screened from 1.8-2.3' below ground surface. The wellpoint responded to testing approximately fifteen minutes after the test began and water in the wellpoint rose to the surface water level approximately 2 hours after the test began.

INFILTRATION TEST RESULTS:

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #2

Assessed On:
 August 17, 2023



Bioretention Soil Rate (in/hr): >14.1
 Subgrade Soil Rate (in/hr): 14.1

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying Vashon Advance Outwash deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils. The flow rate was turned down approximately three hours after the start of testing as water was observed flowing laterally out of the cell through the non-designed overflow pipe.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The non-design overflow pipe is not specified by the plans and could be amended by maintenance.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---|
| Weather | Clear 70-80s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Samantha Seabury, Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 6 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 3 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230817-175218.jpg



Site Photo: FA_SitePhotos-20230817-175311.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #2

Assessed On:
 August 17, 2023



Site Photo: FA_SitePhotos-20230817-175334.jpg



Site Photo: FA_SitePhotos-20230817-175404.jpg



Site Photo: FA_SitePhotos-20230817-175451.jpg

Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Several small sprinklers are located around the perimeter of the rain garden, none in base of cell. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| <p>Additional Comments</p> <p>Water is conveyed to the cell from 3 paired rain leaders with associated rain garden outfall structures that drain the surrounding rooves and enter the rain garden either through a metal spout directly from the wall of the building, or through the designed rain garden rock outfall structures. Water is designed to infiltrate through the bioretention soil before reaching the underlying scarified substrate. There are two rain garden overflow structures both designed to allow a maximum storage capacity of 1 foot depth. The first is a bee-hive grate catch basin located on the south end of the cell, the second is a 3-foot-wide berm weir lined with outfall rock on the northeast edge of the cell. The weir and the outlet pipe from the catch basin are shown to convey water to the stream outfall structure which is lined with large cobbles and drains to the stream restoration area.</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.32'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230817-185428.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Pipe drains the roof and discharges onto 0.4 foot diameter stream cobbles about 1.7 feet above ground service. Abundant pine needles from roof have mostly buried the cobbles.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)

Cell: Rain Garden #2

Assessed On:

August 17, 2023



IN-2

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230817-190713.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment
- Organic
- Rock
- Trash
- Vegetation

Additional Details: The blockage fills most of the pipe and had to be dug out to acquire data. There is 3 inches of head from blockage to top of the aluminum pipe.



FA_INBLPhoto-20230817-190638.jpg

Additional Details: Angled cut corrugated aluminum pipe with trash rack on top pipe is 50% buried in soils and plant debris. Any energy dissipation would be completely buried. Design notes a 3 foot diameter pad of outfall rock lined with geotextile fabric under each rain garden rock outfall structure.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.4'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230817-191010.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Man hole cover is underneath, acts almost as a splash apron, the man hole cover has 0.4 foot diameter stream cobbles all around it.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



IN-4

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230817-191249.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: PVC pipe connected to an angled cut, corrugated aluminum trash rack. Stream cobbles are almost completely buried. Design notes a 3 foot diameter pad of outfall rock lined with geotextile fabric under each rain garden rock outfall structure.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



IN-5

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.4'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230817-191519.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Man hole cover set in concrete underneath the pipe acts almost as a splash apron, with 0.4 foot diameter stream cobbles all around.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)

Cell: Rain Garden #2

Assessed On:

August 17, 2023



IN-6

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230817-191831.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Soils and plant debris causing some blockage, any energy dissipation is buried.



FA_INBLPhoto-20230817-191820.jpg

Additional Details: PVC pipe connected to an angled cut , corrugated aluminum trash rack. Stream cobbles are completely buried. Design notes a 3 foot diameter pad of outfall rock lined with geotextile fabric under each rain garden rock outfall structure.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023




Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.67' Width: 1.29' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.3 Relative from staff gauge: 1.5 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |



FA_DOPhoto-20230817-192516.jpg

| | |
|--|-------------|
| DO - 2 | |
| Shape: <input type="checkbox"/> Round <input type="checkbox"/> Rectangular <input checked="" type="checkbox"/> Other: Rock weir with designed stream outfall | Dimensions: |
| Additional Details: Total width is about 8 feet, the base of the weir is roughly 3 feet where the water is designed to flow through gaps between small boulders with diameters of about 2 feet combined with cobbles of about 3 inch diameter. | |
| Stickup (ft) From Ground: 0.4 Relative from staff gauge: 0.7 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |




FA_DOPhoto-20230817-193934.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



| | |
|---|---|
| DO - 3 | |
| Shape: <input type="checkbox"/> Round Dimensions: <input type="checkbox"/> Rectangular <input checked="" type="checkbox"/> Other: Crushed 0.3 diameter pipe Additional Details: Non-engineered, crushed, corrugated plastic pipe at base of cell, midway between overflow catch basin and overflow weir structure, beneath a placed log that holds up the east side of cell. |  <p>IMG_0481.jpg</p> |
| Stickup (ft) From Ground: 0.2 Relative from staff gauge: 0.2 | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No This pipe bypasses the designed overflow structures and renders more than half of the cell ineffectual. This pipe allows for only 0.2 feet of ponded depth before overflowing. | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input type="checkbox"/> No | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|--|--|---|-------------------------------------|---------------------------------------|---|
| Mulch: | <input checked="" type="checkbox"/> None | <input type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth (ft): |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| There is 0.2 feet of thick natural mulch, pine needles and Douglas fir pine cones that cover the base and sides of the rain garden. Minimal garbage was observed. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Additional Details: | | | | | |
| Vegetation Description | | | | | |
| The cell is densely vegetated with about 75% coverage. This vegetation limits access points of some parts of cell, mainly the central and northern portions of the cell. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 0.8-1.9 feet of bioretention soil, with an average of 1.4 feet of soil before encountering the underlying Vashon Advance Outwash deposits. This is consistent with the 1.5 feet of bioretention soil at the base of the cell as specified by the plans. On the cell edges, probe measurements found 0.4-1.8 feet of soil encountered above native soils. This deviates from the cell design | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #2

Assessed On:
 August 17, 2023



which shows a gentle slope with bioretention soil thickness tapering near the edges. No zones of compaction were observed.

Hand Auger

| | |
|--|---|
| BVCC2-HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 2.6 |
| Rain/Garden Mix Soil Texture: Loose slightly moist dark brown fine to medium SAND; some coarse sand, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: Medium dense, moist, tan, gravelly, fine to medium SAND, trace silt (SP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
|  <p>FA_FPhoto-20230817-225157.jpg</p>  <p>FA_FPhoto-20230817-155613.jpg</p> | |
| Additional Details | |
| Observed a response in the WellPoint immediately after water was turned on for the test. | |

| | |
|---|--|
| BVCC2-HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



| | |
|---|---|
| BVCC2-HA-2 | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 0.9 |
| to Import/Underdrain: | |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Loose slightly moist dark brown fine to medium SAND; some coarse sand, some fine gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: Medium dense, moist, tan, gravelly, fine to medium SAND, trace silt (SP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  <p>FA_FPhoto-20230817-160312.jpg</p> | |
| Additional Details | |

| | |
|---|---|
| BVCC2-HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Loose slightly moist dark brown fine to medium SAND; some coarse sand, trace gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: Medium dense, moist, tan, gravelly, fine to medium SAND, trace silt (SP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  <p>FA_FPhoto-20230817-160746.jpg</p> | |
| Additional Details | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #2

Assessed On:
August 17, 2023



Infiltration Test

| | |
|--|--------|
| IT-2 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 119 |
| Ponded Depth (ft) | 0.1 |
| Total Gallons | 16,855 |
| Steady State Flow Rate (GPM) | 17 |
| Additional Details: Midway through the test AESI personnel noticed the ponded area made it to a non-engineered outlet described in more detail as outlet 3. Field personnel reduced flow significantly as to not overflow into this non-engineered outlet. This reduced the ponded area and depth significantly. Additional test details can be found in the executive summary. | |
|  | |

IT_Photo-20230818-000724.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)

Cell: Rain Garden #2

Assessed On:

August 17, 2023

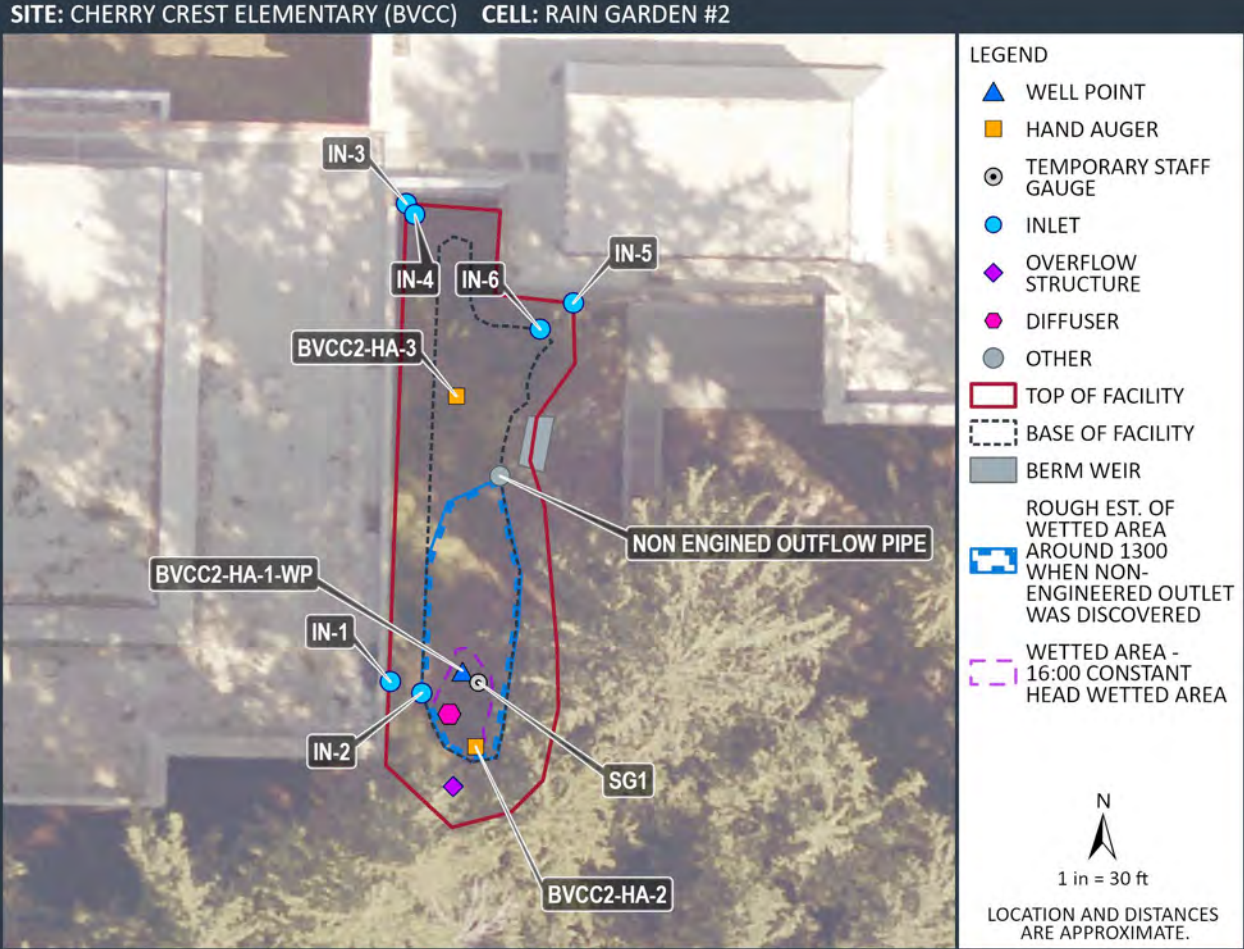


Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #2

Assessed On:
 August 17, 2023





associated
earth sciences
incorporated

Well Point

BVCC-2-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations
20150387H008

Start Date: 8/17/23
Ending Date: 8/17/23

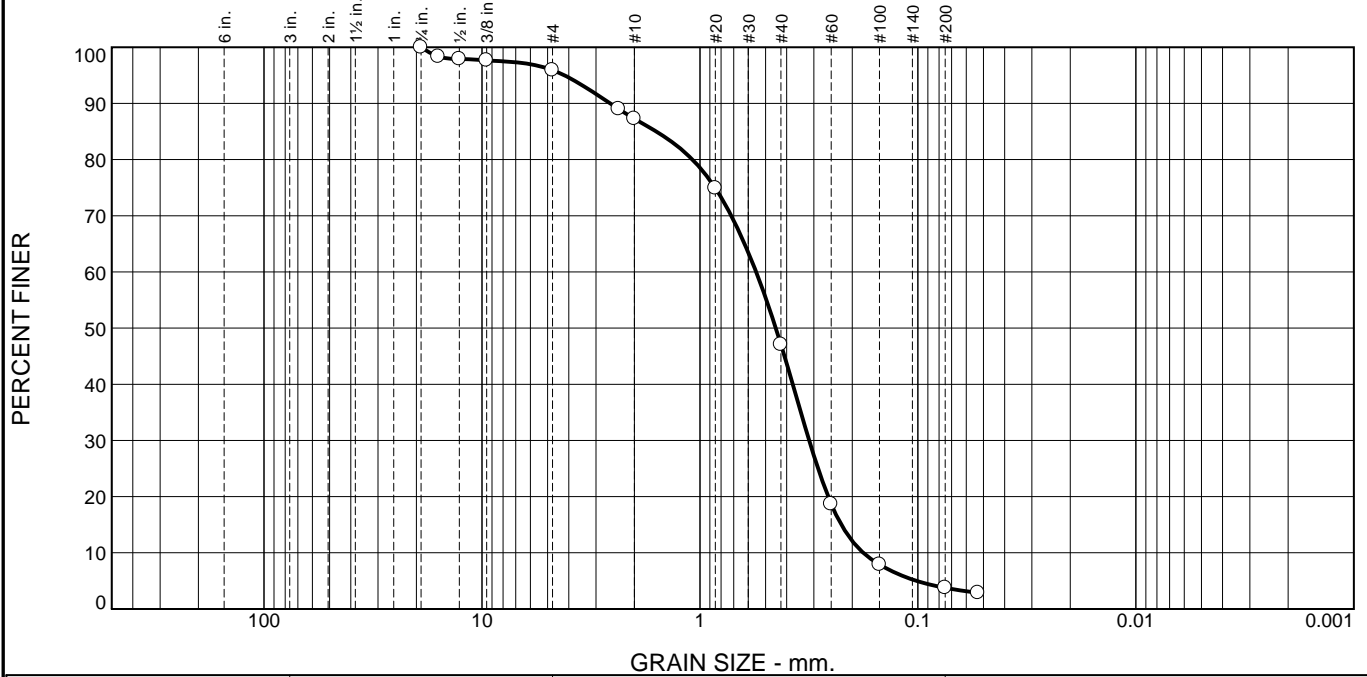
Logged By: SNCF/CSI/SS
Approved By: JHS

Driller/Equipment: Hand Auger
Hammer Weight/Drop: N/A
Hole Diameter (in): 4
Ground Surface Elevation (ft): 100
Water Level Elevation (ft): N/A
Total Depth (ft): 2.6
Well Completion Depth (ft): 2.9
Well Tag No.: N/A
Top of Well Casing Elevation (ft): 104.8
Datum: Project Datum
Groundwater Depth ATD (ft): Not encountered
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Natural mulch, pine needles. | | | | | | | Stick up -4.8 to 0 feet Bioretention soil mix 0 to 1 feet 1.25-inch I.D. threaded galvanized steel casing -4.8 to 0.3 feet; duct tape covers screen 0.3 to 1.8 feet 3/8-inch bentonite chips 1 to 1.2 feet Medium grain sand 1.2 to 2.6 feet 1.25-inch stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.8 to 2.3 feet Cast iron endcap 2.3 to 2.6 feet Native sand 2.6 to 2.9 feet Cast iron drivepoint 2.6 to 2.9 feet |
| 1 | | | | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, trace silt; abundant organics (SP-SM). | | | | | | | |
| 2 | | | | Vashon Advance Outwash Medium dense, moist, tan, gravelly, medium to fine SAND, trace silt (SP). Dense, moist, tan, fine SAND, some silt, trace gravel (SP). | | | | | | | |
| 3 | | | | No seepage. No caving. Refusal at 2.6 feet Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/29/2024
20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 4.1 | 8.6 | 40.2 | 43.3 | 3.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 98.3 | | |
| 1/2" | 97.9 | | |
| 3/8" | 97.7 | | |
| #4 | 95.9 | | |
| #8 | 89.0 | | |
| #10 | 87.3 | | |
| #20 | 74.9 | | |
| #40 | 47.1 | | |
| #60 | 18.7 | | |
| #100 | 7.9 | | |
| #200 | 3.8 | | |
| #270 | 2.8 | | |

Material Description
SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)
 PL= _____ LL= _____ PI= _____

Classification
 USCS (D 2487)= SP AASHTO (M 145)= _____

Coefficients
 D₉₀= 2.5821 D₈₅= 1.5888 D₆₀= 0.5525
 D₅₀= 0.4488 D₃₀= 0.3153 D₁₅= 0.2246
 D₁₀= 0.1783 C_u= 3.10 C_c= 1.01

Remarks

Date Received: 8-17-2023 Date Tested: 10-20-2023

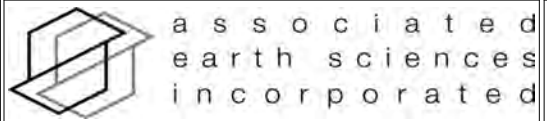
Tested By: FEW

Checked By: SNCF/CSI/JS

Title: _____

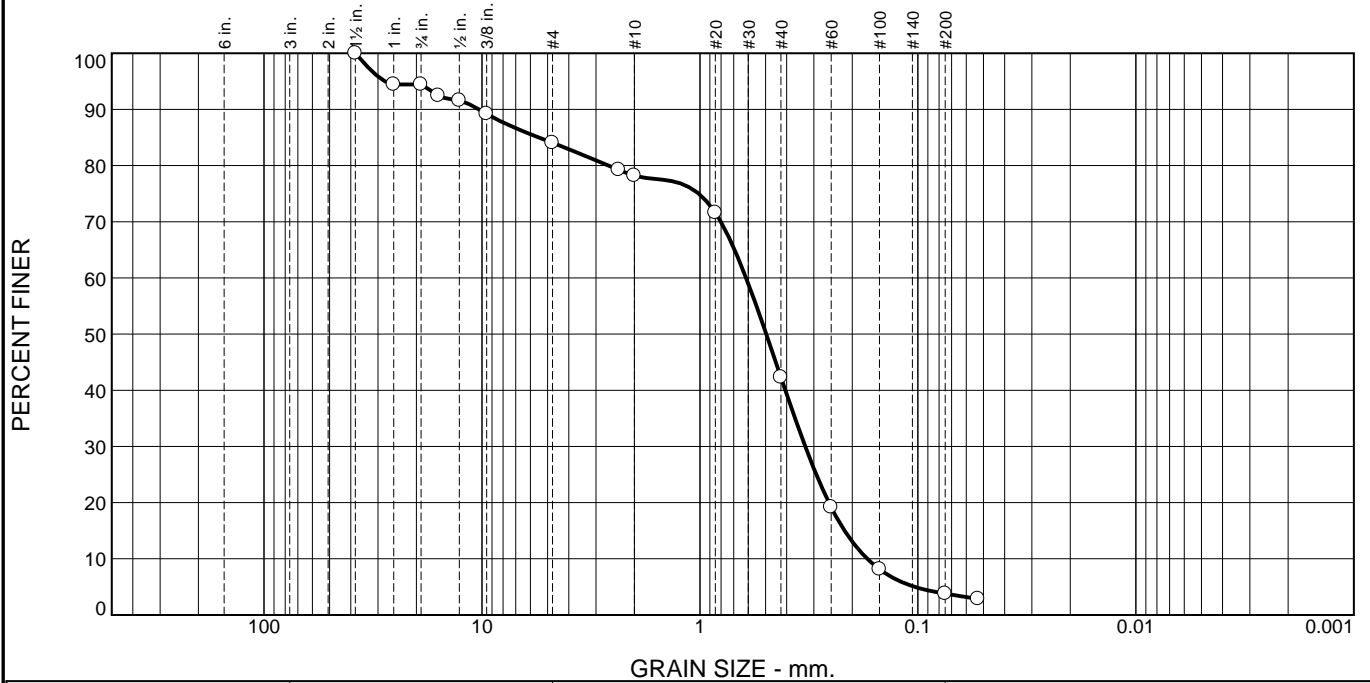
* (no specification provided)

Location: Onsite - BVCC-2 Date Sampled: 8-17-2023
 Sample Number: HA-1 Depth: 0.2-1.4'



Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study
 Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.6 | 10.3 | 5.9 | 35.9 | 38.5 | 3.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 94.4 | | |
| 3/4" | 94.4 | | |
| 5/8" | 92.4 | | |
| 1/2" | 91.6 | | |
| 3/8" | 89.2 | | |
| #4 | 84.1 | | |
| #8 | 79.2 | | |
| #10 | 78.2 | | |
| #20 | 71.6 | | |
| #40 | 42.3 | | |
| #60 | 19.2 | | |
| #100 | 8.1 | | |
| #200 | 3.8 | | |
| #270 | 2.9 | | |

* (no specification provided)

Material Description

Gravelly SAND trace silt

Atterberg Limits (ASTM D 4318)

PL= _____ LL= _____ PI= _____

Classification

USCS (D 2487)= SP AASHTO (M 145)= _____

Coefficients

D₉₀= 10.3218 D₈₅= 5.4838 D₆₀= 0.6142
D₅₀= 0.4964 D₃₀= 0.3285 D₁₅= 0.2170
D₁₀= 0.1707 C_u= 3.60 C_c= 1.03

Remarks

Date Received: 8-17-2023 Date Tested: 10-20-2023

Tested By: FEW

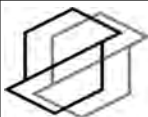
Checked By: SNCF/CSI/JS

Title: _____

Location: Onsite - BVCC-2
Sample Number: HA-1

Depth: 1.4-1.9'

Date Sampled: 8-17-2023



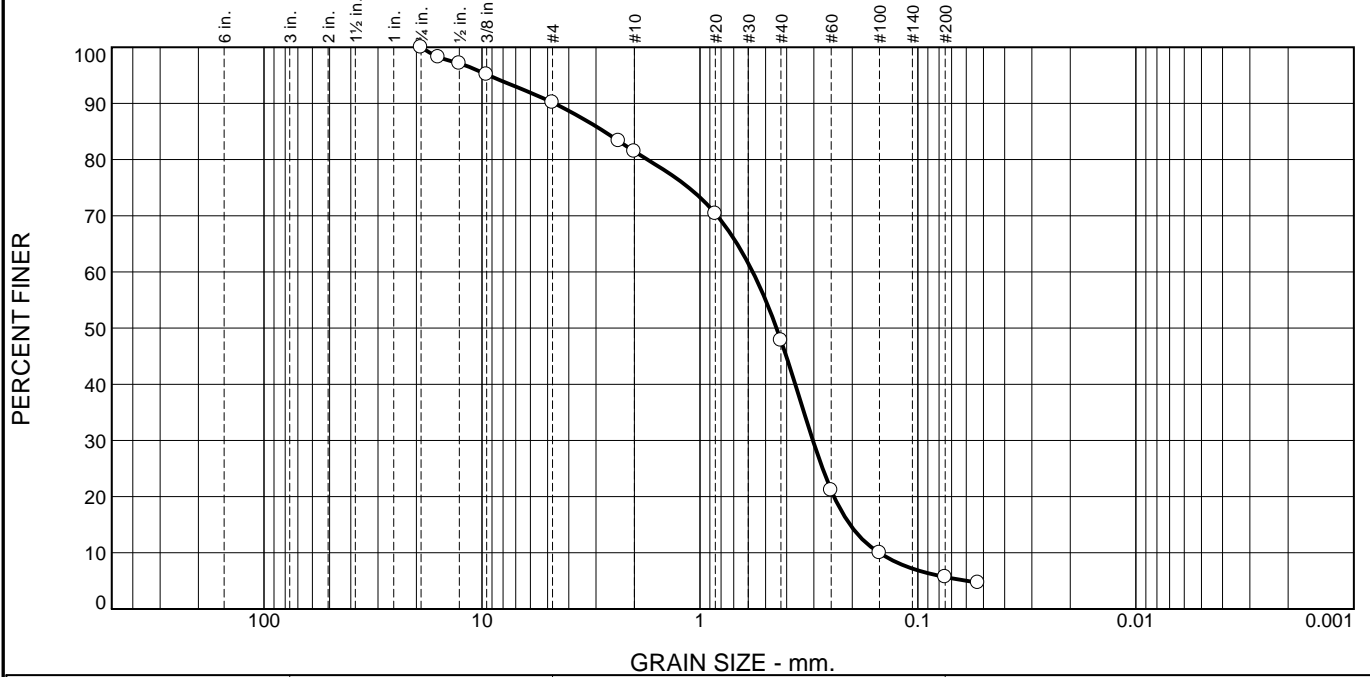
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.8 | 8.7 | 33.7 | 42.1 | 5.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 98.3 | | |
| 1/2" | 97.1 | | |
| 3/8" | 95.2 | | |
| #4 | 90.2 | | |
| #8 | 83.3 | | |
| #10 | 81.5 | | |
| #20 | 70.4 | | |
| #40 | 47.8 | | |
| #60 | 21.1 | | |
| #100 | 10.0 | | |
| #200 | 5.7 | | |
| #270 | 4.7 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 4.6604 | D ₈₅ = 2.7518 | D ₆₀ = 0.5726 |
| D ₅₀ = 0.4451 | D ₃₀ = 0.3031 | D ₁₅ = 0.2049 |
| D ₁₀ = 0.1502 | C _u = 3.81 | C _c = 1.07 |

Remarks

Date Received: 8-17-2023 Date Tested: 10-18-2023

Tested By: FEW

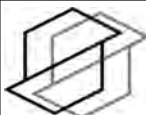
Checked By: APJ/JHS

Title: _____

Location: Onsite - BVCC-2
 Sample Number: HA-2

Depth: .2-.9'

Date Sampled: 8-17-2023



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 earth sciences
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Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|---------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/1/2023 | Project BHPS - BVCC-2 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellevue, WA. | EB/EP No. BVCC-2-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.2-1.4' | HA-2 @ 0.2-0.9' |
|--------------------|-----------------|-----------------|
| Wet Weight + Pan | 937.99 | 936.52 |
| Dry Weight + Pan | 897.59 | 896.56 |
| Weight of Pan | 247.05 | 247.55 |
| Weight of Moisture | 40.40 | 39.96 |
| Dry Weight of Soil | 650.54 | 649.01 |
| % Moisture | 6.21 | 6.16 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 897.59 | 896.56 |
| Dry Soil After Burn + Pan | 872.77 | 855.65 |
| Weight of Pan | 247.05 | 247.55 |
| Wt. Loss Due to Ignition | 24.82 | 40.91 |
| Actual Wt. Of Soil After Burn | 625.72 | 608.10 |
| % Organics | 3.82 | 6.30 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|--|--------------------------------|---|
| Project Name: | Cherry Crest Elementary School-Raingarden #2 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM 6 (10-100) |
| Date: | 8/17/2023 | Wetted Area (sq. feet): | 11:00: 276.9 ft^2 / 14:15: 113.7 ft^2 / 16:00: 119.1 ft^2 |
| Weather: | Clear, 70's | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.32 |
| Performed By: | SNCF / SS rep 2 CSI | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|-------------|----------------------|---------------------|---|
| 10:00 | 0 | 0 | 4.58 | | 0 | Water on |
| 10:02 | 53.77 | | | | 70.82 | |
| 10:04 | 53.88 | 0.04 | 4.58 | | 178 | |
| 10:15 | 54.9 | 0.12 | 4.59 | 5.11 | 777 | |
| 10:30 | 54 | 0.14 | 4.63 | 4.92 | 1595 | |
| 10:45 | 54.4 | 0.16 | 4.6 | 4.85 | 2407 | |
| 11:00 | 54.78 | 0.2 | 4.62 | 4.83 | 3222 | Staff gauge was reset due to falling over |
| 11:15 | 55 | 0.22 | 4.66 | 4.81 | 4078 | Water is halfway through cell |
| 11:25 | | | 4.58 | | | Catch Basin static |
| 11:30 | 53.6 | 0.24 | 4.58 | 4.76 | 4855 | Flow up ~75 gpm to get to 1 ft depth |
| 11:45 | 71.5 | 0.26 | 4.59 | 4.74 | 5935 | |
| 12:00 | 72.1 | 0.26 | 4.58 | 4.74 | 7013 | |
| 12:15 | 72.3 | 0.26 | 4.58 | 4.71 | 8091 | Flow up to 90 gpm |
| 12:30 | 89.32 | 0.3 | 4.58 | 4.68 | 9288 | |
| 12:46 | 98.1 | 0.3 | 4.58 | 4.65 | 10715 | |
| 13:00 | 90.2 | 0.32 | 4.58 | 4.64 | 11971 | |
| 13:15 | 37.58 | | 4.58 | | 12892 | Water was escaping in hole, flow rate turned down to 17 gpm |
| 13:33 | 17.5 | 0.1 | 4.58 | 4.88 | 13253 | |
| 13:45 | 17.5 | 0.08 | 4.58 | 4.91 | 13462 | |
| 14:00 | 17.4 | 0.08 | 4.58 | 4.95 | 13720 | |
| 14:15 | 17.4 | 0.08 | 4.58 | 4.97 | 13986 | |
| 14:30 | 17.48 | 0.08 | 4.58 | 4.96 | 14248 | |
| 14:45 | 17.5 | 0.08 | 4.58 | 4.97 | 14505 | |
| 15:00 | 17.5 | 0.08 | 4.58 | 4.98 | 14765 | |
| 15:15 | 17.1 | 0.09 | 4.58 | 4.98 | 15029 | |
| 15:30 | 17.5 | 0.09 | 4.59 | 4.97 | 15291 | |
| 15:45 | 17.6 | 0.09 | 4.57 | 4.97 | 15555 | |
| 16:00 | 17.4 | 0.1 | 4.57 | 4.97 | 15811 | |
| 16:11 | 17.6 | 0.1 | 4.57 | 4.97 | 16019 | |
| 16:21 | 17.4 | 0.1 | 4.58 | 4.96 | 16192 | |
| 16:30 | 17.2 | 0.1 | 4.56 | 4.95 | 16350 | |
| 16:40 | 17.2 | 0.1 | 4.58 | 4.96 | 16508 | |
| 16:50 | 17.3 | 0.1 | 4.58 | 4.97 | 16680 | |
| 17:00 | 17.3 | 0.1 | 4.58 | 4.97 | 16855 | Water Off |
| 17:01:00 | | 0.06 | | | | |
| 17:02:00 | | 0.05 | | | | |
| 17:02:30 | | 0.04 | | | | |
| 17:02:45 | | 0.02 | | | | |

| | | | | | |
|----------|--|------|--|------|--|
| 17:03:00 | | 0.01 | | | |
| 17:04 | | 0 | | 5.09 | |
| 17:06 | | | | 5.14 | |
| 17:09 | | | | 5.37 | |
| 17:10 | | | | 5.41 | |
| 17:11 | | | | 5.43 | |
| 17:13 | | | | 5.5 | |
| 17:17 | | | | 5.6 | |
| 17:30 | | | | 5.87 | |
| 17:35 | | | | 5.89 | |
| 17:40 | | | | 5.92 | |
| 17:48 | | | | 5.99 | |
| 17:57 | | | | 6.05 | |
| 18:00 | | | | 6.08 | |

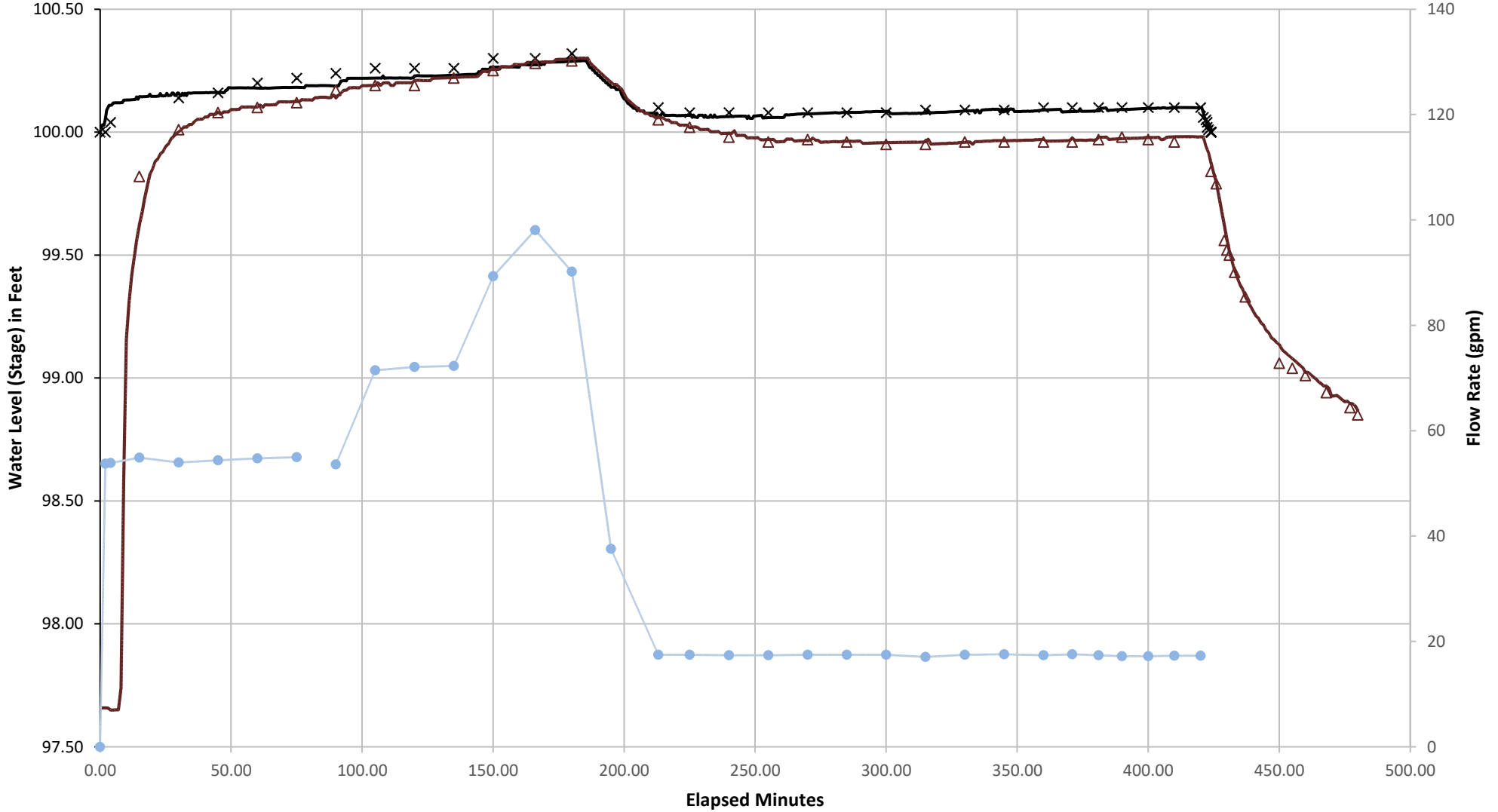
| | |
|---|------|
| SG-1: Average Infiltration Rate (in/hr) during last hour of inflow: | 14.1 |
| SG-1: Average Infiltration Rate (in/hr) during falling head (hand): | 17.3 |
| SG-1: Average Infiltration Rate (in/hr) during falling head (logger): | 21.9 |

| | |
|---|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 14.1 |
| WP Average Infiltration Rate (in/hr) during falling head 17:00-17:17: | 26.7 |

| | |
|---|-----|
| WP Average Infiltration Rate (in/hr) during falling head 17:17-18:00: | 8.0 |
|---|-----|

Cherry Crest Elementary Raingarden 2 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
 - △ Wellpoint Hand
 - Flow Rate (gpm)
- Staff Gauge #1 Logger
 - Wellpoint Logger

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #1

Assessed On:
August 1, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and collects roof runoff from the adjacent Elementary school building. The cell is constructed with 3" of mulch above 1.5' of bioretention soil. The bioretention soil is underlain by the existing native subgrade, which was scarified prior to soil placement. The cell has an emergency overflow structure which sits 1' above the cell base. All water conveyed to the cell is designed to infiltrate into the ground.

BIORETENTION SOIL

Thickness: 1.1-1.5'

The apparent thickness of the loose bioretention soil ranges from 1.1-1.5' based on hand auger and probe results with an average depth of 1.3', slightly less than the 1.5' specified by the plans.

Composition: The plans call for the city of Bellevue's 2012 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation for the tested material was finer than the specification for the 2019 Ecology specification but the silt and organic content was within the specified range.

Organic Matter Content (% by weight): 5.4

Percent passing #200 sieve: 3.1

Coefficient of Uniformity (Cu): 2.6

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense, moist, light brown, fine SAND, some silt, trace gravel (SP-SM)

BUILT PER PLAN: Built Per Plan

The cell was generally consistent with the design plans besides the relative elevation of the overflow structure which was positioned 1' higher than the plans.

GROUNDWATER CONDITIONS: Groundwater Conditions

No groundwater was observed during excavations of hand augers. The temporary wellpoint was screened from 2.1-5' below ground surface. The wellpoint responded to testing approximately six hours after the test began. The water level in the wellpoint rose to 4' below ground surface.

INFILTRATION TEST RESULTS: Infiltration Test Results

Bioretention Soil Rate (in/hr): >5.6

Subgrade Soil Rate (in/hr): 5.6

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying Vashon Advance Outwash deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #1

Assessed On:
 August 1, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:
 The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|-------------------------|
| Weather | Clear, 70's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Alex Johanson |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230801-181423.jpg



Site Photo: FA_SitePhotos-20230801-181449.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #1

Assessed On:
August 1, 2023



Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation of this cell consists of 5 small sprinklers along the perimeter of the raingarden. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 75% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments The rain garden is tucked in between buildings on 3 sides, water is conveyed to the cell from a roof drain and sheet flow from the pervious pavement sidewalk that surrounds cell for roughly 75% of the cell. Due to the rain garden being mostly surrounded by the building, the sheet flow from the sidewalk provides minimal volumes of runoff. Water is designed to infiltrate through the bioretention soil into the underlying scarified subgrade. The overflow catch basin is designed to provide a maximum storage capacity of 1 foot depth, however the overflow structure was installed 1.08 feet higher than designed (2.08 feet above staff gauge zero), which based on field observations, will likely cause water to pond against the walls of the building before entering the overflow structure. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #1

Assessed On:
August 1, 2023



Inlets

IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 105'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230801-190633.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Abundant ferns on edges cause a build up sediment, it appears the flow into cell can occur around ferns.



FA_INBLPhoto-20230801-190612.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #1

Assessed On:
August 1, 2023



IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Energy Dissipation
Angular Rock: n/a
Stream Cobble: Buried
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: Functioning



FA_INphoto-20230801-191515.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 90% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Vegetative matter almost fully buries stream cobbles along the concrete dispersion from the roof pipe.



FA_INBLPhoto-20230801-191454.jpg

Additional Details: The rain garden outfall pipe from the roof pours onto the sidewalk, then sheet flows into the cell where there are thickly buried river cobbles placed along edge of sidewalk within the cell for about 4 feet.


BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #1

Assessed On:
 August 1, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.8' Width: 1.5' |
| Additional Details: | |
| Stickup (ft) From Ground: 1.5 Relative from staff gauge: 2.08 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 5% blocked Additional Details: Moss blocks a minimal portion of the trash rack. | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 5% blocked Additional Details: Moss blocks a minimal portion of the overflow structure. | |
|  | |
| FA_DOPhoto-20230801-192538.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|--------------------------------|--|--|------------------------------------|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | | |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| There is an abundant natural mulch layer, pine needles and leaf material occur about 0.1 to .2 feet thick over all of cell base. Grasses, ferns, and small shrubs cover about 40% of cell. Some trash is present in cell. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Animal Plant Damage | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Additional Details: Rodent burrows and droppings are evident in the cell, rabbits were observed in the area. Animal droppings could potentially be deer droppings as well. | | | | | | |
| Vegetation Description | | | | | | |
| There are abundant ferns, shrubs, and Douglas maple trees growing in the rain garden. The vegetation provided some, but minimal hinderance to our work. | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.1-1.5' of bioretention soil before encountering the denser sands of the native soil. Average probe measurements of the base were 1.3'. This is slightly less than the 1.5' specified by the plans. On the cell edges, 0.9-1.2' of soil was encountered above native soils. This is consistent with the cell design which shows a unspecified gentle slope with slightly tapering of amended compost raingarden soil above the existing subgrade. No zones of compaction were observed. | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #1

Assessed On:
 August 1, 2023



Hand Auger

| | |
|--|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.2 |
| to Import/Underdrain: | |
| Total Depth: | 5.3 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist to moist, dark brown, fine to medium SAND, trace grave, trace silt, abundant organics (SP) Native Soil Texture: Medium dense, light brown, moist, fine SAND, some silt, trace gravel (SP-SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 3.92 | |
| Additional Details The Wellpoint was left overnight as ponded area did not infiltrate within 1 hour of shutting off the water. | |



FA_FPhoto-20230801-221133.jpg



IMG_0402.jpg

| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 2.2 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist to moist, dark brown fine to medium SAND, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: (Vashon Advance Outwash) Medium dense, light brown, moist, fine SAND, some silt, trace gravel (SP-SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |



IMG_0401.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
 Cell: Rain Garden #1


Assessed On:
 August 1, 2023



| | |
|--------------------|--|
| HA-2 | |
| Additional Details | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.2 |
| to Import/Underdrain: | |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown fine to medium SAND, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: (Vashon Advance Outwash) Medium dense, light brown, moist, fine SAND, some silt, trace gravel (SP-SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| Additional Details | |

Infiltration Test

| | |
|---|--------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 | |
| Wetted Pond Area (sq. ft) | 751 |
| Ponded Depth (ft) | 0.89 |
| Total Gallons | 24,477 |
| Steady State Flow Rate (GPM) | 43 |
| Additional Details: | |
| WellPoint and SG-1 were left in cell over night due to slow infiltration rate. Data loggers retrieved the following day. Additional test details can be found in the executive summary. | |
|  | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)
Cell: Rain Garden #1

Assessed On:
August 1, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Cherry Crest Elementary (BVCC)

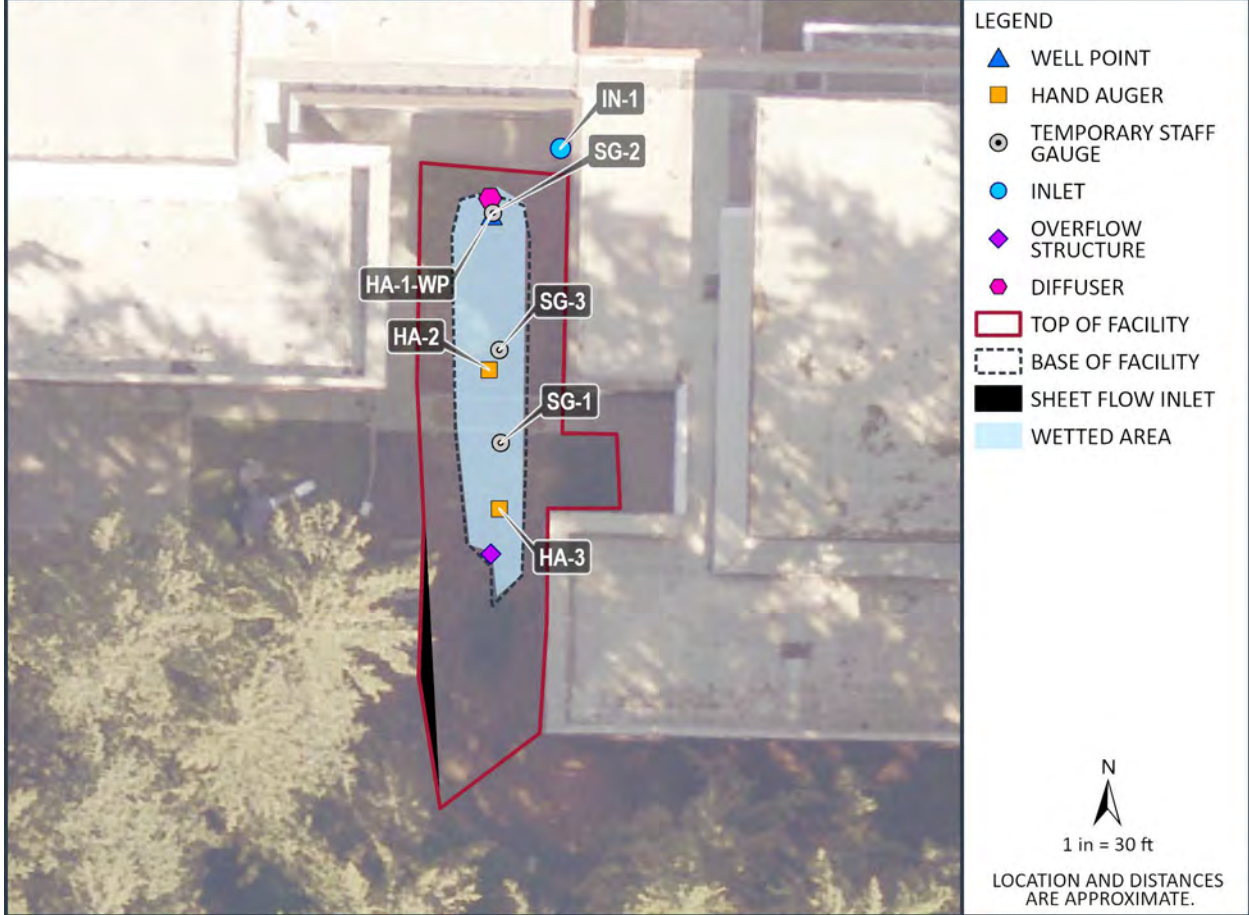
Cell: Rain Garden #1

Assessed On:

August 1, 2023



SITE: CHERRY CREST ELEMENTARY (BVCC) CELL: RAIN GARDEN #1





associated
earth sciences
incorporated

Well Point

BVCC-1-HA-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/1/2023

Logged By: APJ

20150387H008

Ending Date: 8/1/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 5.1

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 5.6

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 102.2

Water Level Elevation (ft): N/A

Datum: Project Datum

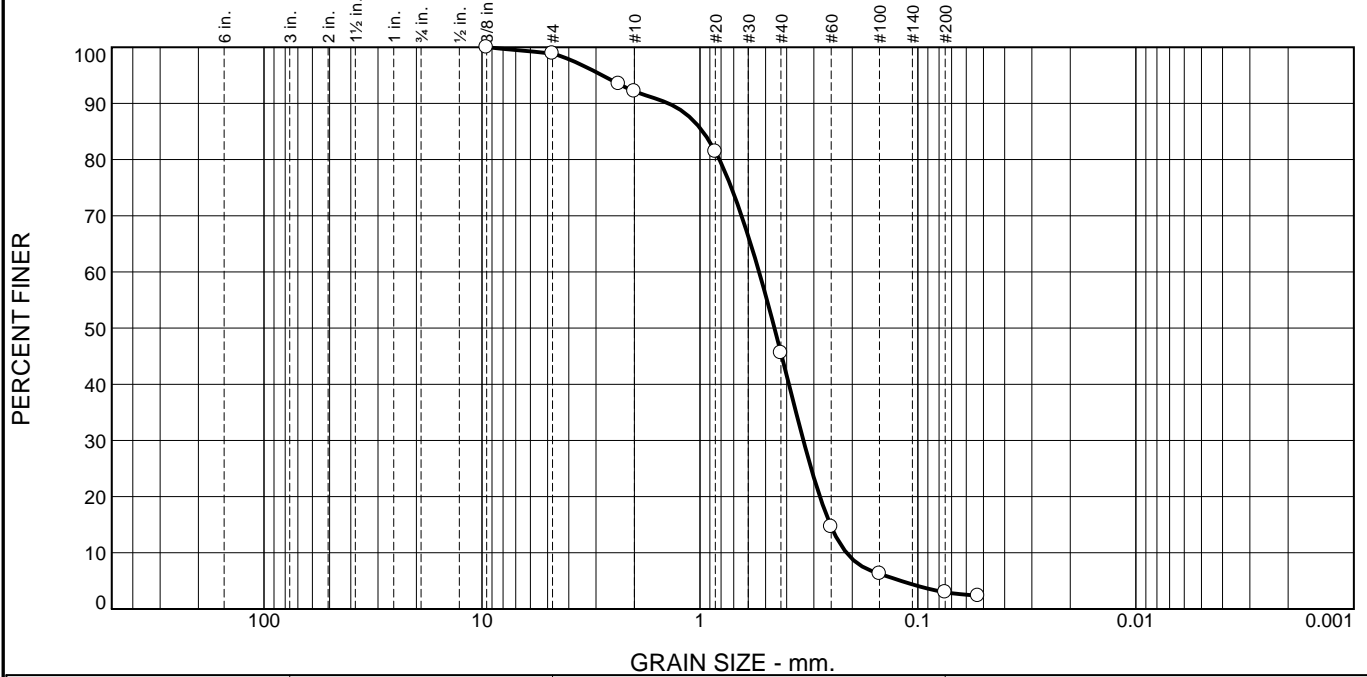
Groundwater Depth ATD (ft): Not encountered

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | 1 | | Mulch Accumulated pine needles. | | | | | | | Stick-up monument +2.2 to 0 feet Bioretention soil mix 0 to 1 foot 1.25 inch I.D. threaded galvanized steel casing +2.2 to 2.1 feet 3/8 inch Bentonite chips 1 to 1.3 feet Native sand 1.3 to 2.1 feet Native sand 1.3 to 2.1 feet 1.25 inch I.D. Stainless steel jacket over stainless steel #60 Gauze welded to perforated steel 2.1 to 5.03 feet Cast iron drive endcap 5.0 to 5.3 feet Cast iron drivepoint 5.3 to 5.6 feet |
| 1 | | 2 | | Bioretention Soil Loose, slightly moist, dark brown, fine to medium SAND, trace gravel, trace silt; abundant organics (SP). As above. | | | | | | | |
| 2 | | 3 | | Vashon Advance Outwash Medium dense, moist, light brown, fine SAND, some silt, trace gravel (SP-SM). | | | | | | | |
| 3 | | 4 | | As above. | | | | | | | |
| 4 | | 5 | | As above; occasional layers (1/4 inch thick) of sandy, silt. | | | | | | | |
| 5 | | 6 | | As above. | | | | | | | |
| 6 | | 7 | | Medium dense, very moist, light brown, gravelly, medium to coarse SAND, trace silt (SP). | | | | | | | |
| 6.5 | | | | No groundwater encountered. No caving. HA located near inlet #1 at bottom of cell. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 7 | | | | | | | | | | | |

20150387H008 1/23/2024

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.1 | 6.7 | 46.6 | 42.6 | 3.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 98.9 | | |
| #8 | 93.5 | | |
| #10 | 92.2 | | |
| #20 | 81.4 | | |
| #40 | 45.6 | | |
| #60 | 14.6 | | |
| #100 | 6.3 | | |
| #200 | 3.0 | | |
| #270 | 2.4 | | |

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 1.3935 D₈₅= 0.9705 D₆₀= 0.5357
D₅₀= 0.4551 D₃₀= 0.3351 D₁₅= 0.2523
D₁₀= 0.2127 C_u= 2.52 C_c= 0.99

Remarks

Date Received: 8-1-2023 Date Tested: 10-30-2023

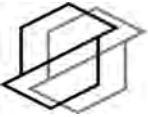
Tested By: FEW

Checked By: CSI/JHS

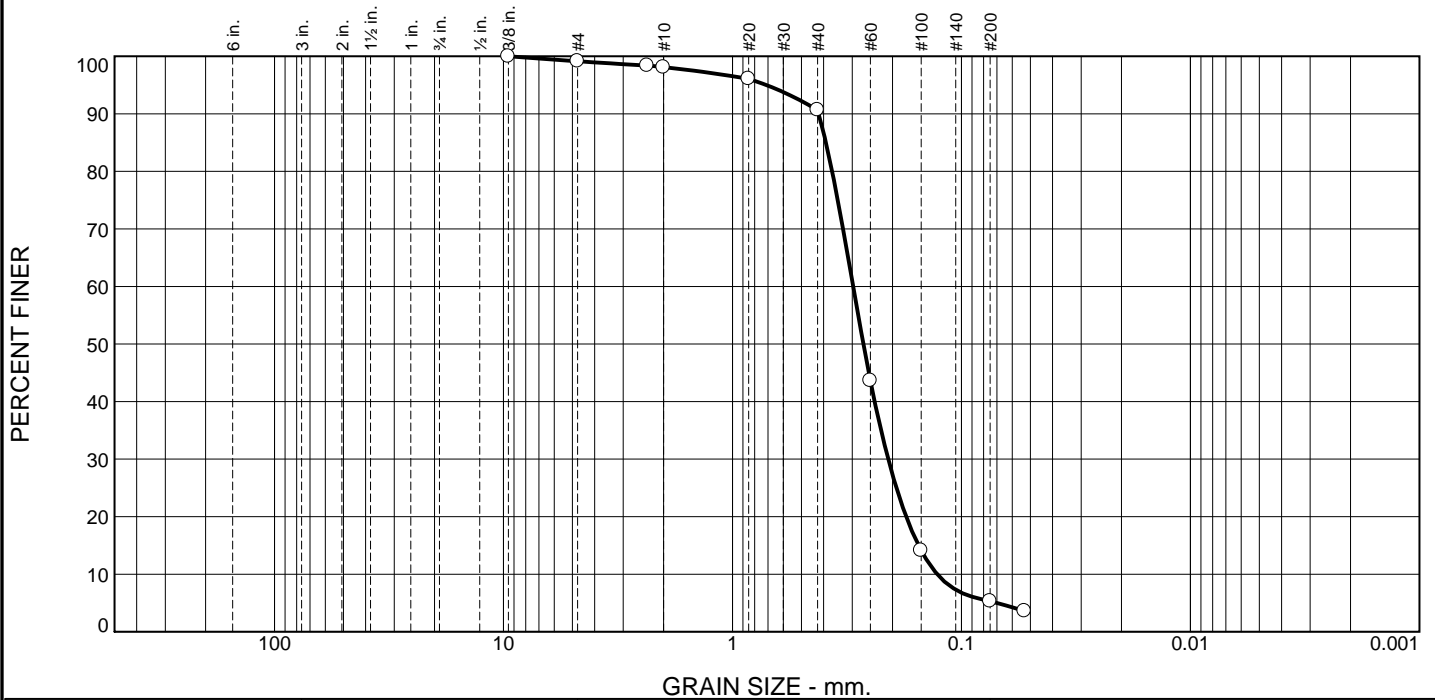
Title: _____

* (no specification provided)

Location: Onsite - BHPS-BVCC-1 Date Sampled: 8-1-2023
Sample Number: HA-2 Depth: 0.1-1'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study |
| | Project No: 20150387 H008 | |
| | Figure | |

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.9 | 1.0 | 7.4 | 85.4 | 5.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 99.1 | | |
| #8 | 98.4 | | |
| #10 | 98.1 | | |
| #20 | 96.1 | | |
| #40 | 90.7 | | |
| #60 | 43.6 | | |
| #100 | 14.1 | | |
| #200 | 5.3 | | |
| #270 | 3.6 | | |

* (no specification provided)

Material Description

Advance Outwash
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-3

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 0.4203 | D ₈₅ = 0.3905 | D ₆₀ = 0.2971 |
| D ₅₀ = 0.2681 | D ₃₀ = 0.2089 | D ₁₅ = 0.1540 |
| D ₁₀ = 0.1277 | C _u = 2.33 | C _c = 1.15 |

Remarks

Date Received: 8/1/2023 Date Tested: 9/7/2023

Tested By: FEW

Checked By: APJ/JHS

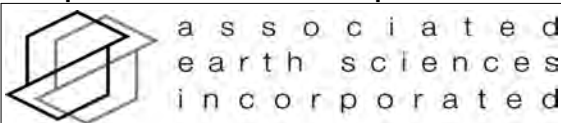
Title: _____

Location: Onsite - BVCC1

Sample Number: HA-2

Depth: 1.5-2.3'

Date Sampled: 8/1/2023



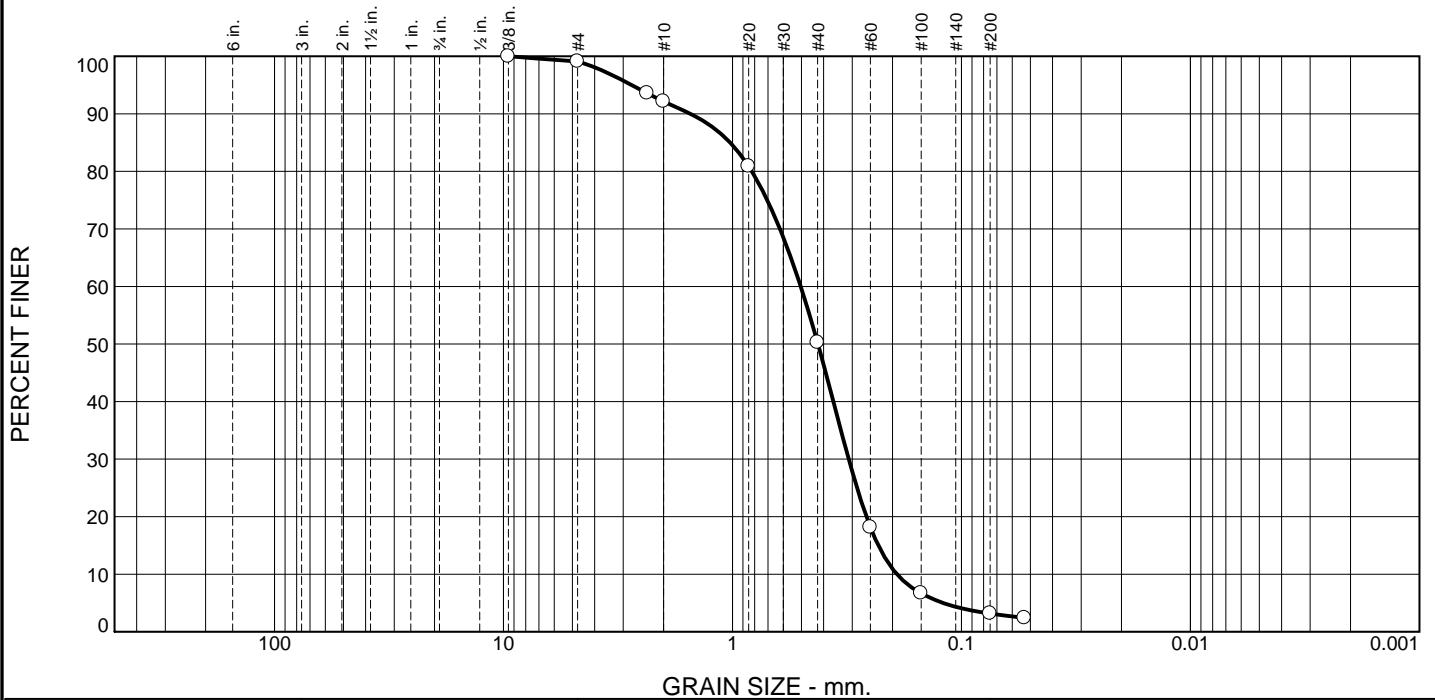
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.9 | 7.0 | 41.8 | 47.1 | 3.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 99.1 | | |
| #8 | 93.6 | | |
| #10 | 92.1 | | |
| #20 | 80.9 | | |
| #40 | 50.3 | | |
| #60 | 18.2 | | |
| #100 | 6.7 | | |
| #200 | 3.2 | | |
| #270 | 2.4 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 1.5273 | D ₈₅ = 1.0237 | D ₆₀ = 0.5034 |
| D ₅₀ = 0.4233 | D ₃₀ = 0.3107 | D ₁₅ = 0.2308 |
| D ₁₀ = 0.1916 | C _u = 2.63 | C _c = 1.00 |

Remarks

Date Received: 8/01/2023 Date Tested: 10/03/2023

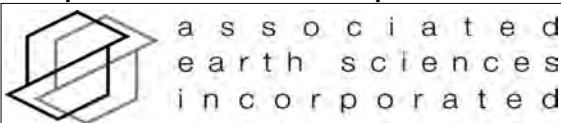
Tested By: FEW

Checked By: SNCF/APJ/JHS

Title: _____

Location: Onsite - Bellevue Cherry Crest ES #1
 Sample Number: HA-3 Depth: 0.2-0.5'

Date Sampled: 8/01/2023



Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|---------------------------------|--------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/0/2023 | Project BHPS-BVCC-1 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellvue, WA | EB/EP No. BVCC-1-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0.1-1' | HA-3 @ 0.2-0.5' |
|--------------------|---------------|-----------------|
| Wet Weight + Pan | 1535.1 | 850.6 |
| Dry Weight + Pan | 1451.5 | 786.5 |
| Weight of Pan | 392.0 | 247.5 |
| Weight of Moisture | 83.5 | 64.2 |
| Dry Weight of Soil | 1059.5 | 539.0 |
| % Moisture | 7.9 | 11.9 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|-------|
| Dry Soil Before Burn + Pan | 1451.5 | 786.5 |
| Dry Soil After Burn + Pan | 1403.3 | 753.1 |
| Weight of Pan | 392.0 | 247.5 |
| Wt. Loss Due to Ignition | 48.2 | 33.4 |
| Actual Wt. Of Soil After Burn | 1011.3 | 505.6 |
| % Organics | 4.6 | 6.2 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--|-----------------------------|---|
| Project Name: | Cherry Crest Elementary School-Raingarden #1 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 8/1/2023 | Pit Area (sq. feet): | 13:45: 751 ft ² / 14:45: 751 ft ² |
| Weather: | Clear, 70's | Underdrain | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.66 |
| Performed By: | SNCF / APJ | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Staff Gauge #3 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|---------------------|----------------------|---------------------|---|
| 9:38 | 55 | | | | | | Water on |
| 9:40 | 54.94 | | | | | 84 | Adjusted diffuser |
| 9:43 | 55.46 | | | | | 255 | |
| 9:45 | 55.62 | | | | | 364 | Placed SG-2 |
| 9:50 | 55.9 | | 0.2 | | | 675 | |
| 10:00 | 55.46 | | 0.2 | | | 1202 | CB = 3.25' |
| 10:15 | 73.2 | | 0.21 | | | 2077 | Increase flow to 72 gpm; water expanding to bridge |
| 10:30 | 73.48 | 0.1 | 0.2 | | | 3144 | 10:25 - water made it passed bridge |
| 10:35 | | 0.14 | 0.2 | 0.5 | | | Placed SG-3; increased flow to 75 gpm; pond reached outlet base |
| 10:45 | 77.2 | 0.16 | 0.25 | 0.5 | | 4263 | |
| 11:00 | 77.6 | 0.24 | 0.25 | 0.58 | | 5415 | CB = 3.26' |
| 11:15 | 76.76 | 0.32 | 0.3 | 0.68 | | 6588 | |
| 11:30 | 76.9 | 0.38 | 0.42 | 0.72 | | 7736 | |
| 11:45 | 77.1 | 0.46 | 0.44 | 0.78 | | 8875 | |
| 12:00 | 77.8 | 0.5 | 0.5 | 0.84 | | 10029 | |
| 12:15 | 76.8 | 0.59 | 0.55 | 0.9 | | 11224 | CB = 3.26' |
| 12:30 | 77.4 | 0.62 | 0.6 | 0.94 | | 12346 | |
| 12:45 | 76.4 | 0.68 | 0.64 | 1 | | 13498 | |
| 12:55 | | | | | | | Decrease flow to 50 gpm |
| 13:00 | 51.8 | 0.66 | 0.64 | 0.98 | | 14343 | |
| 13:15 | 51.6 | 0.66 | 0.62 | 0.98 | | 15103 | |
| 13:33 | 51.5 | 0.66 | 0.62 | 0.98 | | 16024 | CB = 3.25' |
| 13:45 | 51.7 | 0.66 | 0.62 | 0.98 | | 16689 | |
| 14:00 | 51.7 | 0.68 | 0.62 | 0.99 | | 17487 | |
| 14:15 | 48.1 | 0.68 | 0.6 | 1 | | 18145 | Decrease flow slightly |
| 14:30 | 42.8 | 0.68 | 0.64 | 1 | | 18838 | Decrease flow slightly; CB = 3.25' |
| 14:45 | 43.1 | 0.66 | 0.64 | 0.98 | | 19485 | |
| 15:00 | 42.3 | 0.66 | 0.62 | 0.98 | | 20153 | |
| 15:15 | 43.05 | 0.66 | 0.62 | 0.98 | | 20796 | |
| 15:32 | 42.5 | 0.66 | 0.62 | 0.98 | | 21521 | |
| 15:40 | 43.4 | 0.66 | 0.62 | 0.98 | | 21858 | Moisture in WP; CB = 3.24' |
| 15:50 | 43.9 | 0.66 | 0.62 | 0.98 | 6.53 | 22289 | |
| 16:00 | 43.5 | 0.66 | 0.62 | 0.98 | 6.43 | 22726 | |
| 16:12 | 43.4 | 0.66 | 0.62 | 0.98 | 6.33 | 23237 | |
| 16:20 | 42.5 | 0.66 | 0.62 | 0.98 | 6.27 | 23582 | CB = 3.24' |

| | | | | | | | |
|-------|------|------|------|------|------|-------|-----------|
| 16:30 | 42.9 | 0.66 | 0.62 | 0.98 | 6.22 | 24014 | |
| 16:40 | 42.9 | 0.66 | 0.62 | 0.98 | | 24477 | Water off |
| 16:43 | | 0.64 | 0.6 | 0.96 | 6.16 | | |
| 16:50 | | 0.6 | 0.58 | 0.94 | 6.16 | | |
| 16:55 | | 0.56 | 0.52 | 0.88 | 6.14 | | |
| 17:05 | | 0.48 | 0.45 | 0.8 | 6.13 | | |
| 17:16 | | 0.42 | 0.4 | 0.74 | 6.12 | | |
| 17:25 | | 0.38 | 0.34 | 0.7 | 6.12 | | |
| 17:35 | | 0.3 | 0.28 | 0.62 | 6.12 | | |
| 17:45 | | 0.28 | 0.22 | 0.68 | 6.13 | | |
| 17:55 | | 0.2 | 0.16 | 0.54 | 6.13 | | |
| 18:05 | | 0.14 | 0.1 | 0.48 | 6.14 | | |
| 18:20 | | 0.08 | 0 | 0.42 | 6.14 | | |

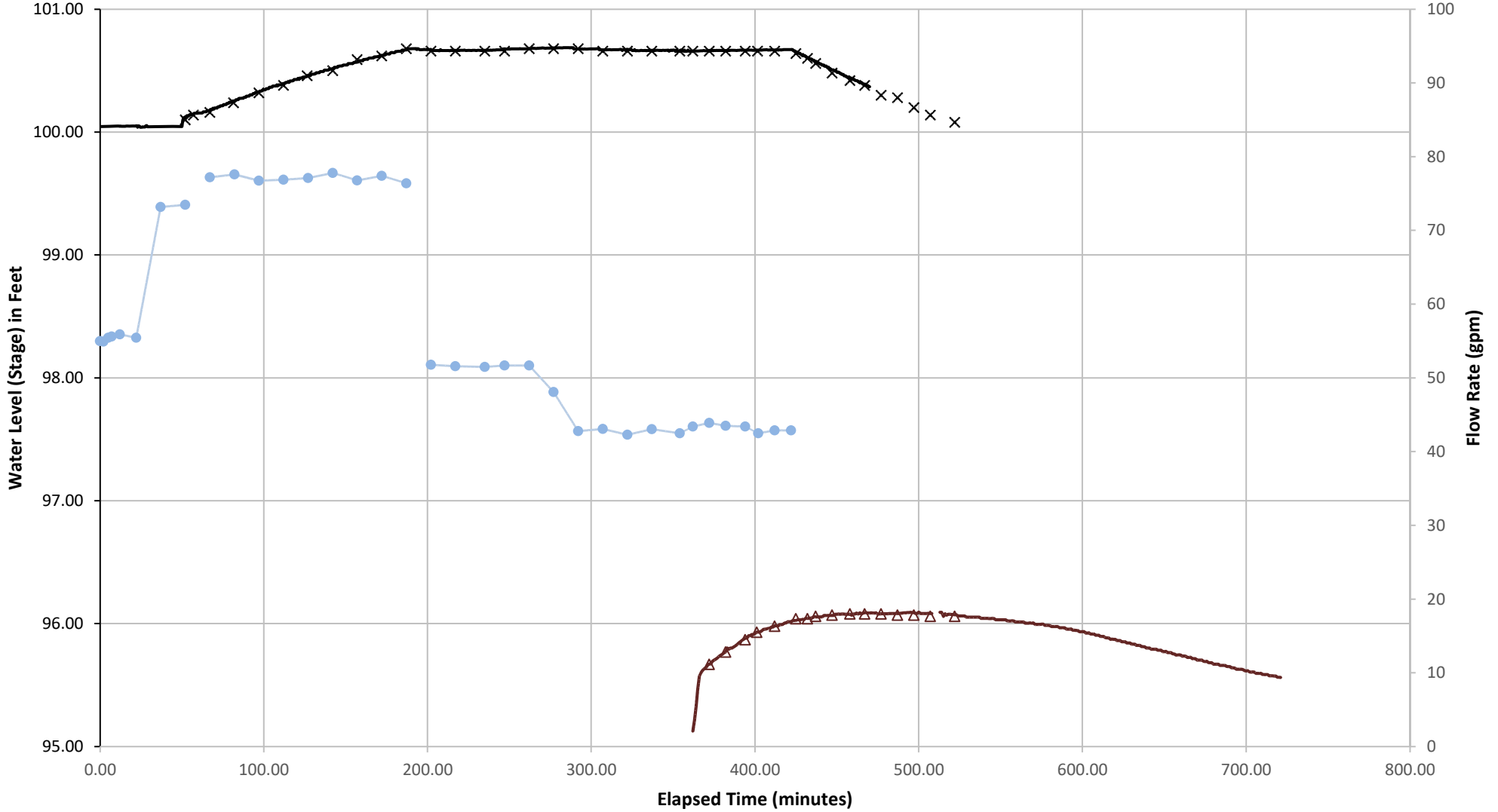
| | |
|---|-----|
| SG-1: Average Infiltration Rate (in/hr) during last hour of inflow: | 5.6 |
| SG-1: Average Infiltration Rate (in/hr) during falling head: | 4.2 |

| | |
|---|-----|
| SG-2: Average Infiltration Rate (in/hr) during last hour of inflow: | 5.6 |
| SG-2: Average Infiltration Rate (in/hr) during falling head: | 4.4 |

| | |
|---|-----|
| SG-3: Average Infiltration Rate (in/hr) during last hour of inflow: | 5.6 |
| SG-3: Average Infiltration Rate (in/hr) during falling head: | 4.0 |

| | |
|--|------|
| WP: Average Infiltration Rate (in/hr) during last hour of inflow: | 11.1 |
| WP: Average Infiltration Rate (in/hr) during falling head 17:13-20:40: | 2.2 |

Cherry Crest Elementary School-Raingarden #1 Infiltration Test Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface. Wellpoint dry until minute 362.

- x Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
Cell: Cell 1

Assessed On:
July 27, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2013 and collects runoff from several different land uses onsite including athletic fields to the north and school buildings to the south. The cell is constructed with 3 inches of mulch above 1.5' of bioretention soil. The bioretention soil is underlain by a geotextile filter fabric and 0.5' of gravel drain rock. Embedded into the existing subgrade sit four 6" perforated pipes, each surrounded by 18" of gravel drain rock which run parallel to the long axis of the cell. All four pipes terminate into a fifth pipe which runs perpendicular to the long axis of the cell and flows into the catch basin. No water is designed to infiltrate into the native soils.

BIORETENTION SOIL:

Thickness: 1.2-1.6'

The apparent thickness of the bioretention soil was found to range from 1.2-1.6' with an average depth of 1.5'.

Composition: The plans call for the city of Bellevue's 2013 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation for the tested material was finer than the specification and the fines content exceeded the specified range for the 2019 Ecology specification while the organic content met the standard.

Organic Matter Content (% by weight): 5.9

Percent passing #200 sieve: 5.1

Coefficient of Uniformity (Cu): 4.0

Coefficient of Curvature (Cc): 1.2

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Subgrade soils were not encountered in hand augers due to the presence of the underdrain.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plan.

GROUNDWATER CONDITIONS:

No groundwater was observed during the excavation of hand augers. The temporary wellpoint was screened from 2.3-3' below ground surface and showed a .15' increase in water levels during testing. We interpret this response to be pooling of water in the underdrain gravels as it is conveyed to the perforated pipe and out of the cell.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 52.9

Subgrade Soil Rate (in/hr): N/A

Two infiltration tests were performed on either side of a pedestrian bridge which allows for access across the bioretention cell. IT-1 measured a rate of 53.6 in/hr and IT-2 measured a rate of 52.1 in/hr. The

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
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Assessed On:
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presented rate is an average of the two test results. The subgrade soil infiltration rate cannot be determined from our infiltration test due to the presence of the underdrain.

MAINTENECE OBSERVATIONS/CONSIDERATIONS:
 The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|-------------------------|
| Weather | Clear, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Alex Johanson |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 4 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230727-191937.jpg



Site Photo: FA_SitePhotos-20230727-133722.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)

Cell: Cell 1

Assessed On:

July 27, 2023



Site Photo: FA_SitePhotos-20230727-133742.jpg



Site Photo: FA_SitePhotos-20230727-133749.jpg



Site Photo: FA_SitePhotos-20230727-133757.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
Cell: Cell 1

Assessed On:
July 27, 2023



Cell Construction

| | |
|---|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation for the cell consisted of 16 sprinkler heads evenly spaced around the perimeter and down the center of the cell. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width 37' There are four, 6-inch, perforated pipes that run east to west evenly spaced along the full base of the cell. The four pipes join together before meeting up with the catch basin in a pipe that runs north to south. The underdrain trench is backfilled with a minimum of 6 inches of gravel backfill for drains. The underdrain pipes are placed in individual 18 inch deep by 18-inch-wide trenches of gravel backfill located below the overlying 6 inches of gravel backfill. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell by a perimeter of curb cuts that drain run off from the paved student drop off area that surrounds the cell, an inlet on the north side of the cell that drains the sport field upgradient of the cell, and two inlets on the south side of the cell that collects water from the buildings rooves located south of the cell. Water is designed to infiltrate through the bioretention soil before reaching the underdrain pipes where it flows to the catch basin and out to the storm drain network. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
Cell: Cell 1

Assessed On:
July 27, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230727-213639.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: There is minimal blockage of inlet 1 consisting of some vegetation and dead leaf matter.



FA_INBLPhoto-20230727-213626.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
Cell: Cell 1

Assessed On:
July 27, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230727-213833.jpg

Erosion Present? Yes No

Blockage Present? Yes No


Additional Details:


BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
Cell: Cell 1

Assessed On:
July 27, 2023



| | |
|---|--|
| IN-3 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: Pipe: Material <input checked="" type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.5' Energy Dissipation Angular Rock: Functioning Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230727-213935.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Angular rock | |

| | |
|--|--|
| IN-4 | |
| <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.4' Energy Dissipation Angular Rock: Functioning Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230727-220652.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Angular rock scattered around the sidewalls on the perimeter of the cell. Curb cut inlets surround the entire perimeter of the cell. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
Cell: Cell 1

Assessed On:
July 27, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.65' Width: 1.28' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.6 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |



FA_DOPhoto-20230727-221255.jpg

Cell Surface and Geotech Probe Observations

| | | |
|---|--|---|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | Depth (ft): |
| Cell Coverage | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare ground and dead leaf litter (natural mulch from weed-whacking) covers the base of the cell. Plans state a minimum of 3 inches of compost mulch was to be placed during cell construction. | | |
| Pest Evidence | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No |
| Additional Details: | | |
| Vegetation Description The cell is covered in healthy vegetation. Plants on the east side of the cell appear to be drier and slightly less healthy. | | |
| Additional Details Geotech Probe Observations: At the cell base, probe measurements found 1.2-1.6' of bioretention soil before encountering the underdrain gravels. This is relatively consistent with the 1.5' specified by the plans. On the cell edges, probe measurements found 0-0.9' of bioretention soil before encountering underdrain gravels. This is consistent with the cell design which shows a 4:1 slope with 6" of soil above the underdrain gravels and existing subgrade. No zones of compaction were observed. | | |

Hand Auger

| | |
|--|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 | <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 |
| <input type="checkbox"/> Outside Cell | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
 Cell: Cell 1

Assessed On:
 July 27, 2023



| | |
|--|--|
| HA-1-WP | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | 1.3 |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown fine to medium SAND, trace gravel, trace silt, abundant organics (rootlets) (SP) | |
| Native Soil Texture: (Underdrain Gravel) Loose, slightly moist, gray, fine 1/4-3/4" rounded GRAVEL, some sand, trace silt (GP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Searation Geofabric |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 2.24 | |
| Additional Details | |
| Moderate caving and no groundwater present at time of digging. Wellpoint showed a response to testing. Water level stayed constant throughout test presumably showing water in underdrain. | |



FA_FPhoto-20230727-162952.jpg

| | |
|---|--|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | 1.45 |
| Total Depth: | 1.45 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Filter fabric encountered at 1.5' |
| Additional Details | |



IMG_0389.jpeg

| | |
|--|--|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)
 Cell: Cell 1

Assessed On:
 July 27, 2023



| | |
|--|--|
| HA-3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.3 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some silt, trace gravel, abundant organics, scattered rootlets (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No filter fabric encountered at 1.3' |
| Additional Details | |



IMG_0390.jpeg

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 10-100 | |
| Wetted Pond Area (sq. ft) | 175 |
| Ponded Depth (ft) | 0.18 |
| Total Gallons | 17,654 |
| Steady State Flow Rate (GPM) | 97 |
| Additional Details: | |
| Two infiltration tests were performed. The first test was conducted in the center of the cell near inlets 2 and 3 on the east side of the bridge. The second test was completed in the center of the cell on the west side of the bridge. Additional test details can be found in the executive summary. | |
| Water was observed flowing out of inlet 3 for the duration of the tests at a very slow trickle, estimated at 0.5 gpm. Water from this discharge pools in the rip rap surrounding the pipe. | |



IT_Photo-20230727-221849.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)

Cell: Cell 1

Assessed On:

July 27, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Bellevue High School (BVHS)

Cell: Cell 1

Assessed On:

July 27, 2023



SITE: BELLEVUE HIGH SCHOOL (BVHS) CELL: CELL 1





associated
earth sciences
incorporated

Well Point

BVHS-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/27/23

Logged By: APJ/SNCF

20150387H008

Ending Date: 7/27/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.9

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.6

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.2

Water Level Elevation (ft): N/A

Datum: Project Datum

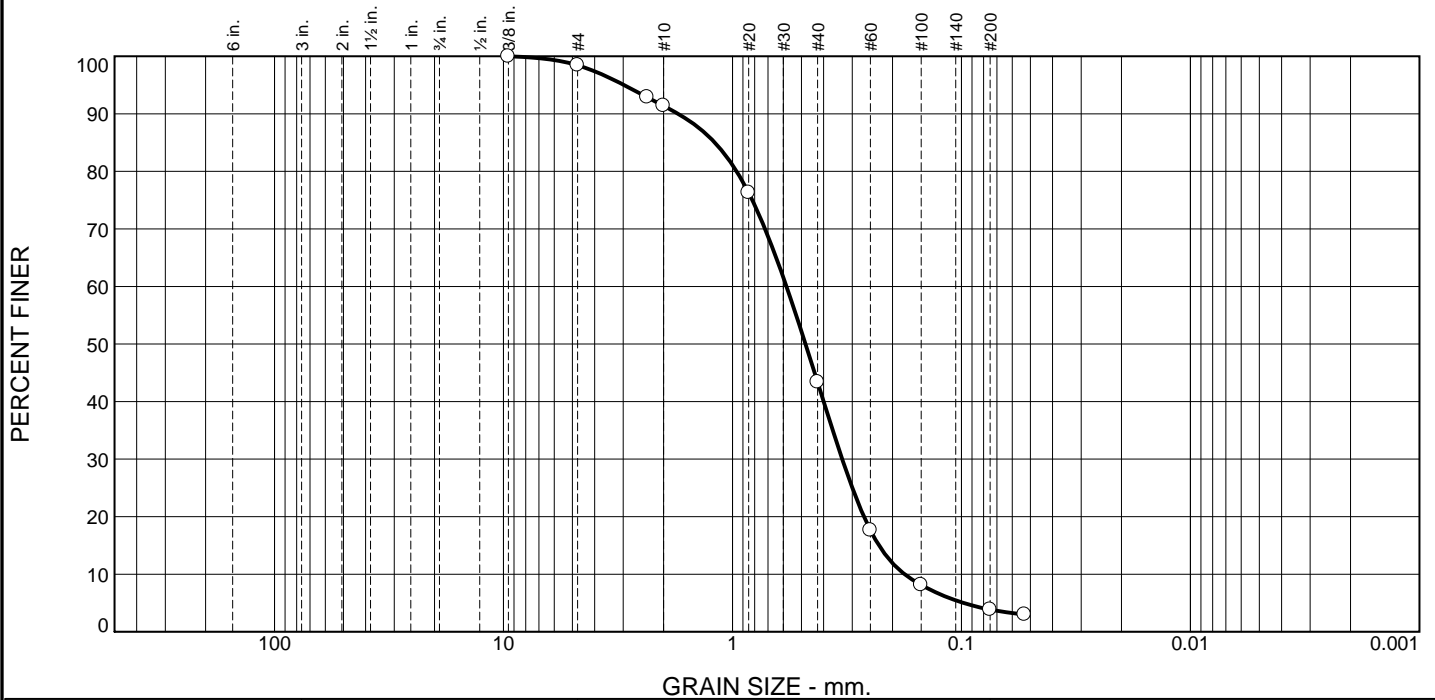
Groundwater Depth ATD (ft): Not encountered

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction | |
|------------|-------------|------------|---|---|-------------|----------|----|----|----|----|-------------------|---|
| | | | | | | Blows/6" | 10 | 20 | 30 | 40 | | 50+ |
| 0 | | | | Mulch Loose vegetative debris and cut grasses. | | | | | | | | Stickup -4.2 to 0 feet Bioretention soil mix 0 to 1.2 feet 1.25-inch I.D. threaded galvanized steel casing -4.2 to 0.1 feet; duct tape covers screen 0.1 to 2.3 feet 3/8-inch bentonite chips 1.2 to 1.5 feet Native gravel 1.5 to 2.3 feet Silica sand 2.3 to 2.8 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 2.3 to 3 feet Cast iron drive endcap 3 to 3.3 feet Cast iron drivepoint 3.3 to 3.6 feet |
| 1 | | 1 | Bioretention Soil Mix Loose, slightly moist, dark brown, medium to fine SAND, trace gravel, trace silt; abundant organics; rootlets (SW). | | | | | | | | | |
| | | 2 | Filter fabric at 1.3 feet. | | | | | | | | | |
| | | | Underdrain Gravel Loose, slightly moist, gray, fine GRAVEL, some sand, trace silt (GP). | | | | | | | | | |
| 2 | | | | No seepage. Moderate caving 1.3 to 1.9 feet. Refusal on gravel. Located at bottom of cell near bridge. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | |
| 3 | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | |

1/23/2024
20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.6 | 7.0 | 48.0 | 39.5 | 3.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 98.4 | | |
| #8 | 92.9 | | |
| #10 | 91.4 | | |
| #20 | 76.3 | | |
| #40 | 43.4 | | |
| #60 | 17.6 | | |
| #100 | 8.1 | | |
| #200 | 3.9 | | |
| #270 | 3.0 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 1.7276 D₈₅= 1.1941 D₆₀= 0.5809
D₅₀= 0.4797 D₃₀= 0.3318 D₁₅= 0.2293
D₁₀= 0.1773 C_u= 3.28 C_c= 1.07

Remarks

Date Received: 7/27/2023 Date Tested: 10/03/2023

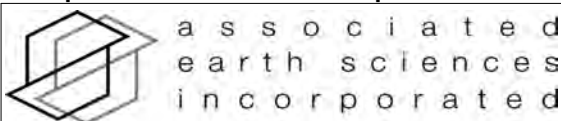
Tested By: FEW

Checked By: SNCF/APJ/JHS

Title: _____

Location: Onsite - Bellevue High School
Sample Number: HA-1 **Depth:** 0.2-0.5'

Date Sampled: 7/27/2023

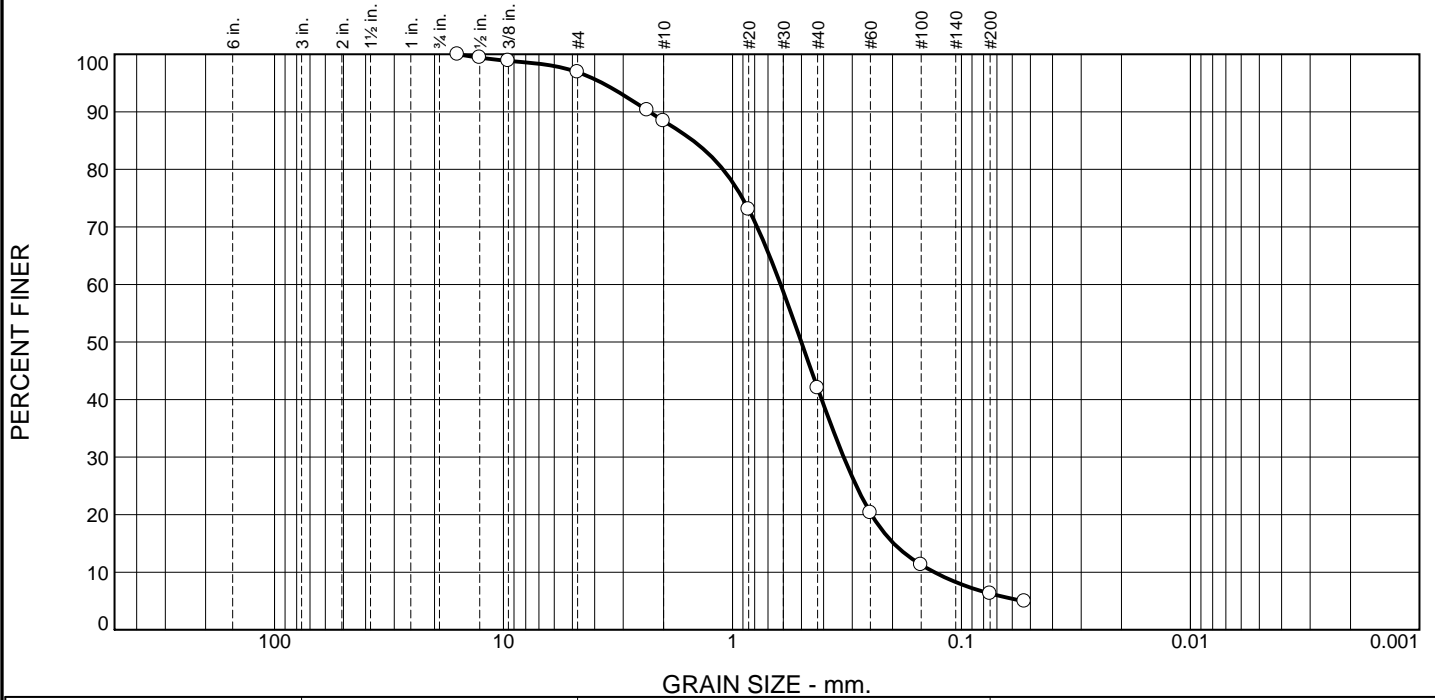


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 3.1 | 8.5 | 46.4 | 35.7 | 6.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 99.4 | | |
| 3/8" | 98.9 | | |
| #4 | 96.9 | | |
| #8 | 90.3 | | |
| #10 | 88.4 | | |
| #20 | 73.1 | | |
| #40 | 42.0 | | |
| #60 | 20.3 | | |
| #100 | 11.3 | | |
| #200 | 6.3 | | |
| #270 | 4.9 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.3027 D₈₅= 1.4858 D₆₀= 0.6162
D₅₀= 0.5003 D₃₀= 0.3268 D₁₅= 0.1977
D₁₀= 0.1313 C_u= 4.69 C_c= 1.32

Remarks

Date Received: 7/27/2023 Date Tested: 10/03/2023

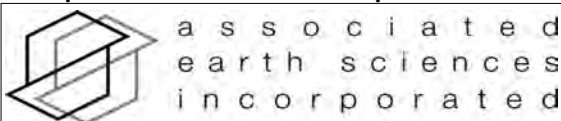
Tested By: FEW

Checked By: SNCF/APJ/JHS

Title: _____

Location: Onsite - Bellevue High School
Sample Number: HA-3 **Depth:** 0-0.9'

Date Sampled: 7/27/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--------------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 7/27/2023 | Project BHPS - Bellevue HS | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellevue, WA | EB/EP No. BVHS-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.2-0.5' | HA-3 @ 0-0.9' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 1119.26 | 1398.83 |
| Dry Weight + Pan | 1083.59 | 1313.16 |
| Weight of Pan | 391.96 | 391.96 |
| Weight of Moisture | 35.67 | 85.67 |
| Dry Weight of Soil | 691.63 | 921.20 |
| % Moisture | 5.16 | 9.30 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------|---------|
| Dry Soil Before Burn + Pan | 1083.59 | 1313.16 |
| Dry Soil After Burn + Pan | 1047.12 | 1253.40 |
| Weight of Pan | 391.96 | 391.96 |
| Wt. Loss Due to Ignition | 36.47 | 59.76 |
| Actual Wt. Of Soil After Burn | 655.16 | 861.44 |
| % Organics | 5.27 | 6.49 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|-------------------------------------|--------------------------------|---|
| Project Name: | Bellevue High School Cell #1 (IT-1) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM 6 (10-100) |
| Date: | 7/27/2023 | Wetted Area (sq. feet): | 10:00: 170 ft ² / 11:35: 175 ft ² |
| Weather: | Clear 70's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.18 |
| Performed By: | APJ / SNCF | Receptor Soils: | Gravel Underdrain |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Catch Basin | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|-------------|----------------------|---------------------|---|
| 9:17 | 35 | 0 | | 4.23 | 0 | 0 | Water On |
| 9:18 | 45 | 0.06 | | | | 38 | Leaky connections |
| 9:20 | | | | | | 229 | Water off to fix connections |
| 9:24 | 63.8 | 0 | | | | 229 | Water On |
| 9:28 | 66.67 | 0.08 | | 4.07 | | 504 | Flow up 85gpm, catch basin flowing |
| 9:30 | 84.9 | 0.1 | | 4 | DRY | 696 | |
| 9:45 | 84.33 | 0.04 | 0.16 | 3.93 | 6.51 | 1,969 | Staff Gauge #2 added at deeper portion of pond |
| 10:00 | 85.25 | 0 | 0.16 | 3.94 | 6.49 | 3,239 | Ponded area shrinking |
| 10:15 | 84.56 | 0 | 0.16 | 3.94 | 6.48 | 4,496 | |
| 10:17 | 84.9 | | | | | 4,665 | Flow rate up to 97 gpm |
| 10:23 | 98.9 | 0.14 | 0.18 | | | 5,274 | Adjusted location staff gauge #1 to deeper location in pond |
| 10:30 | 96.94 | 0.14 | 0.18 | 3.7 | 6.46 | 5,934 | |
| 10:45 | 99.17 | 0.14 | 0.18 | 3.9 | 6.48 | 7,455 | |
| 11:00 | 97.51 | 0.14 | 0.18 | 3.95 | 6.48 | 8,863 | |
| 11:15 | 96.81 | 0.14 | 0.18 | 3.89 | 6.46 | 10,336 | |
| 11:30 | 97.62 | 0.16 | 0.18 | 3.91 | 6.46 | 11,793 | |
| 11:45 | 97.68 | 0.16 | 0.18 | 3.9 | 6.46 | 13,293 | |
| 12:00 | 97.79 | 0.16 | 0.18 | 3.89 | 6.46 | 14,723 | |
| 12:15 | 98.09 | 0.16 | 0.18 | 3.9 | 6.46 | 16,186 | |
| 12:30 | 97.56 | 0.16 | 0.18 | | | 17,654 | Water off. End of IT-1 |
| 12:31 | | 0.1 | 0.1 | | | | |
| 12:32 | | 0.04 | 0.06 | | | | |
| 12:33 | | 0 | 0.02 | | | | |
| 12:34 | | | 0 | | | | |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 53.6 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 38.4 |

| | | | |
|------------------------|-------------------------------------|--------------------------------|---------------------------------|
| Project Name: | Bellevue High School Cell #1 (IT-2) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM 6 (10-100) |
| Date: | 7/27/2023 | Wetted Area (sq. feet): | 14:05 180 ft^2 / 15:40 176 ft^2 |
| Weather: | Clear, 70s | Underdrain: | Yes |
| Test No.: | IT-2 | Test Depth (feet): | 0.14 |
| Performed By: | APJ / SNCF | Receptor Soils: | Underdrain Gravels |

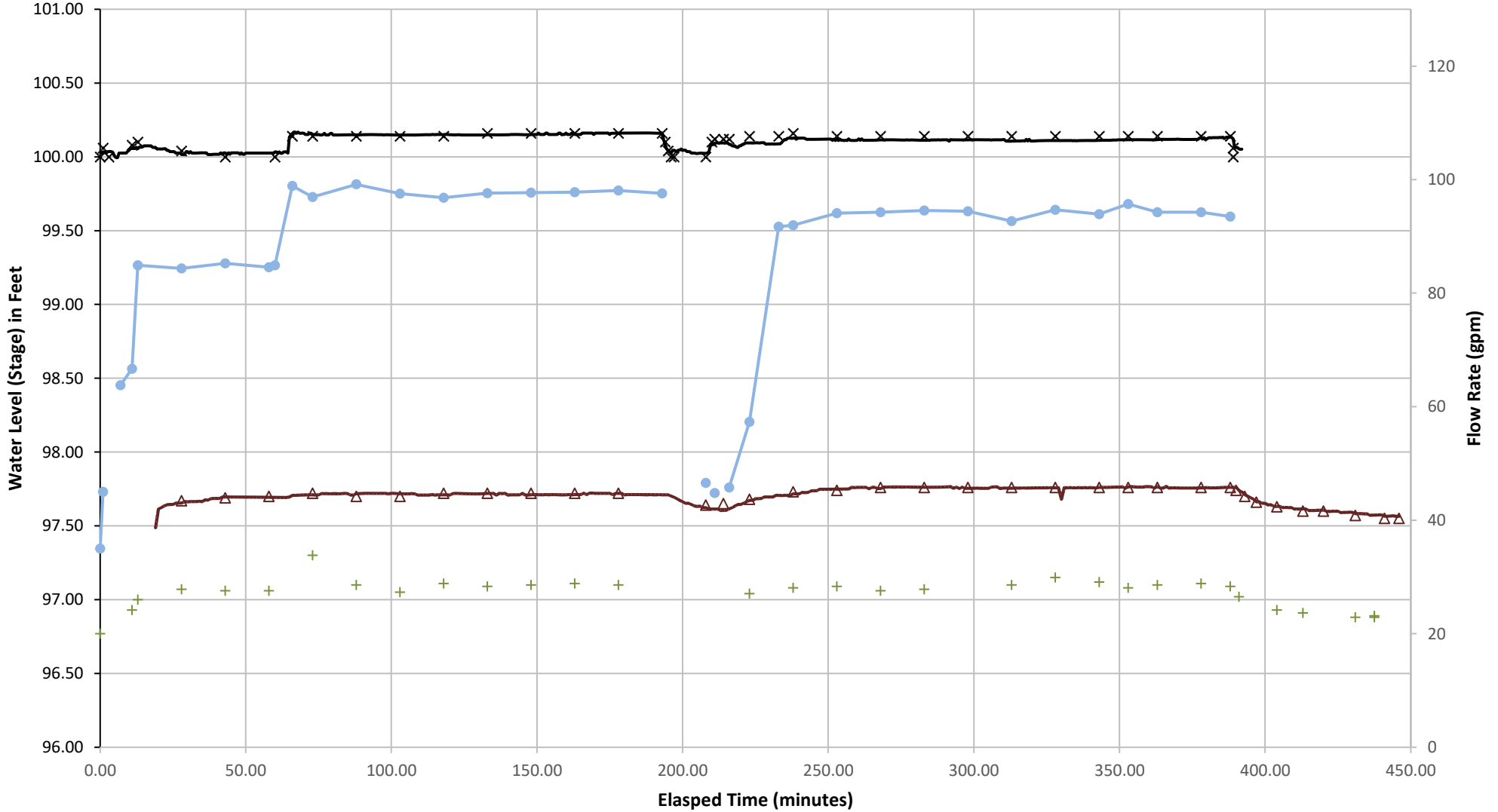
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Catch Basin | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|-------------|----------------------|---------------------|--|
| 12:45 | 46.58 | 0 | 0 | | 6.54 | 0 | Water on, begin IT-2 |
| 12:47 | | 0.1 | 0 | | | | |
| 12:48 | 44.8 | 0.12 | 0 | | | | |
| 12:51 | | 0.12 | 0.08 | | 6.53 | | |
| 12:53 | 45.74 | 0.12 | 0.08 | | | 373 | Flow rate up to 60 |
| 13:00 | 57.3 | 0.14 | 0.1 | 3.96 | 6.5 | 751 | |
| 13:10 | 91.71 | 0.14 | 0.1 | | | 1,431 | Flow rate up to 90 |
| 13:15 | 91.95 | 0.16 | 0.12 | 3.92 | 6.45 | 1,822 | |
| 13:30 | 94.1 | 0.14 | 0.12 | 3.91 | 6.44 | 3,142 | |
| 13:45 | 94.26 | 0.14 | 0.1 | 3.94 | 6.42 | 4,548 | Deepest ponded depth measured .20 |
| 14:00 | 94.56 | 0.14 | 0.1 | 3.93 | 6.42 | 5,963 | |
| 14:15 | 94.44 | 0.14 | 0.1 | | 6.42 | 7,439 | |
| 14:30 | 92.68 | 0.14 | 0.12 | 3.9 | 6.42 | 8,788 | |
| 14:45 | 94.66 | 0.14 | 0.12 | 3.85 | 6.42 | 10,227 | |
| 15:00 | 93.93 | 0.14 | 0.12 | 3.88 | 6.42 | 11,619 | |
| 15:10 | 95.69 | 0.14 | 0.12 | 3.92 | 6.42 | 12,572 | |
| 15:20 | 94.26 | 0.14 | 0.12 | 3.9 | 6.42 | 13,514 | |
| 15:35 | 94.26 | 0.14 | 0.12 | 3.89 | 6.42 | 14,930 | |
| 15:45 | 93.48 | 0.14 | 0.12 | 3.91 | 6.42 | 15,938 | Water Off |
| 15:46:00 | | 0.06 | 0.04 | | | | |
| 15:46:30 | | 0 | 0 | | | | |
| 15:47 | | | | | 6.44 | | Whole pond dry |
| 15:48 | | | | 3.98 | | | |
| 15:50 | | | | | 6.48 | | |
| 15:54 | | | | | 6.52 | | |
| 16:01 | | | | 4.07 | 6.55 | | |
| 16:10 | | | | 4.09 | 6.58 | | |
| 16:17 | | | | | 6.58 | | |
| 16:28 | | | | 4.12 | 6.61 | | |
| 16:38 | | | | 4.11 | 6.63 | | Flow rate in catch basin slowed to trickle |
| 16:45 | | | | 4.12 | 6.63 | | |

| | |
|--|------|
| IT-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 52.1 |
| IT-1 Average Infiltration Rate (in/hr) during falling head: | 57.6 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 52.1 |
| WP Average Infiltration Rate (in/hr) during falling head: | 3.2 |

Bellevue High School Infiltration Tests

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- + Catch Basin Hand
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Raingarden #1

Assessed On:
July 28, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2011 and collects runoff from the adjacent parking lot. The cell is constructed with 3" of mulch above 1.5' of bioretention soil which sits above a geotextile filter fabric. The bioretention soil sits above a 6" gravel drain rock layer which covers the entire cell base. In the central portion of the cell, there is a 5'x30' wide, 12.5' deep "trench drain" which increases the storage of the cell and extends the functional base of the cell into the underlying Advance Outwash soils. A thin layer of till was found underneath this cell during construction, and the plans were amended to account for the field conditions. All water is designed to infiltrate into underlying soils.

BIORETENTION SOIL:

Thickness: 1.0-1.5'

The thickness of the loose bioretention soil based on hand augers and probe results ranged from 1.0-1.5 feet of bioretention soil before encountering the filter fabric with an average of 1.2'. This is less than the 1.5 feet specified by the plans.

Composition: The plans call for the city of Bellevue's 2011 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation and silt content for the tested material exceeded the specification for the 2019 Ecology specification. The organic matter content fell within the specified range.

Organic Matter Content (% by weight): 5.7

Percent passing #200 sieve: 4.2

Coefficient of Uniformity (Cu): 2.9

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: N/A

Native subgrade soils were not encountered in the hand augers. Washed gravels sit underneath the bioretention soil.

BUILT PER PLAN:

Water was observed seeping into the catch basin through cracks in the cement structure. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was observed during excavations of hand augers. The temporary wellpoint was screened 1.7-2.2' below ground surface in the trench drain. The wellpoint responded to testing after 20 minutes of the test began. Once the storage in the gravels became full, the wellpoint water level rose to the same elevation as the surface water.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 28.9

Subgrade Soil Rate (in/hr): 2.3

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Raingarden #1

Assessed On:
 July 28, 2023



The bioretention soil rate was estimated from the initial ponded area before the storage in the gravels became full and the primary control on infiltration was the bioretention soil. Once the gravels storage was full, the water level was controlled by the infiltration rate of the subgrade. A small amount water (~1 gpm) was observed flowing through non-design cracks in the catch basin (CB-1) and not infiltrating into the subgrade soils.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Besides the leaky catch basin, the cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------|---------------|------------------|
| Weather | Clear, 70's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: APJ | | Half Day: CSI |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 5 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230730-200026.jpg



Site Photo: FA_SitePhotos-20230730-200045.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Raingarden #1

Assessed On:
 July 28, 2023



Site Photo: FA_SitePhotos-20230730-200101.jpg



Site Photo: FA_SitePhotos-20230730-200151.jpg



Site Photo: FA_SitePhotos-20230730-200145.jpg



Site Photo: FA_SitePhotos-20230730-200222.jpg

Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation lines run on either side of the long axis of the cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 60% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| <p>Additional Comments Water is conveyed to the cell by sheet flow and a series of curb cut inlets from the adjacent parking lot, and by a catch basin from upgradient in the parking lot that channels water to the rain garden. Water is designed to infiltrate through the bioretention soil before reaching the gravel trench underdrain that underlies a quarter of the cell. Water then infiltrates into the underlying Advance Outwash soil at the base of the trench drain. The raingarden is designed for 1 foot of maximum ponding, any excess run-off water overflows into catch basin #1 which connects to catch basin #2 and into the storm drain network. A rockery splits the cell in two but is pervious and water from the test penetrated both sides of rockery.</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Raingarden #1

Assessed On:
 July 28, 2023



Inlets

| | | |
|--|--|--|
| IN-1 <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.5' Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230728-205455.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Stream cobble surrounds each curb cut, in a series of curb cut inlets. | | |

| | | |
|--|--|--|
| IN-2 <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 110' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230728-205913.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation features were observed. | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Raingarden #1

Assessed On:
July 28, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230728-210019.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Raingarden #1

Assessed On:
July 28, 2023



IN-4

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 132'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230728-211009.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: There is permeable pavement along one edge of cell, otherwise no energy dissipation features were observed.

IN-5

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:
Material
 PVC Metal Concrete Other
Diameter: 0.68'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230730-200631.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Raingarden #1

Assessed On:
July 28, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 0% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Pipe is free of blockages. However, there is 0.1 feet of sediment built up immediately outside the pipe. Pipe collects water from portions of the parking lot that are up gradient of Rain Garden #1.



FA_INBLPhoto-20230730-200616.jpg

Additional Details: Angular rock is buried in sediment and organic debris.


BIORETENTION CELL FIELD ASSESSMENT


Site: Spiritridge Elementary (BVSE)
 Cell: Raingarden #1

Assessed On:
 July 28, 2023



Design Overflow/Outlet

| | | |
|--|------------------------------|--|
| DO - 1 | |  <p>FA_DOPhoto-20230728-211446.jpg</p> |
| Shape: | Dimensions: | |
| <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Length: 1.75' Width: 1.4' | |
| Additional Details: | | |
| Stickup (ft) From Ground: 1.2 Relative from staff gauge: | | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Leaks in catch basin allow for water to penetrate from Rain Garden #1. Water was observed flowing from catch basin #1 into catch basin #2 during testing. | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

| | | |
|---|------------------------------|---|
| DO - 2 | |  <p>FA_DOPhoto-20230728-214519.jpg</p> |
| Shape: | Dimensions: | |
| <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Length: 1.75' Width: 1.4' | |
| Additional Details: | | |
| Stickup (ft) From Ground: 1.252 Relative from staff gauge: | | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 20% blocked Additional Details: Trash rack is blocked by vegetation and gravel. | | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked Additional Details: Overflow is minimally blocked by vegetation and gravel. | | |

Cell Surface and Geotech Probe Observations

| | | |
|---------------|--|-----------------|
| Mulch: | <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth (ft): 0.1 |
| Cell Coverage | | |
| Mulch | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Raingarden #1

Assessed On:
 July 28, 2023



Other None < 25% 25 - 50% 50 - 75% 75 - 100%

Some fibrous mulch was observed in the northern portion of the cell, presumably sloughed off from the landscaped area adjacent the curb. Natural mulch of leafy and woody debris covers mulch of the cell. A decaying log was observed on the western side of cell depositing woody debris in the cell base near the Wellpoint.

Pest Evidence

Animal Burrows Yes No
 Animal Plant Damage Yes No
 Large Deposition of Feces Yes No

Additional Details: Some evidence of rabbit feces were observed near HA-1-WP, vegetation makes observations difficult.

Vegetation Description

Side slopes are heavily vegetated and limited access. The cell base is relatively easy to traverse.

Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 1.0-1.5 feet of bioretention soil before encountering the filter fabric, average probe depth was 1.2 feet. This is less than the 1.5 feet specified by the plans. On the cell edges, probe measurements found 0.4 - 1.7 feet of soil encountered above the filter fabric. This is consistent with the cell design which shows a gradual slope with bioretention soil tapering near the edges above the existing subgrade. No zones of compaction were observed.

Hand Auger

HA-1-WP

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0

to Native Soil:

to Import/Underdrain: 1

Total Depth: 1.5

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant fine organics (SP)

Native Soil Texture: Underdrain Gravel: Loose, brownish-gray, rounded, fine GRAVEL (GP)

Liner Present:
 Yes No

Filter Fabric Present:
 Yes No
 Black unwoven geotextile filter fabric encountered at 1 foot below ground surface.

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft): 0

Additional Details



6cba796f-4b2a-4240-82c7-c5b97f498509.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Raingarden #1

Assessed On:
July 28, 2023



| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1 |
| Total Depth: | 1 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant fine organics (SP) Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black unwoven geotextile filter fabric encountered at 1 foot below ground surface. |
|  | |
| 61716cce-5840-461f-a132-10d06884854d.jpg | |
| Additional Details | |

| | |
|--|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.3 |
| Total Depth: | 1.3 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant fine organics (SP) Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black unwoven geotextile filter fabric encountered at 1.3 feet below ground surface. |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Raingarden #1

Assessed On:
July 28, 2023



HA-3

Additional Details

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-6 (10-100)

Wetted Pond Area (sq. ft) 1,905

Ponded Depth (ft) 0.84

Total Gallons 37,016.5

Steady State Flow Rate (GPM) 95

Additional Details:

Additional test details can be found in the executive summary.



IT_Photo-20230728-223512.jpg



IT_Photo-20230728-223553.jpg



IT_Photo-20230728-223612.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)

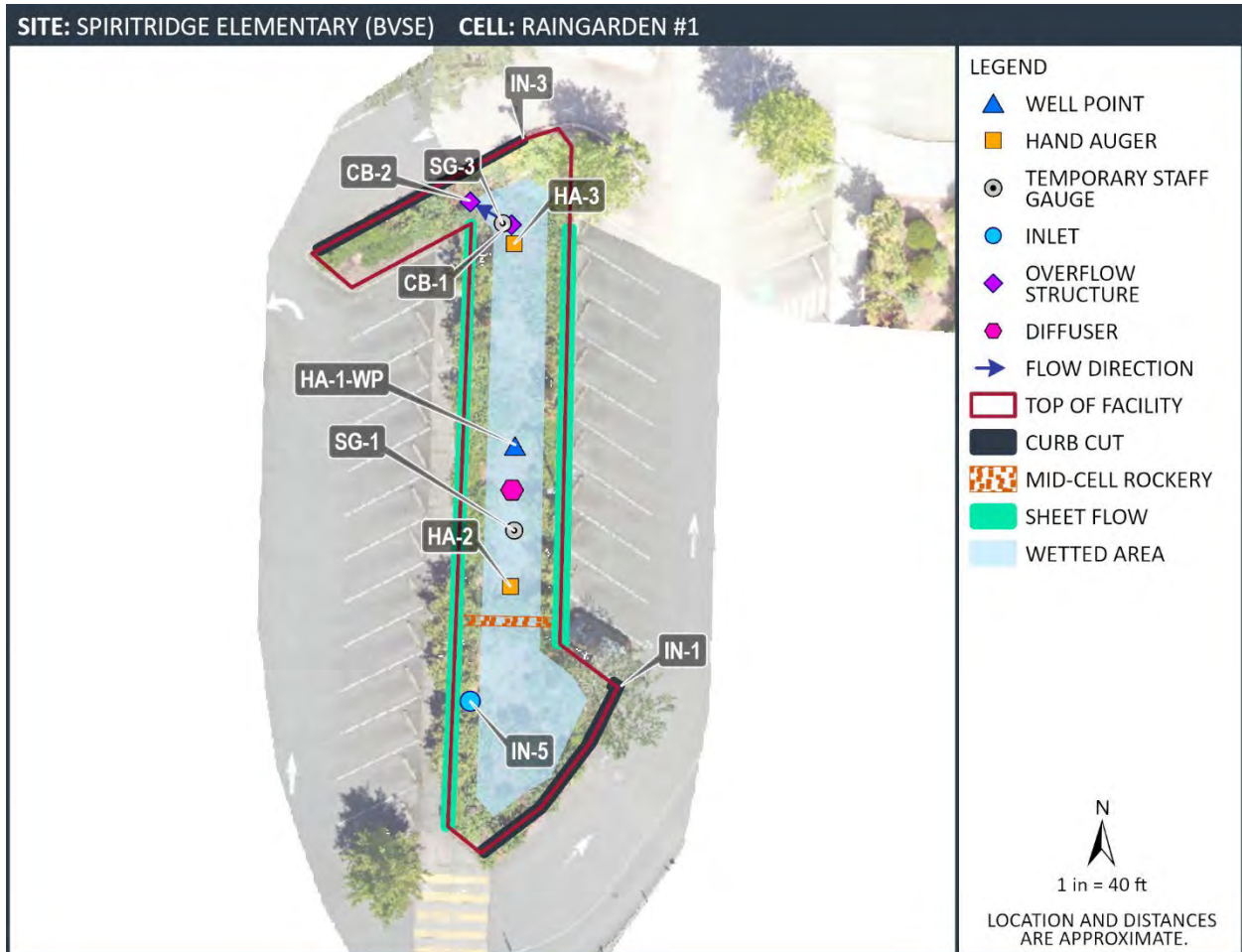
Cell: Raingarden #1

Assessed On:

July 28, 2023



Additional Comments





associated
earth sciences
incorporated

Well Point

BVSE-1-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/28/2023

Logged By: APJ

20150387H008

Ending Date: 7/28/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.8

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.8

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

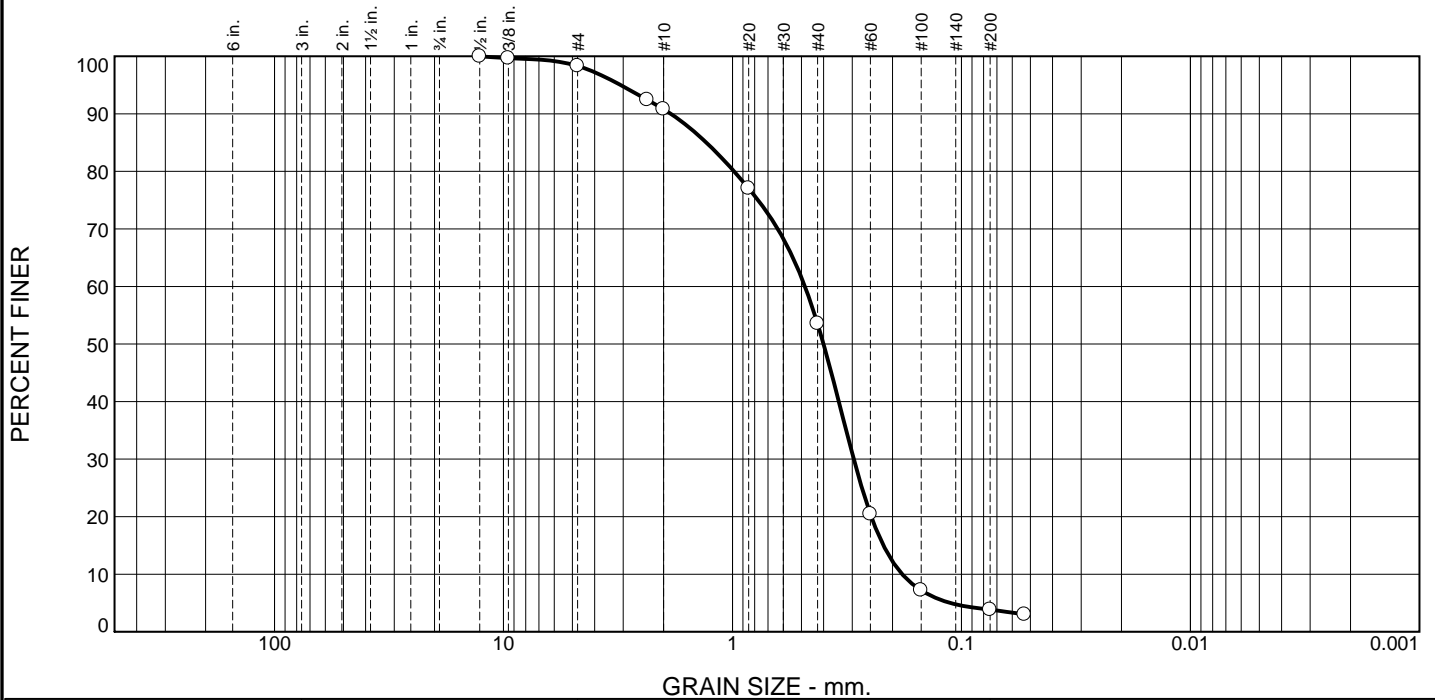
Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, trace gravel, trace to some silt; abundant fine organics (SP). | | | | | | | Stick up -4.8 to 0 feet Native bioretention soil 0 to 0.6 feet 3/8-inch bentonite chips 0.6 to 1.1 feet Native bioretention soil 1.1 to 1.5 feet 1.25-inch I.D. threaded galvanized steel casing -4.8 to 0.7 feet; duct tape covers screen -0.4 to 1.7 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.7 to 2.2 feet Cast iron drive endcap 2.1 to 2.4 feet Cast iron drivepoint 2.5 to 2.8 |
| | Hand | 2 | | | | | | | | | |
| 1 | Hand | 3 | | Black, geotextile filter fabric. | | | | | | | |
| | | | | Underdrain Gravel Loose, moist, brownish gray, GRAVEL; gravel rounded (1 inch average diameter) (GP). | | | | | | | |
| 2 | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. Wellpoint driven to 2.8 feet. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/23/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.7 | 7.5 | 37.2 | 49.8 | 3.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 98.3 | | |
| #8 | 92.4 | | |
| #10 | 90.8 | | |
| #20 | 77.0 | | |
| #40 | 53.6 | | |
| #60 | 20.4 | | |
| #100 | 7.2 | | |
| #200 | 3.8 | | |
| #270 | 3.0 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 1.8560 | D ₈₅ = 1.2999 | D ₆₀ = 0.4822 |
| D ₅₀ = 0.4003 | D ₃₀ = 0.2953 | D ₁₅ = 0.2193 |
| D ₁₀ = 0.1816 | C _u = 2.66 | C _c = 1.00 |

Remarks

Date Received: 7/28/2023 Date Tested: 9/25/2023

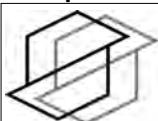
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Spirtridge Cell #1
Sample Number: HA-1 Depth: 0-0.5'

Date Sampled: 7/28/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 7/28/2023 | Project BHPS - Spiritridge Cell #1 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Bellevue, WA | EB/EP No. BVSE-1-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.5' | HA-2 @ 0.5' |
|--------------------|---------------|----------------|
| Wet Weight + Pan | 984.30 | 1338.84 |
| Dry Weight + Pan | 953.50 | 1253.87 |
| Weight of Pan | 247.50 | 357.96 |
| Weight of Moisture | 30.80 | 84.97 |
| Dry Weight of Soil | 706.00 | 895.91 |
| % Moisture | 4.36 | 9.48 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------------|----------------|
| Dry Soil Before Burn + Pan | 953.50 | 1253.87 |
| Dry Soil After Burn + Pan | 924.81 | 1187.43 |
| Weight of Pan | 247.50 | 357.96 |
| Wt. Loss Due to Ignition | 28.69 | 66.44 |
| Actual Wt. Of Soil After Burn | 677.31 | 829.47 |
| % Organics | 4.06 | 7.42 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|--------------------------------------|--------------------------------|------------------------------------|
| Project Name: | Spiritridge Elementary-Raingarden #1 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 7/28/2023 | Wetted Area (sq. feet): | 10:00: 315 ft^2 / 16:30: 1905 ft^2 |
| Weather: | Clear, 70s | Underdrain | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.84 |
| Performed By: | APJ / CSI | Receptor Soils: | Qvt, with finger drain to Qva |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Staff Gauge #3 (ft) | Staff Gauge #4 | Wellpoint (ft, btoc) | CB-1 | CB-2 | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|---------------------|----------------|----------------------|------|------|---------------------|--|
| 8:41 | 30.54 | | | | | DRY | | | | Water On |
| 8:43 | 30 | | | | | DRY | | | 46 | |
| 8:44 | 30 | | | | | DRY | | | 81 | |
| 8:45 | 30.27 | 0.14 | | | | DRY | | | 109 | |
| 8:46 | | | | | | DRY | | | | Increase flow to 50 gpm |
| 8:47 | 48.98 | 0.15 | | | | DRY | | | 184 | No change in CB |
| 8:50 | 48.58 | 0.16 | | | | DRY | | | 330 | Increase flow to ~80 |
| 8:53 | 76.58 | 0.16 | | | | DRY | | | 583 | Row of plants between WP & SG #3 preventing expansion of pond |
| 9:00 | 80.7 | 0.16 | 0.06 | | | 6.55 | | | 1,140 | |
| 9:09 | | | | | | | | 3.44 | | |
| 9:15 | 80.5 | 0.16 | 0.06 | | | | | | 2,360 | Logger added to Catch Basin #2. Pond retreated |
| 9:26 | | 0.15 | 0.06 | | | | | | 3,255 | |
| 9:30 | 94.3 | 0.16 | 0.05 | | | 6.5 | | | 3,639 | Increase flow to 95gpm |
| 9:45 | 94.44 | 0.16 | | | | 6.5 | | | 5,025 | Pond continues to shrink |
| 10:00 | 94.38 | 0.17 | 0.04 | | | 6.31 | 3.37 | 3.42 | 6,431 | |
| 10:15 | 93.7 | 0.17 | 0.04 | | | 6.05 | | | 7,885 | |
| 10:32 | 95.06 | 0.17 | 0.04 | | | 5.76 | | | 9,447 | |
| 10:45 | 95.92 | 0.18 | 0.04 | | | 5.55 | | | 10,687 | |
| 11:00 | 94.72 | 0.18 | 0.04 | | | 5.32 | | | 12,137 | |
| 11:15 | 95.01 | 0.19 | 0.06 | | | 5.13 | | | 13,535 | Pond starting to expand |
| 11:30 | | | | | | | 2.93 | 3.33 | | |
| 11:31 | 94.84 | 0.2 | 0.1 | | | | | | 15,081 | |
| 11:45 | 95.01 | 0.22 | 0.14 | | | 4.8 | 2.94 | 3.32 | 16,380 | |
| 12:01 | 94.61 | 0.26 | 0.19 | | | 4.68 | | 3.31 | 17,981 | |
| 12:15 | 95.12 | 0.3 | 0.24 | | | 4.61 | | | 19,242 | |
| 12:30 | 95.18 | 0.32 | 0.28 | | | 4.56 | | | 20,670 | |
| 12:45 | 94.67 | 0.36 | 0.3 | | | 4.51 | | | 22,074 | Pond full |
| 13:03 | 94.72 | 0.42 | 0.38 | 0.33 | | 4.44 | | | 23,781 | SG-3 added |
| 13:15 | 94.6 | 0.46 | | 0.38 | | 4.4 | 2.91 | 3.29 | 24,932 | |
| 13:30 | 95.12 | 0.51 | 0.48 | 0.44 | | 4.35 | | | 26,396 | CB-1 leaky |
| 13:45 | 95.01 | 0.56 | 0.54 | 0.5 | | 4.27 | 2.91 | 3.29 | | |
| 14:00 | 94.96 | 0.62 | 0.6 | 0.56 | | 4.22 | | | | |
| 14:15 | 76.76 | 0.65 | 0.62 | 0.59 | | 4.19 | | | 30,480 | Flow down to 77gpm to prevent water from entering overflow structure |
| 14:34 | 77 | 0.69 | 0.68 | 0.65 | | 4.14 | | | 31,873 | |
| 14:46 | 76.81 | 0.72 | 0.7 | 0.68 | | | | | 32,809 | South side of rockery completely full of water |
| 14:55 | 76.52 | | | 0.69 | | | | | 33,487 | |
| 15:00 | | 0.75 | 0.72 | 0.69 | | | | | | |
| 15:10 | 76.92 | 0.77 | 0.75 | 0.72 | | 4.08 | | | 34,647 | |
| 15:20 | 76.59 | 0.8 | 0.77 | 0.74 | | | | | 35,412 | |
| 15:30 | 76.47 | 0.82 | 0.8 | 0.76 | | 4.02 | | | 36,166 | |
| 15:41 | 76.47 | 0.84 | 0.82 | 0.78 | | 4 | | 3.27 | 37,017 | Water off |
| 15:43 | | 0.84 | 0.8 | 0.76 | | | | | | |
| 15:45 | | 0.81 | 0.79 | | 0.7 | | | | | Added staff gauge #4 for falling head on south side of rockery |
| 15:49 | | 0.8 | 0.78 | 0.73 | 0.73 | | | | | |
| 15:55 | | 0.78 | 0.75 | 0.7 | 0.7 | 4.06 | | | | |
| 15:57 | | | | | 0.7 | | | | | |
| 16:07 | | 0.74 | 0.69 | 0.69 | 0.68 | | | | | |
| 16:18 | | 0.7 | 0.68 | 0.64 | 0.64 | | | | | |
| 16:21 | | | | | | 4.13 | | | | |

| | | | | | | | | | | |
|-----------------|--|------|------|------|------|-------|------|------|--|--|
| 16:30 | | 0.7 | 0.66 | 0.61 | 0.62 | | | 3.29 | | |
| 16:41 | | 0.65 | 0.62 | 0.58 | 0.61 | 4.18 | 3.31 | | | |
| 16:59 | | 0.61 | 0.58 | 0.57 | 0.57 | | | | | |
| 7/30/2023 12:15 | | DRY | DRY | DRY | DRY | 6.60' | 3.39 | 3.13 | | |

| | |
|---|------|
| Average Infiltration Rate (in/hr) from 10:00-11:00 (BSM inf. rt. est.): | 28.9 |
|---|------|

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 2.1 |

| | |
|--|-----|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.3 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 2.2 |

| | |
|--|-----|
| SG-3 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.4 |
| SG-3 Average Infiltration Rate (in/hr) during falling head: | 1.9 |

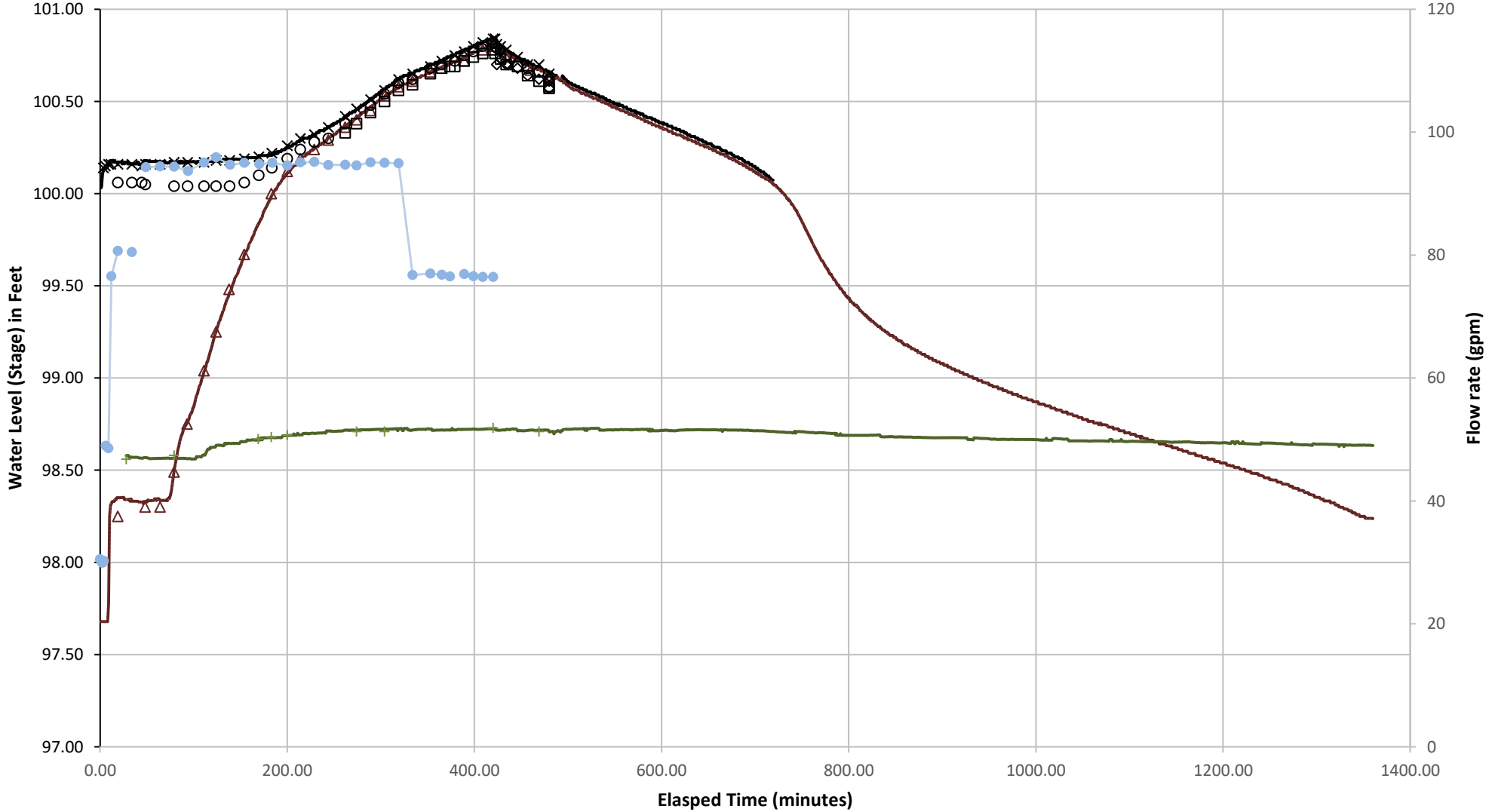
| | |
|---|-----|
| SG-4 Average Infiltration Rate (in/hr) during falling head: | 1.3 |
|---|-----|

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 5.4 |
| WP Average Infiltration Rate (in/hr) during falling head: | 1.9 |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during falling head (Logger) (15:41-20:40): | 1.9 |
|--|-----|

Spiritridge Elementary-Raingarden #1 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface. Dataloggers left in wellpoint and staff gauge over the weekend.

- | | | |
|----------------------------|----------------------------|----------------------------|
| × Staff Gauge #1 Hand Data | — Staff Gauge #1 Logger | △ Wellpoint Hand |
| — Wellpoint Logger | + Catch Basin Hand | — Catch Basin Logger |
| ○ Staff Gauge #2 Hand Data | □ Staff Gauge #3 Hand Data | ◇ Staff Gauge #4 Hand Data |
| ● Flow Rate (gpm) | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Rain Garden #2

Assessed On:
August 14, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2011 and collects runoff from the adjacent parking lot. The cell is constructed with 3" of mulch above 1.5' of bioretention soil which sits above a geotextile filter fabric. The bioretention soil sits above a 6" gravel drain rock layer which covers the entire cell base.

BIORETENTION SOIL:

Thickness: 1.3-1.5'

The thickness of the loose bioretention soil based on hand augers and probe results ranged from 1.3-1.5 feet of bioretention soil before encountering the filter fabric with an average of 1.4'. This is slightly less than the 1.5 feet specified by the plans.

Composition: The plans call for the city of Bellevue's 2011 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation and silt content for the tested material exceeded the specification for the 2019 Ecology specification. The organic matter content fell below the specified range.

Organic Matter Content (% by weight): 3.3

Percent passing #200 sieve: 11.3

Coefficient of Uniformity (Cu): 3.1

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense, slightly moist, grayish-brown, fine to medium SAND, some coarse sand, some gravel (SP)

BUILT PER PLAN:

The cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered during excavation of hand augers. The temporary wellpoint was screened from 1.9-2.4' below ground surface and responded to testing within 30 minutes. Once the storage in the underlying 6" gravel layer was full, the water level in the wellpoint rose to the same elevation as the surface water.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >1.4

Subgrade Soil Rate (in/hr): 1.4

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying Vashon Advance Outwash deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Rain Garden #2

Assessed On:
 August 14, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:
 The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------------------|-------------------------|------------------|
| Weather | Clear, 90s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Catherine Ikeda | Half Day: Alex Johanson | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 3 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230814-195612.jpg



Site Photo: FA_SitePhotos-20230814-195651.jpg



Site Photo: FA_SitePhotos-20230814-195631.jpg



Site Photo: FA_SitePhotos-20230814-195712.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Rain Garden #2


Assessed On:
 August 14, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation sprinklers observed around the perimeter of the cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 70% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments The cell is constructed with 3" of mulch above 1.5' of bioretention soil which sits above a geotextile filter fabric. The bioretention soil sits above a 6" gravel drain rock layer which covers the entire cell base which sits above native sediments. Water is conveyed to the cell from sheet flow run off and curb cuts from the adjacent parking lot, and from a catch basin southwest of the cell. All water is designed to infiltrate into the subgrade. | |

Inlets

| | | |
|--|---|---|
| IN-1 <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.4' Energy Dissipation Angular Rock: Functioning Stream Cobble: Functioning Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230814-215711.jpg</p> |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Stream cobbles and angular rocks at the base of the curb cut. | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Rain Garden #2

Assessed On:
August 14, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 29'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230814-215811.jpg

Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No


Additional Details: Angular rocks scattered along the slope of cell to dissipate energy.

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Rain Garden #2

Assessed On:
August 14, 2023



| | |
|---|--|
| <p>IN-3</p> <p><input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 45'</p> <p>Energy Dissipation Angular Rock: Functioning Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230814-215903.jpg</p> |
| <p>Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor</p> | <p>Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> |
| <p>Additional Details: Angular rocks scattered along the slope of cell to dissipate energy.</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
Cell: Rain Garden #2

Assessed On:
August 14, 2023



Design Overflow/Outlet

| | |
|--|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.1' Width: 1.8' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.3 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked Additional Details: Leaves were observed blocking part of the trash rack. | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| FA_DOPhoto-20230814-215602.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|--|---|---|-----------------------------------|--|------------------------------------|
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| The rain garden cell is heavily vegetated with shrubs and tall grasses. A natural mulch of leaf litter was observed in 50-75% of the cell. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Additional Details: No evidence of pests or animals was observed. Rabbits and squirrels were present in the area. | | | | | |
| Vegetation Description | | | | | |
| The cell is heavily vegetated with shrubs, tall grasses, and trees. The vegetation limits observations due to visual obstruction and thorns. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.3-1.5' of bioretention soil before encountering the filter fabric. This is consistent with the 1.5' specified by the plans. No zones of compaction were observed. Some areas of the cell could not be probed due to thick, thorny vegetation. | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Rain Garden #2

Assessed On:
 August 14, 2023



Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.9 |
| to Import/Underdrain: | 1.4 |
| Total Depth: | 2.3 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine-medium SAND, some coarse sand, abundant organics (SP) Native Soil Texture: Medium-dense, slightly moist, grayish-brown, fine-medium SAND, some coarse sand, some gravel (SP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black non-woven geotextile filter fabric |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details Underdrain Gravel: Loose, brownish-gray rounded fine GRAVEL (GP) Native Soil: Vashon Advance Outwash | |

| | |
|---|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.4 |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, fine-medium SAND, abundant organics, some silt (SP-SM) Native Soil Texture: | |
| Liner Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black non-woven geotextile filter fabric |
| Additional Details | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)
 Cell: Rain Garden #2

Assessed On:
 August 14, 2023



| |
|------|
| HA-2 |
| |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.4 |
| Total Depth: | 1.3 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, fine-medium SAND, some coarse sand, some gravel, trace silt, abundant organics (SP) Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black non-woven geotextile filter fabric |
| Additional Details | |

Infiltration Test

| | |
|--|--------|
| IT-2 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 | |
| Wetted Pond Area (sq. ft) | 1,014 |
| Ponded Depth (ft) | 0.64 |
| Total Gallons | 19,413 |
| Steady State Flow Rate (GPM) | 17 |
| Additional Details: Additional test details can be found in the executive summary. | |

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Spiritridge Elementary (BVSE)

Cell: Rain Garden #2

Assessed On:

August 14, 2023



SITE: SPIRITRIDGE ELEMENTARY (BVSE) CELL: RAIN GARDEN #2



LEGEND

- WELL POINT
- HAND AUGER
- TEMPORARY STAFF GAUGE
- OVERFLOW STRUCTURE
- DIFFUSER
- TOP OF FACILITY
- BASE OF FACILITY
- CURB CUT
- SHEET FLOW
- WETTED AREA



1 in = 40 ft

LOCATION AND DISTANCES ARE APPROXIMATE.



associated
earth sciences
incorporated

Well Point

BVSE-2-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/14/23

Logged By: CSI/APJ

20150387H008

Ending Date: 8/14/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.8

Water Level Elevation (ft): N/A

Datum: Project Datum

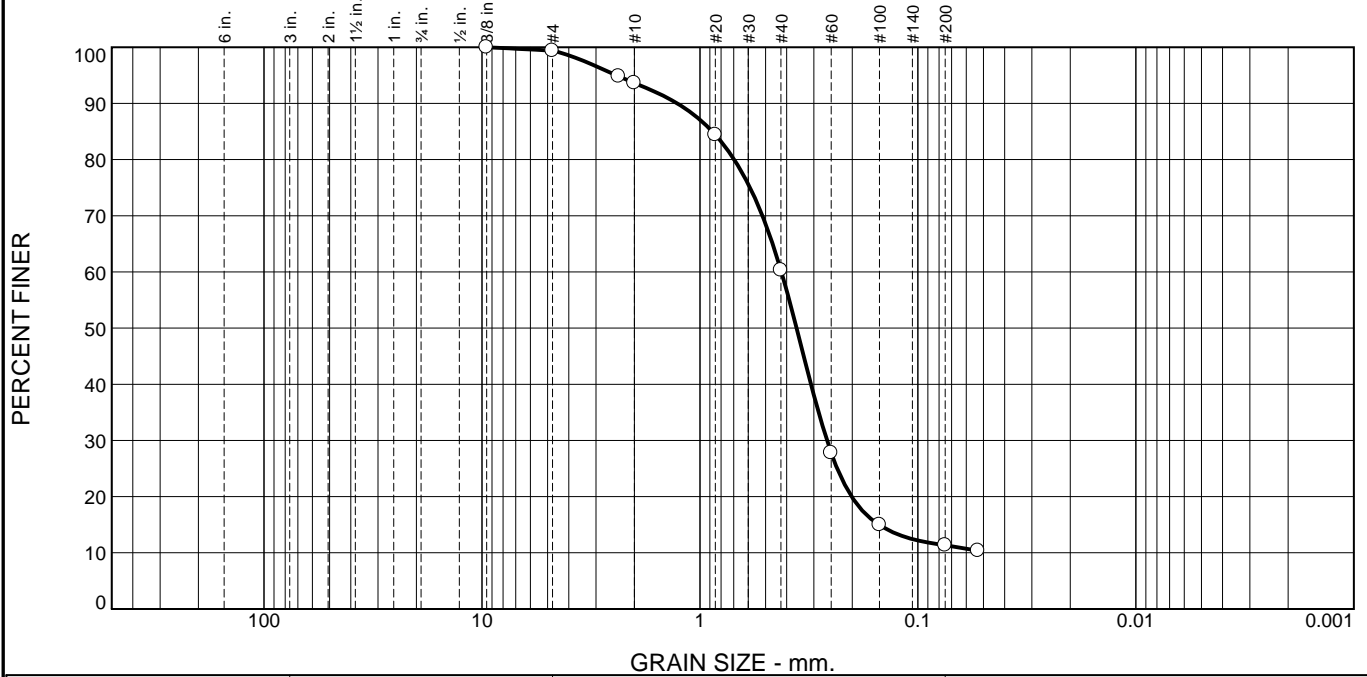
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Bioretention Soil Mix Loose, slightly moist, brown, fine to medium SAND, some silt, trace gravel; abundant organics (SP). | | | | | | | <p>Stick up -4.8 to 0 feet Existing bioretention soil 0 to 1.2 feet 1.25-inch I.D. threaded galvanized steel casing -4.8 to 0.5 feet; duct tape covers screen 0.5 to 1.9 feet</p> <p>3/8-inch bentonite chips 1.2 to 1.4 feet Backfill with gravels and native bioretention soil mix 1.4 to 2.3 feet</p> <p>1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.9 to 2.4 feet Cast iron endcap 2.4 to 2.7 feet Cast iron drivepoint 2.7 to 3 feet</p> |
| 1 | | | | Black geotextile filter liner at 1.4 feet. | | | | | | | |
| 2 | | | | Gravel Drainage Layer Loose, moist, brownish gray, GRAVEL (GP). | | | | | | | |
| 3 | | | | Vashon Advance Outwash Medium dense, slightly moist, grayish-brown, fine to medium SAND, some coarse sand, some gravel (SP). | | | | | | | |
| 3 | | | | No seepage. No caving. Hole terminated at 2.3 feet due to presence of gravel and no returns. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/21/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.6 | 5.8 | 33.3 | 49.0 | 11.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 99.4 | | |
| #8 | 94.8 | | |
| #10 | 93.6 | | |
| #20 | 84.4 | | |
| #40 | 60.3 | | |
| #60 | 27.8 | | |
| #100 | 15.0 | | |
| #200 | 11.3 | | |
| #270 | 10.4 | | |

Material Description

SAND some silt trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 1.2696 D₈₅= 0.8782 D₆₀= 0.4228
D₅₀= 0.3602 D₃₀= 0.2613 D₁₅= 0.1507
D₁₀= C_u= C_c=

Remarks

Date Received: 8-14-2023 Date Tested: 11-15-2023

Tested By: FEW

Checked By: CSI/JHS

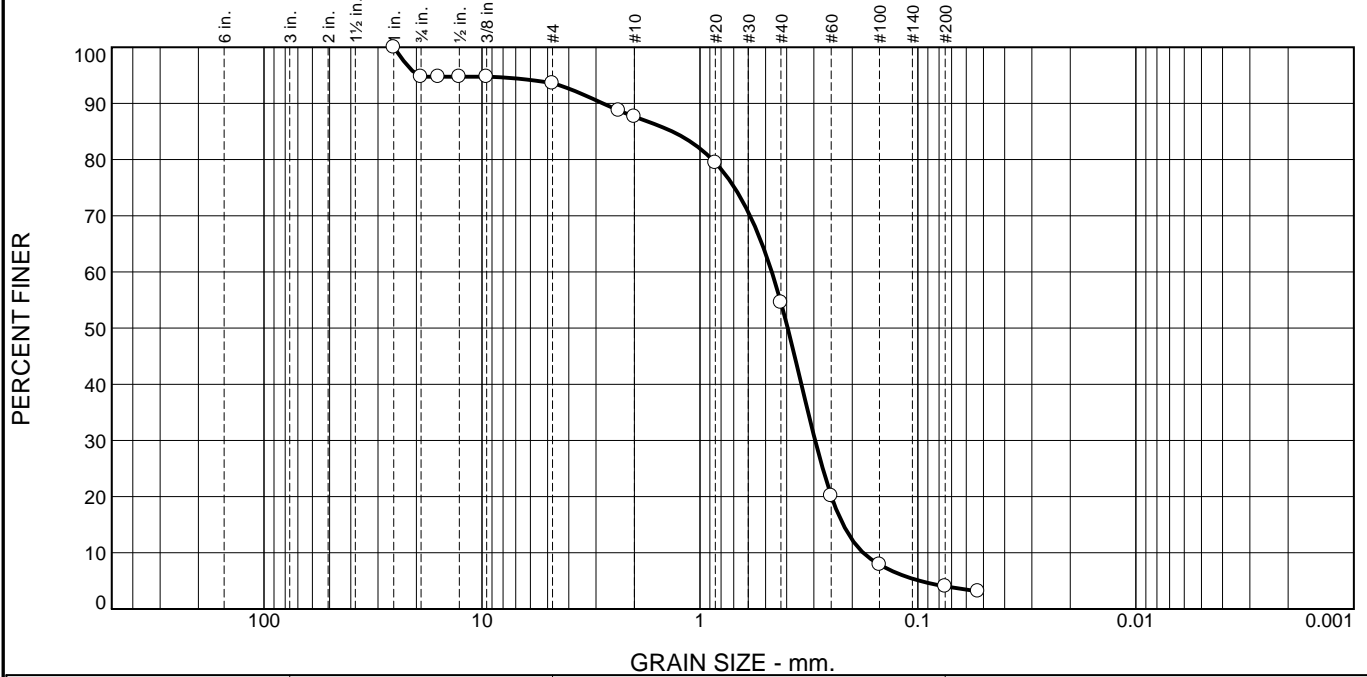
Title: _____

* (no specification provided)

Location: Onsite - BHPS-BVSR#2 Date Sampled: 8-14-2023
Sample Number: HA-1 Depth: 0-1'

| | |
|---------------------------|---|
| | Client: City of Olympia |
| | Project: Bioretention Hydrologic Performance Monitoring Study |
| Project No: 20150387 H008 | Figure |

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.2 | 1.2 | 6.0 | 33.0 | 50.6 | 4.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 94.8 | | |
| 5/8" | 94.8 | | |
| 1/2" | 94.8 | | |
| 3/8" | 94.8 | | |
| #4 | 93.6 | | |
| #8 | 88.8 | | |
| #10 | 87.6 | | |
| #20 | 79.4 | | |
| #40 | 54.6 | | |
| #60 | 20.2 | | |
| #100 | 7.9 | | |
| #200 | 4.0 | | |
| #270 | 3.2 | | |

Material Description

SAND some gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

D₉₀= 2.7876 D₈₅= 1.3390 D₆₀= 0.4680
D₅₀= 0.3956 D₃₀= 0.2961 D₁₅= 0.2202
D₁₀= 0.1782 C_u= 2.63 C_c= 1.05

Remarks

Date Received: 8-14-2023 Date Tested: 11-15-2023

Tested By: FEW

Checked By: CSI/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-BVSR#2 Date Sampled: 8-14-2023
Sample Number: HA-3 Depth: 1.3'

| | |
|---------------------------|---|
| | Client: City of Olympia |
| | Project: Bioretention Hydrologic Performance Monitoring Study |
| Project No: 20150387 H008 | Figure |



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|-----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 10/27/2023 | Project BHPS-BVSE-2 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellevue, WA | EB/EP No. BVSE-2-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-1' | HA-3 @ 1.3' |
|--------------------|-------------|-------------|
| Wet Weight + Pan | 563.13 | 575.04 |
| Dry Weight + Pan | 552.51 | 565.38 |
| Weight of Pan | 255.36 | 258.22 |
| Weight of Moisture | 10.62 | 9.66 |
| Dry Weight of Soil | 297.15 | 307.16 |
| % Moisture | 3.57 | 3.14 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 552.51 | 565.38 |
| Dry Soil After Burn + Pan | 542.73 | 556.61 |
| Weight of Pan | 255.36 | 258.22 |
| Wt. Loss Due to Ignition | 9.78 | 8.77 |
| Actual Wt. Of Soil After Burn | 287.37 | 298.39 |
| % Organics | 3.29 | 2.86 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---|--------------------------------|------------------------|
| Project Name: | Spiritridge Elementary School-Raingarden #2 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 8/14/2023 | Wetted Area (sq. feet): | Static pond: 1014 ft^2 |
| Weather: | Clear, 70's | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.46 |
| Performed By: | CSI/ APJ | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|-------------|----------------------|---------------------|---------------------------------------|
| 10:48 | | | | | 0 | Water on |
| 10:50 | 55.1 | 0.06 | | | 95 | |
| 10:55 | 55.24 | 0.06 | 4.77 | | 364 | Flow up to 77 gpm |
| 11:01 | 77.6 | 0.06 | | - | 766 | |
| 11:10 | 77.36 | 0.05 | | | 1,461 | |
| 11:19 | | 0.06 | 4.78 | 6.42 | | Flow up to 95 gpm |
| 11:30 | 95.4 | 0.06 | 4.78 | 6.25 | 3,242 | |
| 11:45 | 94.96 | 0.08 | 4.78 | 5.78 | 4,669 | |
| 12:00 | 95.12 | 0.1 | | 5.48 | 6,106 | |
| 12:15 | 95.12 | 0.12 | 4.78 | 5.12 | 7,518 | Slight trickle into RG #5 CB |
| 12:31 | 95.01 | 0.18 | | 4.85 | 9,037 | |
| 12:45 | 95.64 | 0.25 | 4.77 | 4.74 | 10,365 | Water reached RG #2 CB |
| 13:03 | 95.86 | 0.37 | | 4.57 | 12,086 | Water trickling into RG #2 CB < 1 gpm |
| 13:15 | 87.9 | 0.47 | | 4.52 | 13,216 | Flow down to 88 |
| 13:23 | 56.74 | 0.5 | | | 13,740 | Flow down to 55 |
| 13:30 | 56.4 | 0.53 | | 4.42 | 14,127 | Flow down to 38 |
| 13:47 | 37.24 | 0.54 | | 4.4 | 15,333 | |
| 14:00 | 37.38 | 0.58 | | 4.38 | 15,880 | Flow down to 30 |
| 14:17 | 29.88 | 0.6 | | 4.35 | 16,377 | |
| 14:34 | 30.1 | 0.61 | | 4.34 | 16,727 | |
| 14:46 | 27.93 | 0.64 | | 4.33 | 16,727 | |
| 14:48 | | | | | 16,782 | Water off to stop CB overflow |
| 15:02 | | 0.59 | | | | Water on |
| 15:05 | 10.7 | 0.59 | | | 16,799 | |
| 15:16 | 10.33 | 0.58 | 4.75 | 4.35 | 16,913 | |
| 15:30 | 10.28 | 0.57 | | 4.34 | 17,056 | No change in RG #5 CB |
| 15:45 | 10.28 | 0.55 | | 4.36 | 17,210 | Flow up to 17 gpm |
| 16:00 | 17.25 | 0.55 | | 4.35 | 17,465 | |
| 16:15 | 21 | 0.56 | | 4.34 | 17,785 | Adjusting flow rate |
| 16:30 | 16.98 | 0.56 | | 4.33 | 18,046 | |
| 16:45 | 17.1 | 0.56 | | 4.33 | 18,303 | |
| 17:00 | 17.15 | 0.56 | | 4.34 | 18,560 | |
| 17:17 | 17.04 | 0.57 | | 4.33 | 18,850 | |
| 17:30 | 17.1 | 0.57 | | 4.33 | 19,073 | |
| 17:45 | 17.04 | 0.58 | | 4.33 | 19,325 | |
| 17:50 | | 0.58 | | 4.32 | 19,413 | Water off |

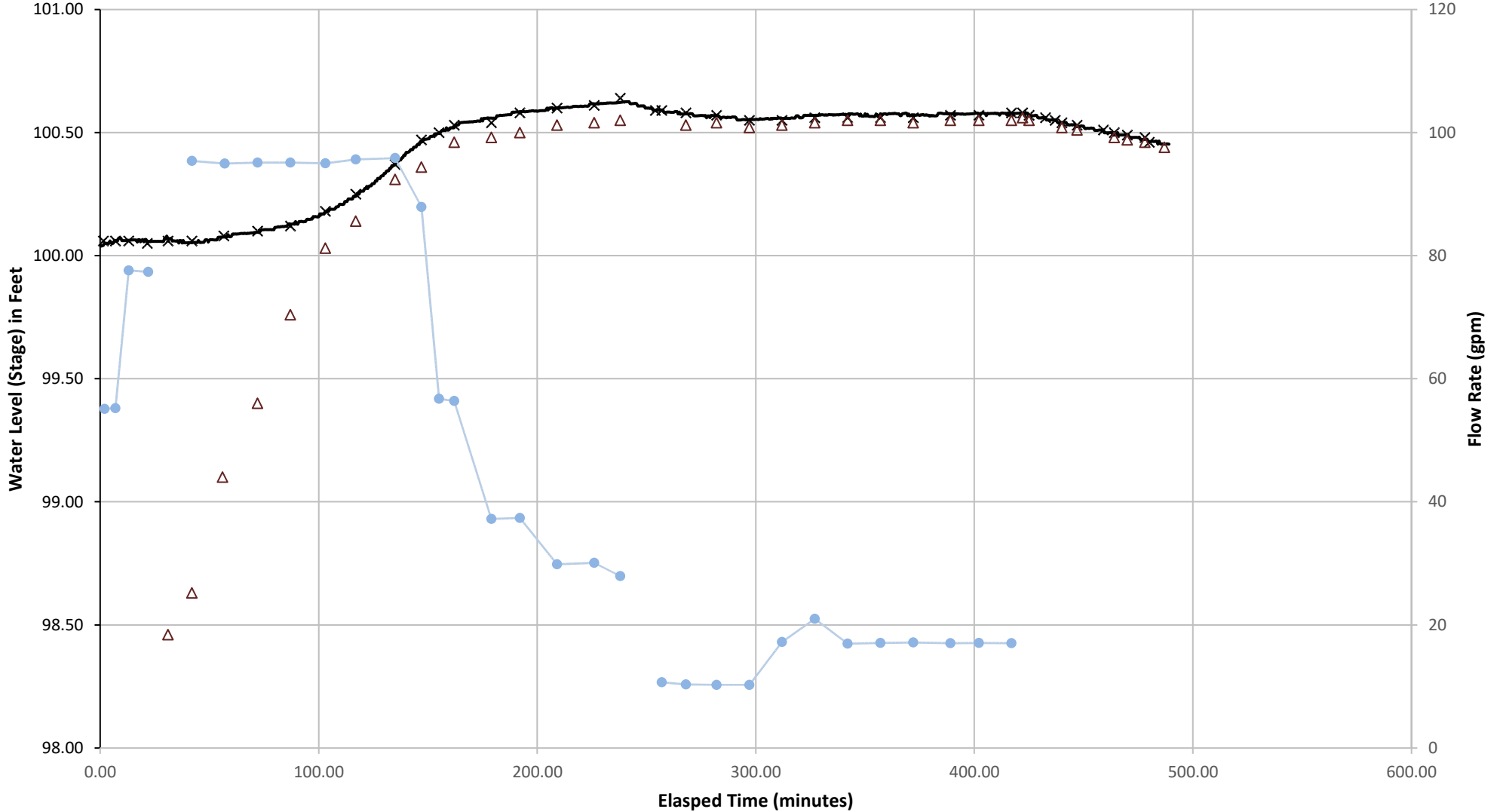
| | | | | | | |
|-------|--|------|--|------|--|--|
| 17:53 | | 0.57 | | 4.33 | | |
| 18:00 | | 0.56 | | | | |
| 18:05 | | 0.55 | | | | |
| 18:08 | | 0.54 | | 4.36 | | |
| 18:15 | | 0.53 | | 4.37 | | |
| 18:27 | | 0.51 | | | | |
| 18:32 | | 0.5 | | 4.4 | | |
| 18:38 | | 0.49 | | 4.41 | | |
| 18:46 | | 0.48 | | 4.42 | | |
| 18:55 | | 0.46 | | 4.44 | | |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 1.4 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 1.3 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 1.7 |
| WP Average Infiltration Rate (in/hr) during falling head: | 1.3 |

Spiritridge Elementary-Raingarden #2 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

× Staff Gauge #1 Hand Data
— Staff Gauge #1 Logger
△ Wellpoint Hand
● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and collects runoff from the adjacent parking lot through a series of curb cut inlets. The cell is constructed 3" of mulch atop 1-1.5' of bioretention soil above a full width gravel underdrain, 10" minimum depth. Prior to construction, the top 3-4" of existing soils are to be scarified and filter fabric is to be placed above the native soils. The underdrain pipe connects the tested cell (Bioretention Pond A) to an adjacent cell (Bioretention Pond B) for further remediation before conveyance to the storm drain network.

BIORETENTION SOIL:

Thickness: 1.1-1.8

The thickness of the loose bioretention soil ranged from 1.1-1.8 feet of bioretention soil with an average depth of 1.4 feet. This is slightly less than the 1.5' specified by the plans.

Composition: The plans call for the city of Bellevue's 2010 surface water engineering standards specification bioretention soil, which is equivalent to Hinman's 2009 guidance. The sand gradation for the tested material barely exceeded the specification for the 2019 Ecology specification. The silt content fell within the specified range and the organic matter content fell below the specified range.

Organic Matter Content (% by weight): 4.4

Percent passing #200 sieve: 3.2

Coefficient of Uniformity (Cu): 3

Coefficient of Curvature (Cc): 1

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Hand auger explorations did not penetrate the underdrain gravels.

BUILT PER PLAN:

The cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered during excavation of hand augers. The temporary wellpoint was screened from 1.9-2.4' below ground surface and did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 62.7

Subgrade Soil Rate (in/hr): N/A

The subgrade soil infiltration rate cannot be determined from our infiltration test due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

BIORETENTION CELL FIELD ASSESSMENT

Site: Tyee Middle School (BVTM)
 Cell: Bioretention Pond A

Assessed On:
 August 8, 2023



The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|-------------------------|---------------------|
| Weather | Cloudy | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.02" | Two Days Ago: 0.01" |
| Field Reps | Full Day: Sarah Faubion | Half Day: Alex Johanson | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 9 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230808-165428.jpg



Site Photo: FA_SitePhotos-20230808-165512.jpg



Site Photo: FA_SitePhotos-20230808-165453.jpg



Site Photo: FA_SitePhotos-20230808-165535.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
 Cell: Bioretention Pond A

Assessed On:
 August 8, 2023



Site Photo: FA_SitePhotos-20230808-165600.jpg



Site Photo: FA_SitePhotos-20230808-165626.jpg

Cell Construction

| | |
|---|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation sprinklers were observed around the perimeter of the cell. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.33' Full Width Width ' Underdrain is set within 6' of underdrain gravels at a 0% slope and runs under Pond A and connects to the underdrain of Pond B before connecting to the catch basin. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from several curb cut inlets through the sidewalk from parking lot, downspout inlets from the roofs and wall cuts at the base of the trash shed. Inlet 1 appears to be an equalization pipe between Pond A and Pond B as both ponds are designed at the same elevation. Bent pipe cleanout located at equalization pipe between Pond A & B. The plans show a 4" underdrain pipe at a 0% slope that runs the center of Pond A, and this possibly connects to Pond B in the same line as the equalization pipe, and is shown continuing through the center of Pond B and connecting into the catch basin located at the south end of Pond B. Water is designed to infiltrate through the bioretention soil before infiltrating into the underdrain gravels before entering the perforated pipe and flowing to the catch basin the connecting storm drainage system. | |

Cleanouts

| | |
|----------------------------------|--|
| CL-1 | |
| Condition | Accessible: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Distance from overflow/outlet: ' | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.65'

Energy Dissipation

Angular Rock: Buried

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230808-171336.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details:



FA_INBLPhoto-20230808-171314.jpg

Additional Details: This inlet connects to an inlet located in Pond B, appears to be possibly an equalization feature to connect the two bioretention ponds.

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.5'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230808-171926.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Leaf debris was observed on the parking lot side of the inlet, sediment blockage increases towards cell.



FA_INBLPhoto-20230808-171903.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.5'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230808-172226.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Sediment deposition was observed on the parking lot side of the inlet. It appears that water pools there before entering cell based on the pattern of the fine sediment deposition.



FA_INBLPhoto-20230808-172305.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



IN-4

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230808-172910.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details:



FA_INBLPhoto-20230808-172859.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



IN-5

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.35'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230808-174403.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details:



FA_INBLPhoto-20230808-174338.jpg


Additional Details: There is no observable energy dissipation for these four cut outs at the base of the wall of the trash shed. These wall cut outs appear to be in place for spray cleaning out the trash shed, as the three sided shed has a roof, and there are some visible signs that water occasionally flows into the cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
 Cell: Bioretention Pond A

Assessed On:
 August 8, 2023



| | |
|--|--|
| <p>IN-6</p> <p><input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 40'</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230808-181205.jpg</p> |
| <p>Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Can identify a main flow path from erosion, but the erosion is not major. Water flow paths are potentially from pressure washing the concrete.</p> | <p>Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> |
| <p>Additional Details: None present, sheet flow from utility access& fire lane</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



IN-7

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230808-183818.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details:



FA_INBLPhoto-20230808-183804.jpg


Additional Details:


BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
 Cell: Bioretention Pond A

Assessed On:
 August 8, 2023



| | |
|--|--|
| IN-8 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: Pipe: Material <input checked="" type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.5' Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230808-184053.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |

| | |
|--|--|
| IN-9 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: Pipe: Material <input checked="" type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.5' Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230808-184225.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



Design Overflow/Outlet

| | |
|--|----------------------------|
| DO - 1 | |
| Shape: <input checked="" type="checkbox"/> Round <input type="checkbox"/> Rectangular <input type="checkbox"/> Other Additional Details: | Dimensions: Diameter: ' |
| Stickup (ft) From Ground: Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input type="checkbox"/> No | |

Cell Surface and Geotech Probe Observations

| | |
|---|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.1 | |
| Cell Coverage | |
| Mulch | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| The bioretention cell is thickly vegetated with woody shrubs and it is difficult to easily access about 50% of cell. Dead grasses leave natural mulch in 75% of cell bottom. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |
| Vegetation Description Thick shrub vegetation limits work in cell. | |
| Additional Details Geotech Probe Observations: At the cell base, probe measurements found 1.1-1.8 feet of bioretention soil before encountering the underdrain gravels with an average of probe depth of 1.4 feet. This is slightly less than the 1.5' specified by the plans. On the cell edges, probe measurements were less than 1 foot, this is consistent with the design as the majority of the sloped sides of the bioretention pond do not have a layer of bioretention soil above subgrade. Zones of compaction were not observed. Some areas of the cell could not be probed due to an electrical utility line on the west end of the cell, and thick vegetation. | |

Hand Auger

| | |
|---|--|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



| | |
|---|---|
| HA-1 | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (rootlets) (SP) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| IMG_0433.jpg | |
| Additional Details | |
| There was a 0-0.2 foot thick rootlet mass at the surface of HA-1, below this consisted of bioretention soil mix, but hit refusal at large roots at 0.5feet depth. | |

| | |
|--|---|
| HA-2-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.5 |
| Total Depth: | 3 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown to brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (rootlets) (SP) | |
| Native Soil Texture: Loose, slightly moist, grey, fine GRAVEL, trace sand (GP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Tyee Middle School (BVTM)
 Cell: Bioretention Pond A

Assessed On:
 August 8, 2023



| | | |
|---|--|---|
| HA-2-WP Shallowest Depth to water during testing from Ground Surface (ft): | | FA_FPhoto-20230808-212652.jpg  |
| Additional Details | | IMG_0434.jpg |

| | | |
|--|---|---|
| HA-3 <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |  |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | | |
| to Import/Underdrain: | 1.6 | |
| Total Depth: | 1.7 | |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown to dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt, abundant organics (SP) Native Soil Texture: Loose, slightly moist, grey, fine GRAVEL, some sand (GP) | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | IMG_0435.jpg |
| Additional Details | | |

Infiltration Test

| | | |
|--|--------|--|
| IT-1 Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck AESI Meter# FM6 (10-100) | | |
| Wetted Pond Area (sq. ft) | 166 | |
| Ponded Depth (ft) | 0.26 | |
| Total Gallons | 40,194 | |
| Steady State Flow Rate (GPM) | 99 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
Cell: Bioretention Pond A

Assessed On:
August 8, 2023



Additional Details:

Additional test details can be found in the executive summary.



IT_Photo-20230808-220843.jpg



IT_Photo-20230808-220904.jpg



IT_Photo-20230808-220921.jpg

Additional Comments

There is a cleanout present, but pipe bends east, away from cell, it is likely this cleanout is for connecting pipe that connects the underdrain of both ponds.

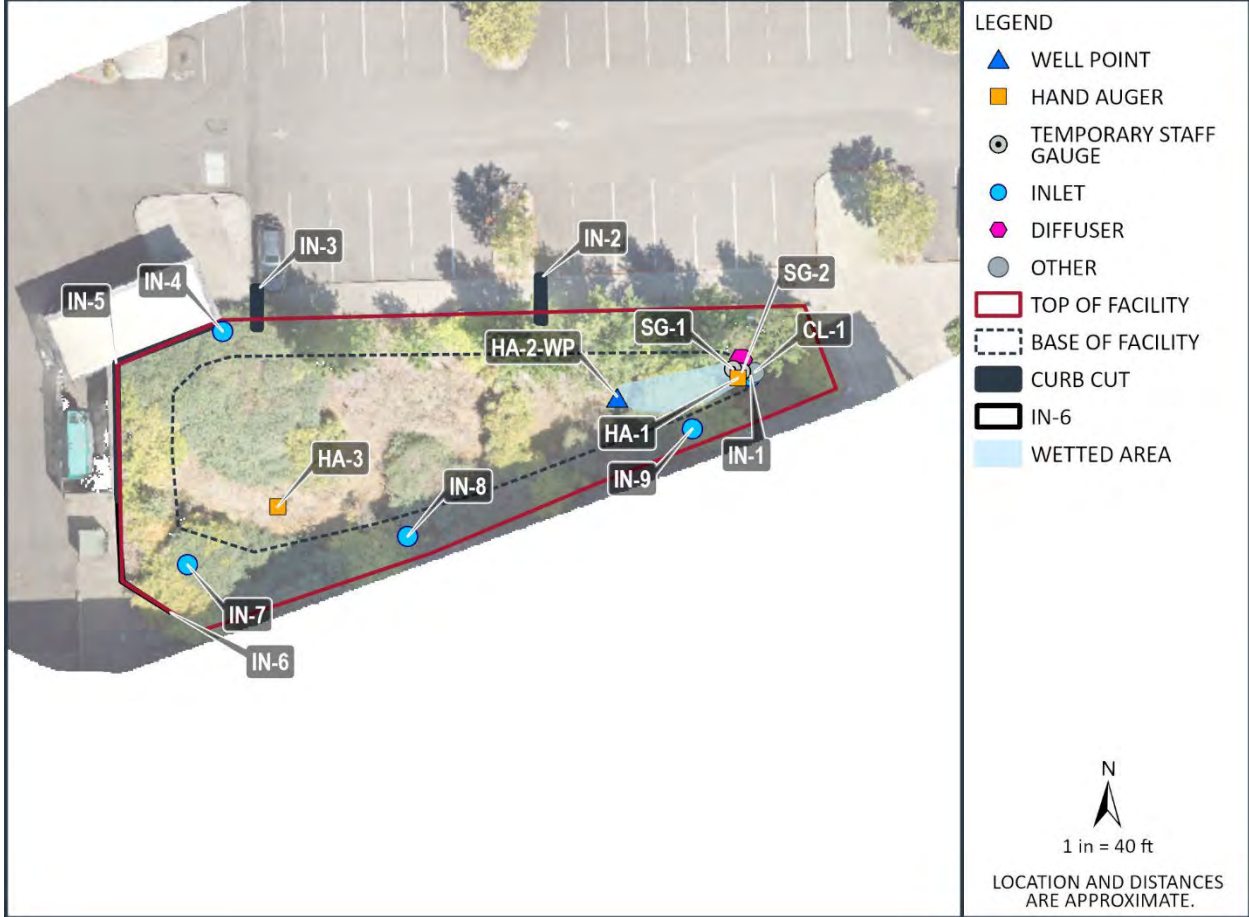
BIORETENTION CELL FIELD ASSESSMENT

Site: Tye Middle School (BVTM)
 Cell: Bioretention Pond A

Assessed On:
 August 8, 2023



SITE: TYEE MIDDLE SCHOOL (BVTM) CELL: BIORETENTION POND A





associated
earth sciences
incorporated

Well Point

BVTM-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/8/23

Logged By: SNCF/APJ

20150387H008

Ending Date: 8/8/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.7

Water Level Elevation (ft): N/A

Datum: Project Datum

∇ Groundwater Depth ATD (ft): N/A

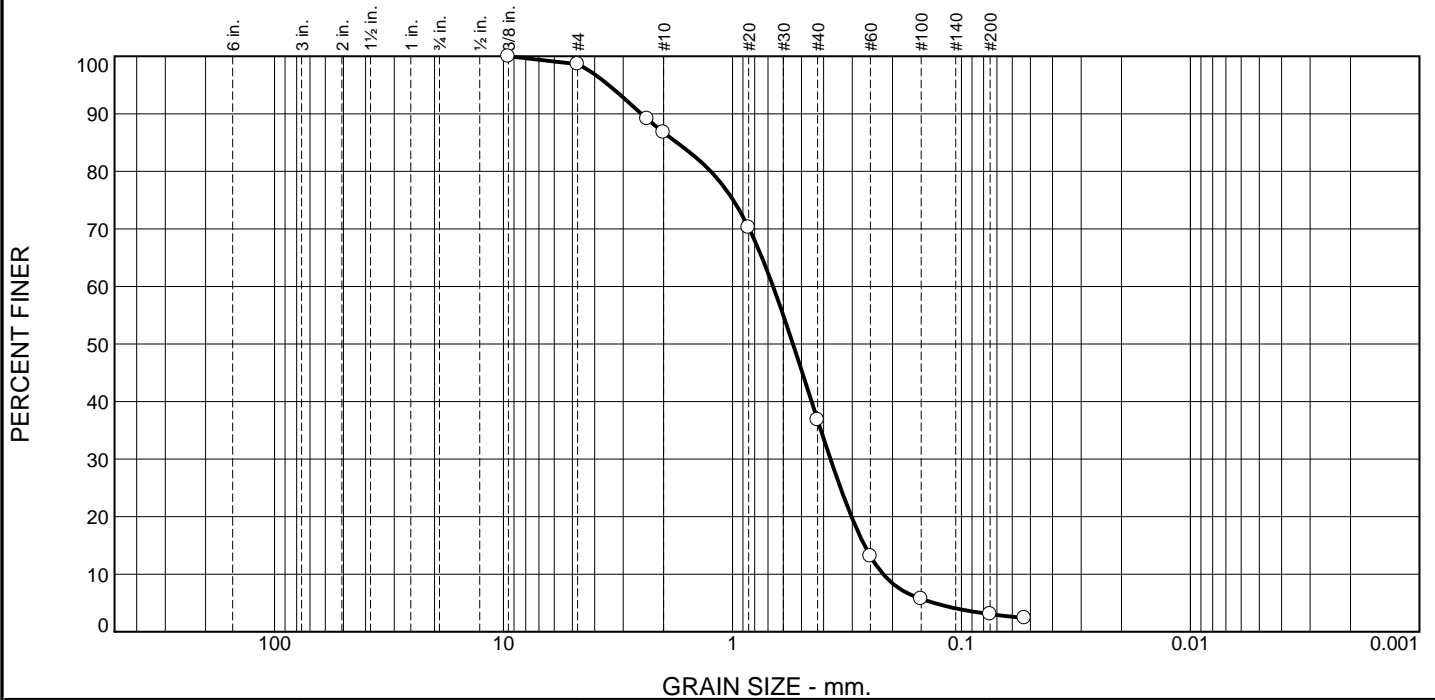
∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----------|----------|----------|----------|---|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | Soil Mix | Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, trace silt, trace gravel; abundant organics (rootlets) (SP). | | | | | | | Stickup -4.7 to 0 feet Bioretention soil mix 0 to 1.3 feet 1.25-inch I.D. threaded galvanized steel casing -4.7 to -0.4 feet; duct tape covers screen -0.4 to 1.9 feet 3/8-inch bentonite chips 1.3 to 1.5 feet Bioretention soil mix 1.5 to 1.9 feet Underdrain gravel 1.9 to 2.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.9 to 2.4 feet Cast iron endcap 2.4 to 2.7 feet Cast iron drivepoint 2.7 to 3 feet |
| 1 | Hand | 2 | Soil Mix | | | | | | | | |
| 2 | Hand | 3 | Gravel | Underdrain Gravel Loose, slightly moist, gray, fine GRAVEL, trace sand (GP). | | | | | | | |
| 3 | | | | No seepage. Moderate caving 1.5 to 2.3 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/20/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.4 | 11.8 | 50.0 | 33.7 | 3.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 98.6 | | |
| #8 | 89.1 | | |
| #10 | 86.8 | | |
| #20 | 70.3 | | |
| #40 | 36.8 | | |
| #60 | 13.1 | | |
| #100 | 5.7 | | |
| #200 | 3.1 | | |
| #270 | 2.4 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.4984 D₈₅= 1.7467 D₆₀= 0.6645
D₅₀= 0.5442 D₃₀= 0.3733 D₁₅= 0.2652
D₁₀= 0.2199 C_u= 3.02 C_c= 0.95

Remarks

Date Received: 8/08/2023 Date Tested: 10/03/2023

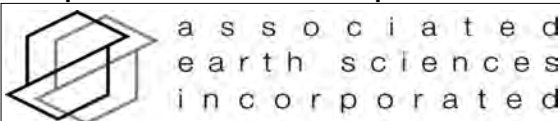
Tested By: FEW

Checked By: SNCF/APJ/JHS

Title: _____

Location: Onsite - Bellevue Tyee MS
Sample Number: HA-1 Depth: 0-0.5'

Date Sampled: 8/8/2023

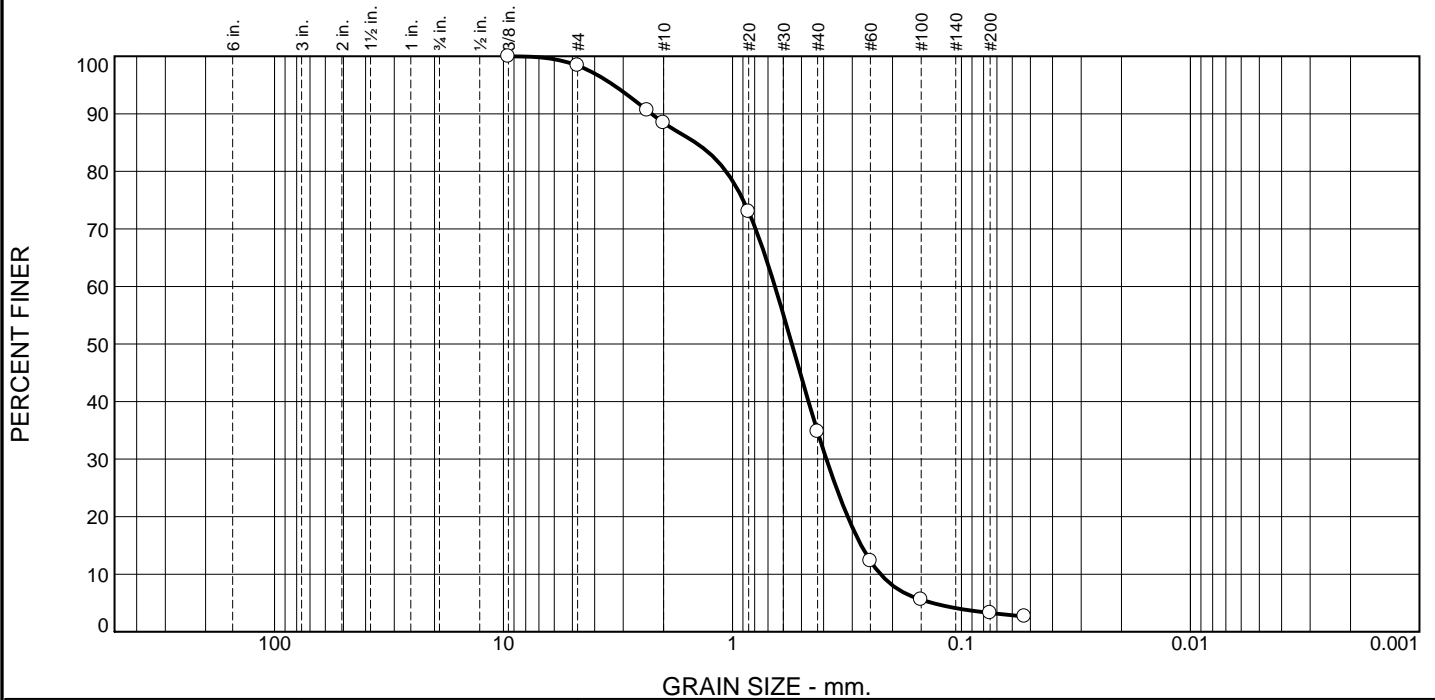


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.6 | 10.0 | 53.6 | 31.5 | 3.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 98.4 | | |
| #8 | 90.6 | | |
| #10 | 88.4 | | |
| #20 | 73.0 | | |
| #40 | 34.8 | | |
| #60 | 12.3 | | |
| #100 | 5.6 | | |
| #200 | 3.3 | | |
| #270 | 2.7 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.2548 D₈₅= 1.4491 D₆₀= 0.6522
D₅₀= 0.5501 D₃₀= 0.3890 D₁₅= 0.2740
D₁₀= 0.2257 C_u= 2.89 C_c= 1.03

Remarks

Date Received: 8/08/2023 Date Tested: 10/03/2023

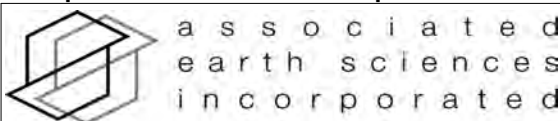
Tested By: FEW

Checked By: SNCF/APJ/JHS

Title: _____

Location: Onsite - Bellevue Tye MS
Sample Number: HA-2 Depth: 0-1.5

Date Sampled: 8/8/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|---------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/8/2023 | Project BHPS - Tyee MS | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellevue, WA | EB/EP No. BVTM-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.5' | HA-2 @ 0.3-1.5' |
|--------------------|---------------|-----------------|
| Wet Weight + Pan | 860.60 | 1450.60 |
| Dry Weight + Pan | 810.14 | 1388.18 |
| Weight of Pan | 247.07 | 358.00 |
| Weight of Moisture | 50.46 | 62.42 |
| Dry Weight of Soil | 563.07 | 1030.18 |
| % Moisture | 8.96 | 6.06 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------------|----------------|
| Dry Soil Before Burn + Pan | 810.14 | 1388.18 |
| Dry Soil After Burn + Pan | 779.30 | 1353.59 |
| Weight of Pan | 247.07 | 358.00 |
| Wt. Loss Due to Ignition | 30.84 | 34.59 |
| Actual Wt. Of Soil After Burn | 532.23 | 995.59 |
| % Organics | 5.48 | 3.36 |

ASSOCIATED EARTH SCIENCES, INC

| | | | |
|------------------------|---|--------------------------------|---|
| Project Name: | Tyee Middle School-Bioretenction Pond A | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM 6 (10-100) |
| Date: | 8/8/2023 | Wetted Area (sq. feet): | 10:45: 102 ft^2 / 12:00: 150 ft^2 / 13:15: 153 ft^2 |
| Weather: | Clear, 70's | Underdrain | Yes |
| Test No.: | IT- 1 | Test Depth (feet): | .26' |
| Performed By: | SNCF / APJ | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Cleanout | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------|----------------------|---------------------|---|
| 9:30 | 47.19 | 0 | | DRY | DRY | 0 | Water on |
| 9:45 | 47.8 | 0 | | | DRY | 711 | Flow up to 80 gpm |
| 9:50 | | 0 | 0.17 | | DRY | | Staff Gauge #2 added, ponded area very small |
| 10:00 | 81.6 | 0 | 0.18 | | DRY | 1,885 | |
| 10:15 | 81.3 | 0 | 0.18 | DRY | DRY | 3,160 | |
| 10:25 | 99.3 | | | | | | Flow up to 100 gpm |
| 10:30 | 99.3 | 0 | 0.2 | DRY | DRY | 4,438 | |
| 10:45 | 98.2 | 0 | 0.22 | DRY | DRY | 5,965 | Small ponding at SG-1, less than 1/2 inch depth |
| 11:00 | 99.6 | 0 | 0.22 | DRY | DRY | 7,413 | Pond growing |
| 11:15 | 98.7 | 0 | 0.22 | DRY | DRY | 8,877 | |
| 11:30 | 98.2 | 0 | 0.22 | DRY | DRY | 10,383 | |
| 11:47 | 99 | 0 | 0.22 | DRY | DRY | 12,074 | |
| 12:00 | 99.1 | 0 | 0.22 | DRY | DRY | 13,346 | |
| 12:18 | 99.1 | 0 | 0.22 | | DRY | 15,131 | |
| 12:33 | 99.68 | | 0.22 | | | 16,619 | |
| 12:50 | 99.1 | 0.26 | 0.22 | | | 18,482 | Moved SG-1 |
| 13:05 | 100.1 | 0.26 | 0.22 | | | 19,819 | Pond still growing |
| 13:17 | 99.3 | 0.26 | 0.22 | DRY | DRY | 21,012 | |
| 13:30 | 99.4 | 0.26 | 0.22 | | | 22,282 | |
| 13:45 | 99.5 | 0.26 | 0.22 | | | 23,783 | |
| 14:00 | 100.02 | 0.26 | 0.22 | Moist | DRY | 25,274 | |
| 14:15 | 99.05 | 0.26 | 0.22 | | | 26,755 | |
| 14:30 | 99.8 | 0.26 | 0.22 | | | 28,240 | |
| 14:45 | 98.3 | 0.26 | 0.22 | Moist | DRY | 29,738 | |
| 15:00 | 99.2 | 0.26 | 0.22 | | | 31,348 | |
| 15:15 | 98.9 | 0.26 | 0.22 | Moist | | 32,715 | |
| 15:30 | 99.9 | 0.26 | 0.22 | Moist | DRY | 34,206 | |
| 15:40 | 99.6 | 0.26 | 0.22 | | | 35,203 | |
| 15:50 | 98.8 | 0.26 | 0.22 | | DRY | 36,198 | Pond still growing slightly |
| 16:00 | 100.9 | 0.26 | 0.22 | | DRY | 37,195 | |
| 16:10 | 99.5 | 0.26 | 0.22 | Moist | DRY | 38,184 | |
| 16:20 | 98.4 | 0.26 | 0.22 | | | 39,177 | |
| 16:30 | | 0.26 | 0.22 | Moist | | 40,194 | Water Off |
| 16:31 | | 0.1 | 0.06 | | | | |
| 16:32 | | 0.02 | 0 | | | | |
| 16:32 | | 0 | | | | | |

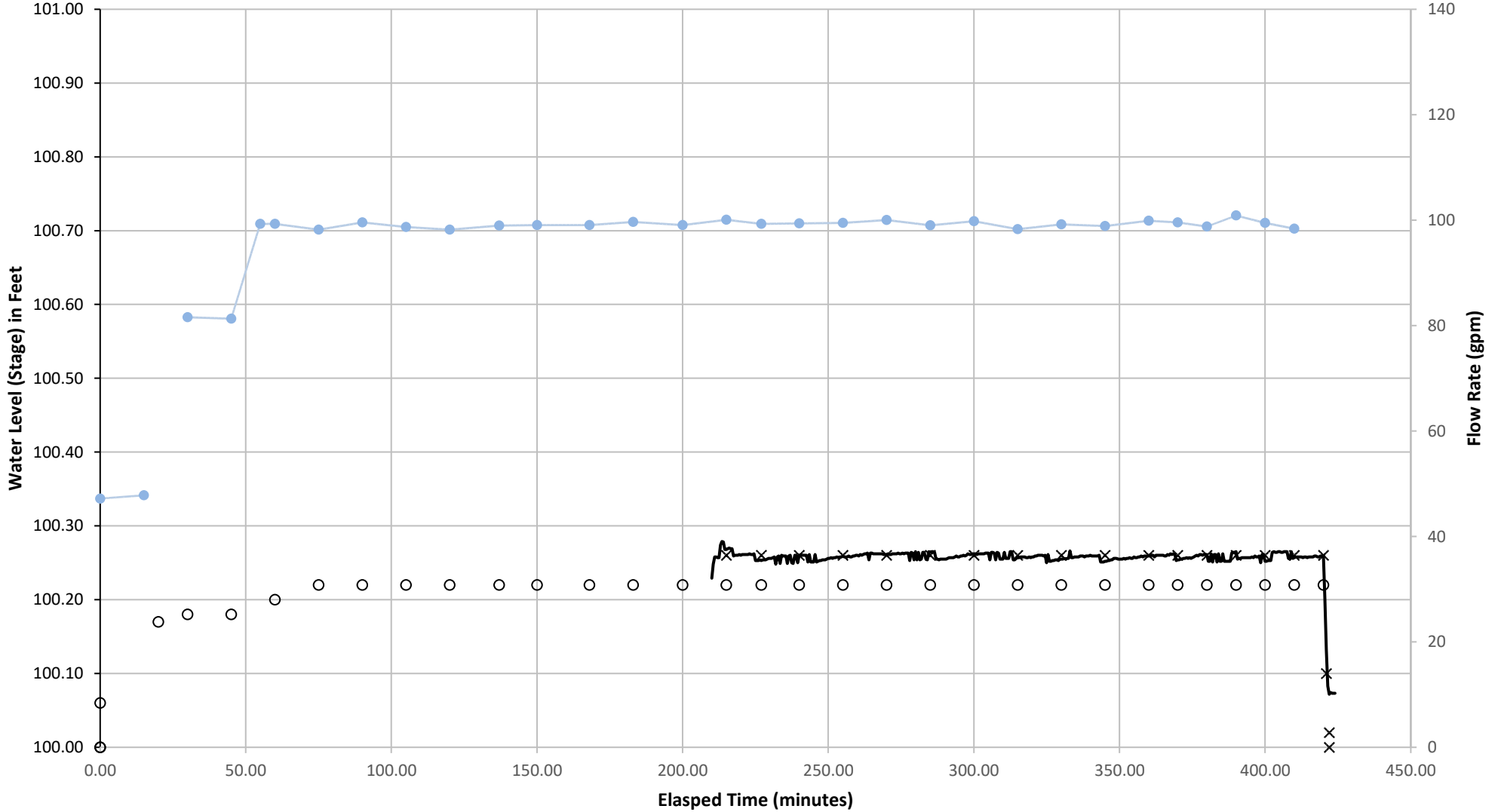
| | |
|---|------|
| SG-1: Average Infiltration Rate (in/hr) during last hour of inflow: | 62.7 |
| SG-1: Average Infiltration Rate (in/hr) during falling head: | 93.6 |

| | |
|---|------|
| SG-2: Average Infiltration Rate (in/hr) during last hour of inflow: | 62.8 |
|---|------|

| | |
|--|-------|
| SG-2: Average Infiltration Rate (in/hr) during falling head: | 115.2 |
|--|-------|

Tye Middle School-Bioretenion Pond A Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and are a relative reference.
Elevation 100 represents ground surface.

× Staff Gauge #1 Hand Data

— Staff Gauge #1 Logger

○ Staff Gauge #2 Hand Data

● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
Cell: Cell 1

Assessed On:
July 25, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2013 and collects road runoff from two piped inlets. The cell is constructed with 1.5' of bioretention soil above a 1' deep underdrain trench and perforated pipe which conveys water to a catch basin on the eastern end of the cell and out to the storm drain network. An overflow structure sits on the eastern end of the cell and is designed to collect water during overflow events. All water is designed to infiltrate through the bioretention soil and into the underdrain.

BIORETENTION SOIL:

Thickness: 0.7-1.4'

The thickness of the loose bioretention soil ranged from 0.7-1.9' based on hand augers and soil probe results with an average of 1.1'. This is less than the 1.5' specified by the plans.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications the tested material the sand gradation was coarser than the standard while the silt content met the standard. The organic matter content was less than the 2019 standard. Soil samples taken from the slower draining half of the cell found silt content which greatly exceeded the 2019 specifications (12.9%)

Organic Matter Content (% by weight): 2.5

Percent passing #200 sieve: 4.9

Coefficient of Uniformity (Cu): 9.9

Coefficient of Curvature (Cc): 1.3

SUBGRADE CONDITIONS:

Geologic Unit: Everson Glaciomarine Drift

Soil Description: Medium stiff, moist, light brown, sandy SILT, some gravel; scattered organics (ML)

BUILT PER PLAN:

A non-design overflow was observed in the southeastern corner of the cell. Water bypassed the design overflow structure at a ponded depth of 0.26' and flows downhill to the adjacent school playfield to the south.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell. The temporary wellpoint was screened from 1.5-2.5' below ground surface in glaciomarine drift sediments directly adjacent to the underdrain and did not respond to infiltration testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 6.1

Subgrade Soil Rate (in/hr): N/A

The subgrade soil infiltration rate cannot be determined due to the presence of the underdrain. SG-3, located in the eastern part of the cell infiltrated at a faster rate than SG-1 during falling head due to the

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
 Cell: Cell 1

Assessed On:
 July 25, 2023



presence of the silty surface material located in the western half of the cell.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The non-design overflow in the southeastern corner of the cell is not functioning per plan and may be worth maintenance considerations.

Field Conditions

| | | | |
|-----------------|-------------------------|------------------|-------------------------|
| Weather | 60s rainy | | |
| Recent Rainfall | Today: 0.04" | Yesterday: 0.43" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Sarah Faubion |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 5 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230725-211503.jpg



Site Photo: FA_SitePhotos-20230725-211552.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)

Cell: Cell 1

Assessed On:

July 25, 2023



Site Photo: FA_SitePhotos-20230725-211652.jpg



Site Photo: FA_SitePhotos-20230725-211820.jpg



Site Photo: FA_SitePhotos-20230725-211726.jpg



Site Photo: FA_SitePhotos-20230725-142630.jpg



Site Photo: FA_SitePhotos-20230725-211750.jpg



Site Photo: FA_SitePhotos-20230725-142645.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
 Cell: Cell 1

Assessed On:
 July 25, 2023



Site Photo: FA_SitePhotos-20230725-235113.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 1' Partial Width Width 2' Underdrain trench is approximately 2 feet wide. There is a clear density contrast between where the probe hits gravel and where the probe hits native/silty fill when probing cell cross section. Full width of cell is approximately 12 feet. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell through a catch basin that collects runoff from the adjacent street, and through a curb inlet located in the sidewalk of the same street. Water is designed to infiltrate through the bioretention soil before reaching the underdrain pipe where it flows to a catch basin and out to the storm drain network. Field staff observed two non-design outlets on the south end of the cell near the overflow structure where water will flow over the side of the cell and downhill to the adjacent school playfield before it can enter the designed overflow. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
Cell: Cell 1

Assessed On:
July 25, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230726-012020.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 40% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Sediment deposition blocks 40% of the inlet at the exit of pipe, organic debris blocks 10% of the grate on the catch basin.



FA_INBLPhoto-20230726-011603.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
Cell: Cell 1

Assessed On:
July 25, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 4.75'

Energy Dissipation
Angular Rock: Functioning
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230725-214153.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A thick build up of pine needles block 50% of the street side of the curb cut.



FA_INBLPhoto-20230725-144339.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
 Cell: Cell 1

Assessed On:
 July 25, 2023



Design Overflow/Outlet

| | |
|---|-------------------------------|
| DO - 1 | |
| Shape: <input checked="" type="checkbox"/> Round <input type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Diameter: 5.4' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.75 Relative from staff gauge: 0.65 | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No The perimeter of the cell adjacent to the overflow structure is lower than the stick up height of the structure. Water bypasses the designed overflow structure at SG-1=0.26 feet ponded depth, and flows downhill towards the fields below. | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 2% blocked Additional Details: Minor sediment and moss growth were observed on the trash rack. | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |



FA_DOPhoto-20230725-214926.jpg

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|---|-----------------------------------|-----------------------------------|---|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | | |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Portions of the cell base near IN-1 are covered in a silty organic surface material which infiltrated significantly more slowly during the falling head portion of the infiltration test than the eastern half of the cell. Abundant fir needles create stepped conditions along base of the cell. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: | | | | | | |
| Vegetation Description Medium vegetation coverage was observed, some black berries near the overflow structure limited access to observe non-designed overflow. | | | | | | |
| Additional Details Geotech Probe Observations: At the cell base, probe measurements found 0.7-1.4' of planting soil, with an average of 1.1', before encountering the underdrain gravels. This is less than the 1.5' specified by the plans. On the cell edges, less than 1 foot of planting soil was encountered above fill soils. This is also inconsistent with the | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
 Cell: Cell 1

Assessed On:
 July 25, 2023



cell design which shows a 3:1 slope with a minimum of 1.5' of planting soil above the existing subgrade. No zones of compaction were observed.

Hand Auger

| | |
|--|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1 |
| Total Depth: | 1.3 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium to coarse SAND, some fine sand, some gravel, some silt, abundant organics. (SW-SM) Native Soil Texture: Underdrain Gravel: Loose, moist, dark grey, sandy, rounded, coarse GRAVEL (GP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Underdrain gravel has an average of 1" diameter. | |



IMG_0364.jpeg

| | |
|---|---|
| HA-2 | |
| <input type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input checked="" type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 0.8 |
| Total Depth: | 1.2 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium to coarse SAND, some fine sand, some gravel, trace silt, abundant organics (SP) Native Soil Texture: Fill: Slightly dense, light brown, moist, silty fine to medium SAND, some coarse sand, trace gravel, moderate organics (SW-SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details 0-0.8 BSM 0.8-0.9 transitional 0.9-1.2 native/fill *Review of plan cross section leads to more likely fill. | |

| | |
|--|--|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
Cell: Cell 1

Assessed On:
July 25, 2023



| | |
|--|--|
| HA-3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.1 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium to coarse SAND, some fine sand, some gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black, double layered, thick geotextile per WSDOT 9-33.2(1) |
| Additional Details | |

| | |
|--|---|
| HA-4-WP | |
| <input type="checkbox"/> Zone 1 <input checked="" type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.1 |
| to Import/Underdrain: | |
| Total Depth: | 3 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium to coarse SAND, some fine sand, some gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: Medium stiff, light brown, moist, sandy SILT, some gravel, scattered organics (ML) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): | |
| Additional Details | |
| Hand auger conducted on southern edge of cell to avoid the underdrain. Soils encountered to be native glaciomarine deposits. | |



IMG_0365.jpeg

| | |
|--|--|
| HA-5 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
 Cell: Cell 1

Assessed On:
 July 25, 2023



| | |
|---|---|
| HA-5 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.5 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, silty medium to coarse SAND, some fine sand, some gravel (SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |

Infiltration Test

| | |
|---|--------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# 6 10-100 | |
| Wetted Pond Area (sq. ft) | 905 |
| Ponded Depth (ft) | 0.3 |
| Total Gallons | 22,512 |
| Steady State Flow Rate (GPM) | 56 |
| Additional Details: Some test water overflowed out of the cell behind catch basin due to the non-designed overflow. Flow rate was adjusted as needed to keep test within perimeter of the cell. The western half of the cell drained much more slowly during falling head due to silty surface material. | |



IT_Photo-20230725-234931.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
Cell: Cell 1

Assessed On:
July 25, 2023



Additional Comments

- Staff gauge 3 in photo 8 shows stage during overflow down hill slope.
- Silty material on the half of the cell near the inlet, slower infiltration rate.
- Some backflow into IN-1 was observed while flow rates were increasing, this stabilized during test and is not a significant loss of water.
- Non-design overflow behind the catch basin. Photo 3/8 captures phenomenon.

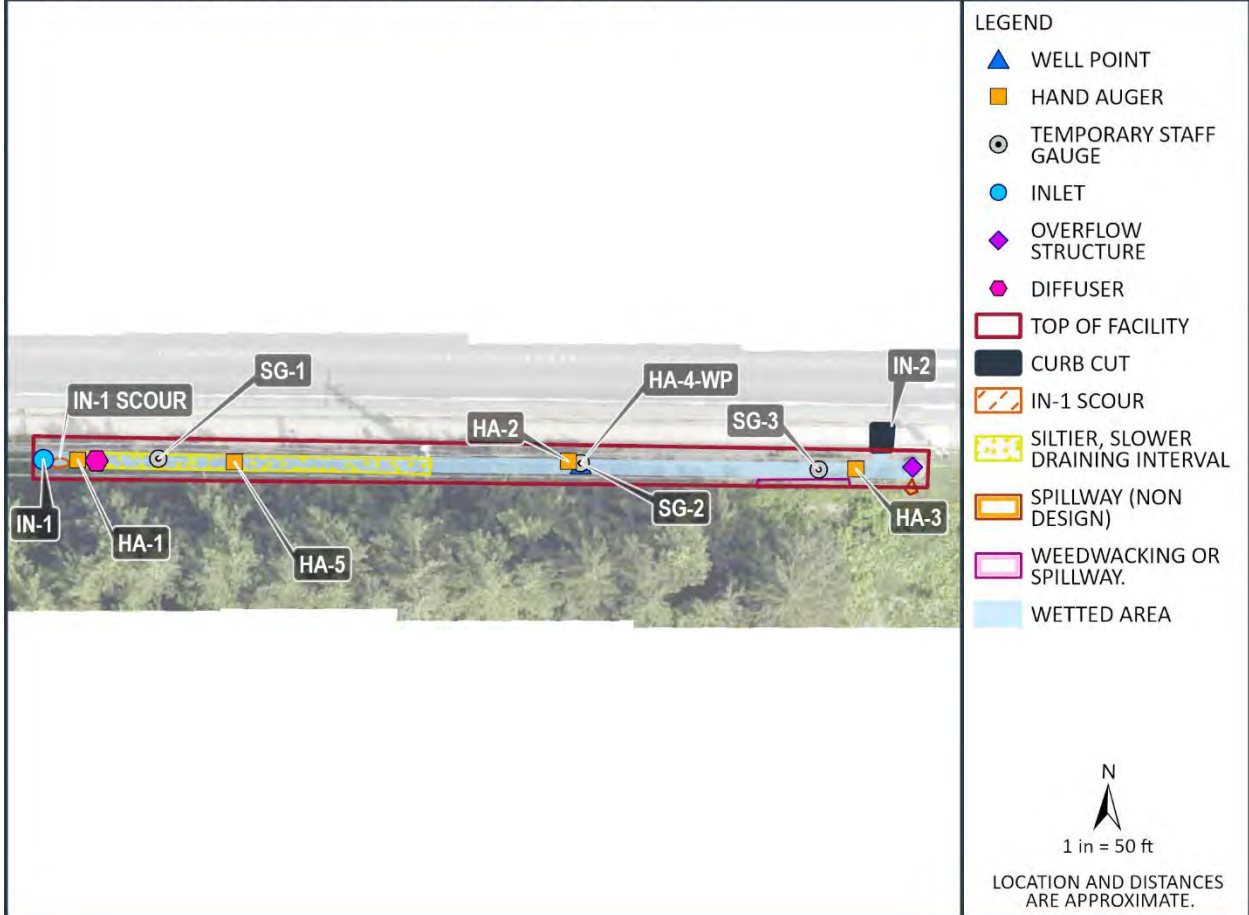
BIORETENTION CELL FIELD ASSESSMENT

Site: Ferndale Thornton and Maureen (FDTM)
 Cell: Cell 1

Assessed On:
 July 25, 2023



SITE: FERNDALE THORNTON AND MAUREEN (FDTM) CELL: CELL 1





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Exploration Boring

FDTM-HA-1

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/25/23

Logged By: APJ/SNCF

20150387H008

Ending Date: 7/25/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.3

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | 1 | | | Bioretention Soil Mix | | | | | | | | | |
| | | 2 | | | Loose, moist, dark brown, medium to coarse SAND some gravel, trace silt; abundant organics and rootlets (SP). | | | | | | | | | |
| 1 | | 3 | | | Underdrain Gravel | | | | | | | | | |
| | | | | | Loose, moist, dark gray, coarse GRAVEL; gravel are rounded (GP). | | | | | | | | | |
| 2 | | | | | No seepage. Moderate caving 0 to 1.3 feet. Refusal in gravel. No filter fabric. HA located at base of cell near IN-1. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

1/23/2024

20150387H008



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Exploration Boring

FDTM-HA-5

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/25/23

Logged By: APJ/SNCF

20150387H008

Ending Date: 7/25/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 0.5

Hammer Weight/Drop: N/A



Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests |
|------------|---|--------|------------|---|--|-------------|----------|------------|----|----|----|-----|-------------|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 |  | 1 | |  | <p>Bioretention Soil Mix Loose, moist, dark brown, silty, SAND, some gravel; abundant organics (SM).</p> <p>No seepage. No caving. Sample representative of slow draining soils on northern 1/3rd of cell. Soils information from adjacent hand auger explorations are described in the Site assessment Field Report.</p> | | | | | | | | |
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |

1/23/2024

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Well Point

FDTM-HA-4-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/25/23

Logged By: APJ/SNCF

20150387H008

Ending Date: 7/25/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.1

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.5

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

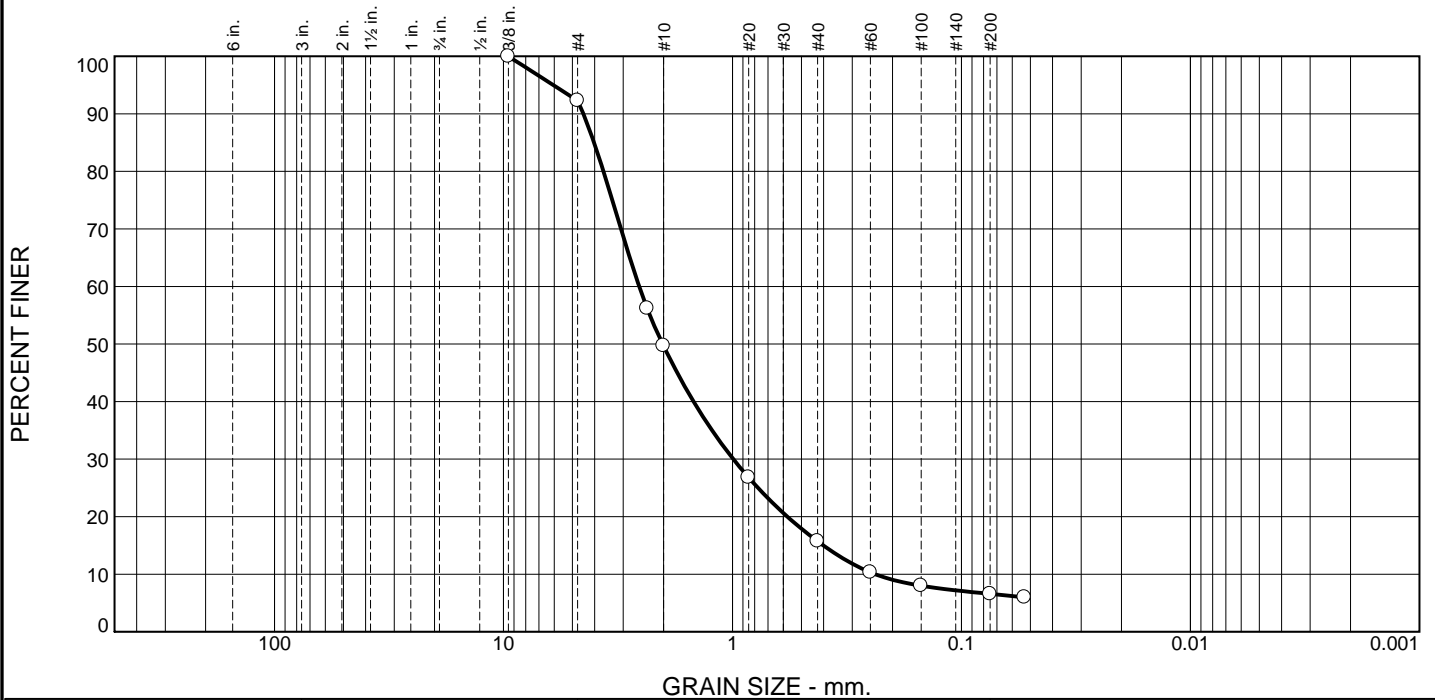
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, some coarse sand, trace gravel, trace silt; abundant organics (SP). | | | | | | | Stick up -4.5 to 0 feet Bioretention soil mix 0 to 1 foot |
| 1 | Hand | 2 | | Everson Glaciomarine Drift Medium stiff, moist, light brown, sandy, SILT, some gravel; scattered organics (ML). | | | | | | | 3/8-inch bentonite chips 1 to 1.5 feet 1.25-inch I.D. threaded galvanized steel casing -4.5 to -0.2 feet; duct tape covers screen -0.2 to 1.5 feet |
| 2 | Hand | 3 | | Medium stiff, moist, tan, SILT, some sand; abundant organics (rootlets) (ML). | | | | | | | Silica sand 1.5 to 3.1 feet |
| 3 | Hand | 4 | | As above. | | | | | | | 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.5 to 2.5 feet |
| 3 | | | | No seepage. No caving. HA located ≈½ foot from bottom of cell. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | Cast iron drive endcap 2.5 to 2.8 feet Cast iron drivepoint 2.8 to 3.1 feet |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/20/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 7.7 | 42.6 | 34.0 | 9.1 | 6.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 92.3 | | |
| #8 | 56.2 | | |
| #10 | 49.7 | | |
| #20 | 26.8 | | |
| #40 | 15.7 | | |
| #60 | 10.3 | | |
| #100 | 8.0 | | |
| #200 | 6.6 | | |
| #270 | 6.0 | | |

* (no specification provided)

Material Description

SAND, some gravel, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-a

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 4.4793 | D ₈₅ = 4.0221 | D ₆₀ = 2.5552 |
| D ₅₀ = 2.0173 | D ₃₀ = 0.9915 | D ₁₅ = 0.4010 |
| D ₁₀ = 0.2386 | C _u = 10.71 | C _c = 1.61 |

Remarks

Date Received: 7/25/2023 Date Tested: 10/6/2023

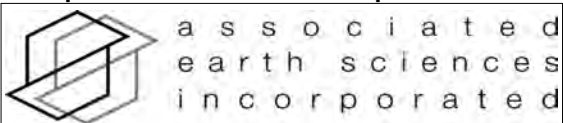
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Ferndale Thornton & Maureen
 Sample Number: HA-1 Depth: 0-0.2'

Date Sampled: 7/25/2023

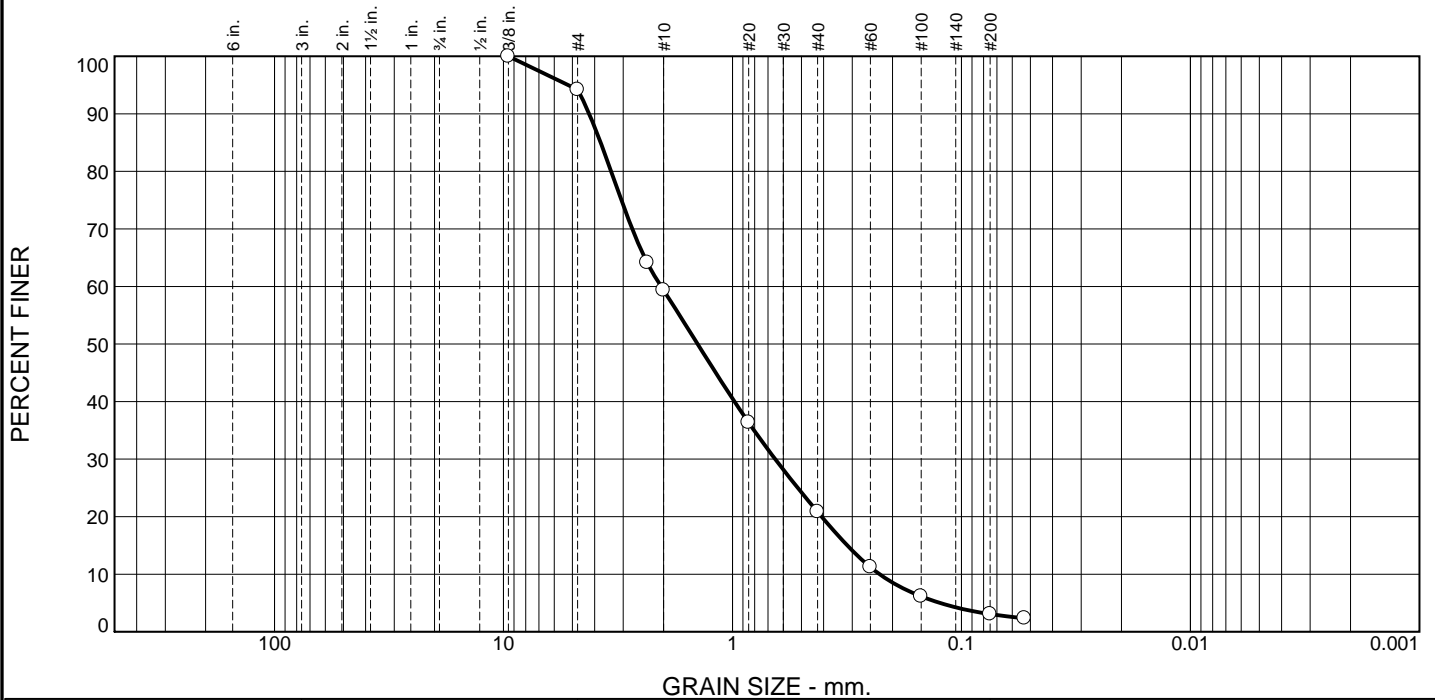


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.8 | 34.8 | 38.6 | 17.7 | 3.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 94.2 | | |
| #8 | 64.1 | | |
| #10 | 59.4 | | |
| #20 | 36.4 | | |
| #40 | 20.8 | | |
| #60 | 11.2 | | |
| #100 | 6.2 | | |
| #200 | 3.1 | | |
| #270 | 2.3 | | |

* (no specification provided)

Material Description

BSM
SAND, some gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 4.2237 | D ₈₅ = 3.7649 | D ₆₀ = 2.0488 |
| D ₅₀ = 1.4194 | D ₃₀ = 0.6506 | D ₁₅ = 0.3152 |
| D ₁₀ = 0.2278 | C _u = 8.99 | C _c = 0.91 |

Remarks

Date Received: 7/25/2023 Date Tested: 10/03/2023

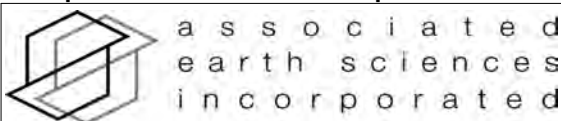
Tested By: FEW

Checked By: SNCF/APJ/JHS

Title: _____

Location: Onsite - Ferndale Thornton & Maureen
Sample Number: HA-2 **Depth:** 0-0.8'

Date Sampled: 7/25/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 7/25/2023 | Project BHPS - FDTM | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Ferndale, WA | EB/EP No. FDTM-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.2' | HA-2 @ 0-0.8' | HA-5 @ 0-.3' |
|--------------------|---------------|---------------|--------------|
| Wet Weight + Pan | 979.7 | 1026.3 | 1554.1 |
| Dry Weight + Pan | 928.2 | 990.9 | 1343.1 |
| Weight of Pan | 358.0 | 247.5 | 358.0 |
| Weight of Moisture | 51.5 | 35.4 | 211.1 |
| Dry Weight of Soil | 570.3 | 743.4 | 985.1 |
| % Moisture | 9.0 | 4.8 | 21.4 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|-------|-------|--------|
| Dry Soil Before Burn + Pan | 928.2 | 990.9 | 1343.1 |
| Dry Soil After Burn + Pan | 916.3 | 969.1 | 1279.8 |
| Weight of Pan | 358.0 | 247.5 | 358.0 |
| Wt. Loss Due to Ignition | 12.0 | 21.8 | 63.2 |
| Actual Wt. Of Soil After Burn | 558.3 | 721.6 | 921.8 |
| % Organics | 2.1 | 2.9 | 6.4 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-------------------------|--------------------------------|---|
| Project Name: | Thorton and Maureen | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 7/25/2023 | Wetted Area (sq. feet): | 11:30: 884 ft ² / 16:10: 905 ft ² |
| Weather: | Scattered Showers, 60's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.30' |
| Performed By: | APJ / SNCF | Receptor Soils: | Glaciomarine Drift |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Staff Gauge #3 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|---------------------|----------------------|---------------------|--|
| 11:17 | | | | | Dry | 0 | Water on |
| 11:18 | 15.08 | 0.04 | | | | 20 | Backflow into IN-1 |
| 11:20 | 14.7 | 0.08 | | | | 46 | |
| 11:25 | 14.26 | | | | | 123 | Increase flow to 50 gpm |
| 11:26 | | | | | | | Backflow into inlet; water slowly flowing out to street - will monitor |
| 11:27 | | 0.16 | | | | | |
| 11:30 | 5.12 | 0.18 | | | | 369 | |
| 11:34 | | | | | | | Water in inlet has stabilized. No backflow |
| 11:45 | 51.15 | 0.22 | | | Dry | 1,136 | Increase flow to 83 gpm; slow down near telephone pole |
| 11:55 | | | | | | | |
| 12:00 | 87.22 | 0.29 | 0.04 | 0.14 | | 2,450 | Audible trickle into CB |
| 12:05 | | | | | | | Water in CB at 12:02 |
| 12:15 | 87.11 | 0.3 | 0.04 | 0.18 | | 3,732 | |
| 12:22 | | | | | | | Water flowing passed CB and down hill slope |
| 12:25 | 87.7 | | | | | 4,702 | Decrease flow to 74 gpm |
| 12:30 | 75.34 | 0.28 | 0.03 | 0.2 | | 4,995 | Still losing water passed CB and down hill slope |
| 12:37 | 75.54 | | | | | 5,536 | Decrease flow to 65 gpm |
| 12:50 | 67.12 | 0.26 | 0.02 | 0.14 | Dry | 6,392 | |
| 13:00 | 66.66 | 0.26 | 0.02 | 0.12 | | 7,058 | |
| 13:15 | 66.44 | 0.28 | 0.02 | 0.14 | | 8,089 | Outlet is good/not overflow |
| 13:30 | 66.62 | 0.28 | 0.03 | 0.14 | | 9,053 | |
| 13:45 | 66.28 | 0.27 | 0.03 | 0.14 | | 10,048 | Raining |
| 14:00 | 66.22 | 0.28 | 0.03 | 0.16 | | 11,040 | |
| 14:15 | 65.77 | 0.28 | 0.03 | 0.19 | Dry | 12,034 | Water observed overflowing |
| 14:22 | 66.62 | | | | | 12,492 | Decrease flow to 55 gpm |
| 14:30 | 55.74 | 0.26 | 0.01 | 0.18 | | 12,945 | |
| 14:45 | 55.79 | 0.26 | 0.01 | 0.14 | | 13,790 | |
| 15:00 | 56.06 | 0.26 | 0.01 | 0.14 | | 14,624 | Water retreated |
| 15:15 | 56.12 | 0.26 | 0.01 | 0.14 | | 15,463 | |
| 15:30 | 56.24 | 0.26 | 0.01 | 0.14 | | 16,300 | |
| 15:46 | 56.12 | 0.26 | 0.01 | | | 17,206 | |
| 16:00 | 56.12 | 0.26 | 0.01 | 0.16 | | 18,042 | |
| 16:15 | 56.68 | 0.26 | 0.01 | 0.16 | Dry | 18,834 | |
| 16:30 | 56.07 | 0.26 | 0.01 | 0.17 | | 19,701 | |
| 16:40 | 56.12 | 0.26 | 0.02 | 0.18 | | 20,270 | |
| 16:50 | 56.91 | 0.26 | 0.02 | 0.18 | | 20,833 | |
| 17:00 | 57.13 | 0.26 | 0.02 | 0.18 | | 21,372 | |
| 17:10 | 56.96 | 0.26 | 0.02 | 0.18 | | 21,952 | |
| 17:20 | 56.96 | 0.25 | 0.02 | 0.18 | | 22,512 | Water off |
| 17:23 | | 0.22 | 0 | 0.17 | | | |
| 17:25 | | 0.19 | | 0.16 | | | |
| 17:26 | | 0.18 | | 0.16 | | | |
| 17:27 | | 0.16 | | 0.14 | | | |
| 17:29 | | 0.16 | | 0.12 | | | |
| 17:30 | | 0.14 | | 0.1 | | | |
| 17:31 | | 0.14 | | 0.08 | | | |
| 17:33 | | 0.12 | | 0.06 | | | |
| 17:34 | | 0.12 | | 0.04 | | | |
| 17:36 | | 0.1 | | 0.02 | | | |
| 17:37 | | 0.1 | | 0 | Dry | | |

| | | | | | | | |
|-------|--|------|--|--|-----|--|-------------------------|
| 17:38 | | 0.08 | | | | | |
| 17:41 | | 0.06 | | | | | |
| 17:44 | | 0.04 | | | | | |
| 17:47 | | 0.03 | | | | | |
| 17:49 | | 0.02 | | | | | |
| 17:51 | | 0 | | | Dry | | |
| 18:02 | | | | | | | Pond still wet in spots |
| 18:10 | | | | | | | |
| 18:23 | | | | | | | Offsite; pond dry |

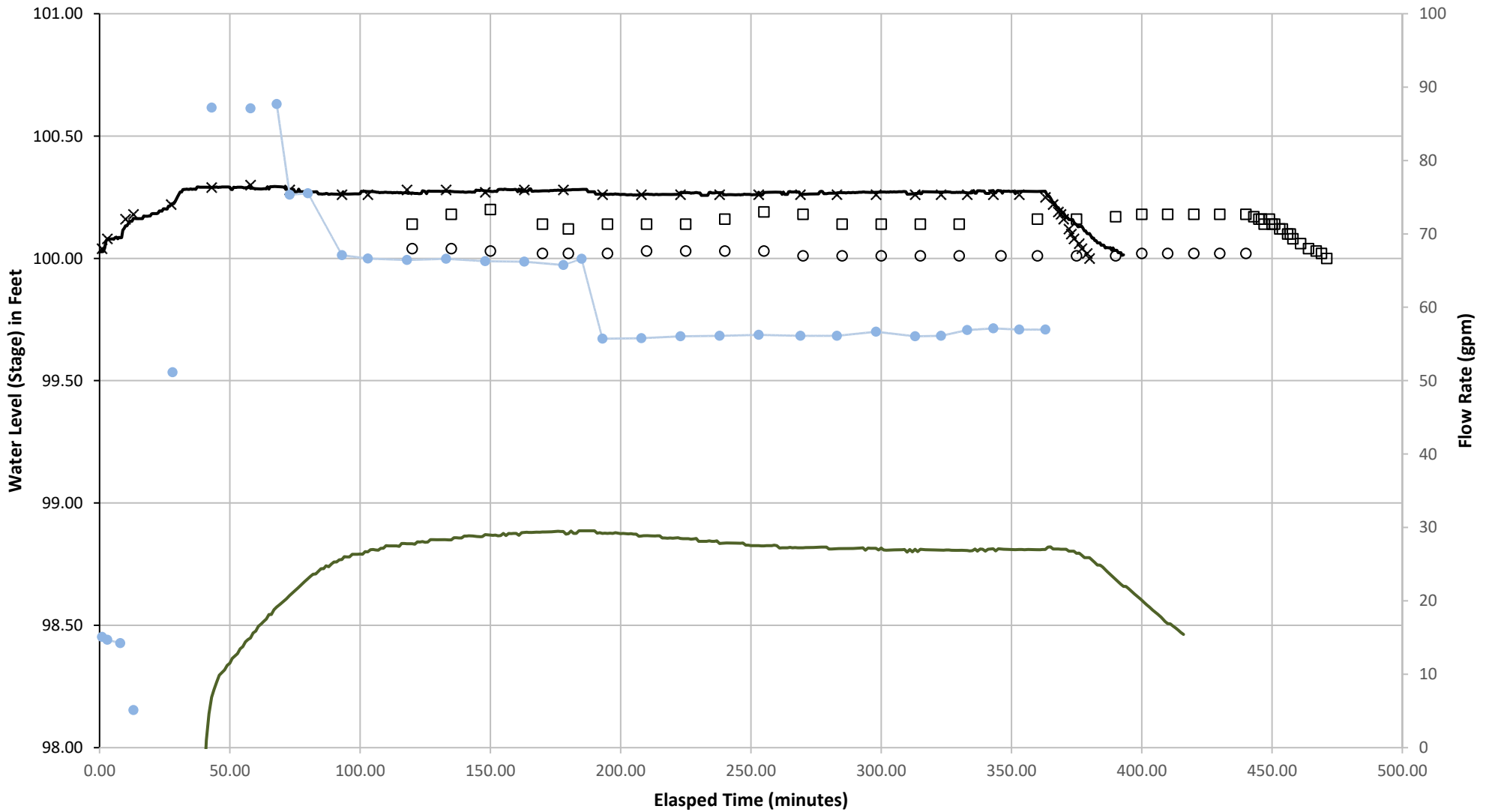
| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 6.0 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 5.5 |

| | |
|--|-----|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 5.9 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 4.8 |

| | |
|--|-----|
| SG-3 Average Infiltration Rate (in/hr) during last hour of inflow: | 5.8 |
| SG-3 Average Infiltration Rate (in/hr) during falling head: | 8.3 |

Thornton & Maureen Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data — Staff Gauge #1 Logger + Catch Basin Hand
- Catch Basin Logger ○ Staff Gauge #2 Hand Data □ Staff Gauge #3 Hand Data
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell #24

Assessed On:
September 11, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This bioretention cell is one of 24 bioretention cells constructed in 2011 and collects runoff from the surrounding school parking lot through two catch basins that convey water to the cell via two inlet pipes. The cell design calls for bioretention soil overlying 1-1/2" to 3/4" washed rock with a dispersion pipe. The dispersion pipe is in two sections, with a catch basin connecting them, which connect to two 10+ ft pit drains that assist in infiltrating the water into the underlying native soil. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 0.9-1.8 ft

The apparent thickness of loose bioretention soil based on probe data and hand augers ranged from 0.9-1.8 ft, with an average thickness of 1.4 ft. On the cell edges the thickness of the soil tapered to less than 1 ft.

Composition:

The plans call for amended soil for WQ treatment, with an infiltration rate of 1" per hour. In comparison to the 2019 Ecology bioretention soil specifications, the representative tested material at 0.1-0.7 ft below ground surface matches the grain size distribution closely with only a minor deviation of more fine gravel and slightly higher silt percentages. Organic matter content in the representative sample was slightly above the 2019 Ecology specifications. A surface sample (ISHS-24_HA-2_0-0.2') was tested from an area that showed signs of pooling and sediment deposition, the sieve results show a large deviation from the 2019 Ecology grain size distribution for bioretention soils with 41% passing the #200 sieve. Organic matter content for this surface sample showed a higher percentage (14.1%) than the 2019 Ecology specifications.

Organic Matter Content (% by weight): 8.5

Percent passing #200 sieve: 7.8

Coefficient of Uniformity (Cu): 7.2

Coefficient of Curvature (Cc): 1.2

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Moist, light brown, fine to medium SAND, few fine to coarse sand, sub-rounded gravel, few sub-rounded cobbles, few silt (SM)

Subgrade soil was not encountered during testing, previous AESI geotechnical exploration logs (2007) provide descriptions of native soil.

BUILT PER PLAN:

The inlet on the northwest portion of the site was not able to be located. Previous studies conducted by AESI staff (2016) at this cell had observed partial burial of this inlet, it is presumed that the inlet is now completely buried. Otherwise, the cell was constructed to designed specifications.

GROUNDWATER CONDITIONS:

No groundwater was observed during the excavation of hand augers. The piezometer (P 24-2), with slots

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell #24

Assessed On:
September 11, 2023



at 11.35 ft below ground surface, and adjacent to the tested portion of the cell, was also dry prior to the test. The piezometer responded to the test 40 minutes after the test began, the shallowest water level recorded was 3.0 ft below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 80.5
Subgrade Soil Rate (in/hr): 65

The bioretention soil infiltration rate is calculated using the constant head rate from staff gauge #1. Subgrade soil infiltration rate is calculated using the falling head rate from the piezometer (P 24-2).

This cell was tested during phase one of this study. The infiltration rate of the bioretention soil was measured to be 61 in/hr in 2016.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Inlet #2 in the northwest portion of the cell was not located, it is presumed buried with sediment and no longer functions as an inlet.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | Cloudy | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Hand Augers | 4 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)

Cell: Cell #24

Assessed On:
September 11, 2023



Site Photo: IMG_0581.jpg



Site Photo: IMG_0578.jpg



Site Photo: IMG_0576.jpg



Site Photo: IMG_0579.jpg



Site Photo: IMG_0577.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell #24

Assessed On:
September 11, 2023



Cell Construction

| | |
|---|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Ground level sprinklers were observed around the perimeter of the cell. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width ' There are 2 horizontal perforated pipes, both originating in the overflow structure, one going east 20 feet, the other going south 31 feet. Identified on plans, helps disperse water coming into the cell. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from the adjacent parking lot through two catch basin inlet pipes. Water is designed to infiltrate through the bioretention soil before reaching one of the dispersal pipes, which are designed for greater infiltration area away from the inlets. Two piezometers are installed in finger drains in this cell, the washed gravels surrounding the dispersion pipe facilitate groundwater flow to the finger drains. The finger drains are over 10 feet deep and also aid in infiltration into the surrounding native substrate. Cleanouts are described in the plans, but field staff were unable to locate them in the field due to dense vegetation. The overflow structure is a catch basin that channels overflow to the dispersal pipes which facilitate water infiltration to the finger drains. The catch basin is not connected to a storm drain network. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell #24

Assessed On:
September 11, 2023



Inlets


| | |
|--|---|
| <p>IN-1</p> <p><input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Pipe: Material <input type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input checked="" type="checkbox"/> Other Other: Other Diameter: 1.3'</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: Buried Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230911-172542.jpg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 15% blocked</p> <p>Types: <input checked="" type="checkbox"/> Sediment <input checked="" type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input type="checkbox"/> Vegetation</p> <p>Additional Details: The inlet's stream cobble is buried, some dead vegetation blocks the inlet, water backs up over 5 feet into the pipe, full depth of back up was not determined due to dense blackberry canes limiting access.</p> |
| <p>Additional Details:</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell #24

Assessed On:
September 11, 2023



| | |
|---|---|
| <p>IN-2</p> <p><input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Pipe: Material <input type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: '</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: Buried Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> | |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 100% blocked</p> <p>Types: <input checked="" type="checkbox"/> Sediment <input type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input type="checkbox"/> Vegetation</p> <p>Additional Details: Field staff could not find inlet as described on plans and in previous field notes, it is assumed that it is completely buried and 100% blocked.</p>  |
| <p>Additional Details:</p> | <p>FA_INBLPhoto-20230911-224728.jpg</p> |


BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
 Cell: Cell #24

Assessed On:
 September 11, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.2' Width: 1.8' |
| Additional Details: | |
| Stickup (ft) From Ground: 2.5 Relative from staff gauge: 2.5 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| FA_DOPhoto-20230911-223825.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|---|--|--|--|--|------------------------------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Natural mulch covers 75% of the cell. Moderate garbage was observed in the cell. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Additional Details: Some small holes of animal burrows were observed in the cell. | | | | | |
| Vegetation Description | | | | | |
| Vegetation limits access, med-large shrubs inter grown with blackberries. Understory choked with dead branches, some dead shrubs | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 0.5-2.2' of bioretention soil, with an average of 1.5', before encountering the dispersion gravels. Depth of bioretention soil was not specified by the available plans. On the cell edges, less than 1 foot of soil was encountered above native soils. This is consistent with the cell design which shows a 3:1 slope on the sides with no bioretention soil above the existing subgrade. | | | | | |

BIORETENTION CELL FIELD ASSESSMENT


Site: Issaquah High School (ISHS)
 Cell: Cell #24


Assessed On:
 September 11, 2023



No zones of compaction were observed. Some areas of the cell could not be probed due to thick, thorny vegetation.

Hand Auger

| | | |
|---|---|--|
| HA-1 | |  <p>IMG_0573.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | | |
| to Import/Underdrain: | 1.5 | |
| Total Depth: | 1.5 | |
| Rain/Garden Mix Soil Texture: Medium, dense, moist, dark brown fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (root mat)(SW-SM) | | |
| Native Soil Texture: | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |

| | | |
|---|---|---|
| HA-2 | |  <p>FA_FPhoto-20230911-154303.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0 | |
| to Native Soil: | | |
| to Import/Underdrain: | | |
| Total Depth: | 0.2 | |
| Rain/Garden Mix Soil Texture: medium dense, slightly moist, dark brown, very silty fine to medium SAND, some coarse sand, some gravel, abundant organics (SM) | | |
| Native Soil Texture: | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |
| Sample of fines deposit from inlet 1 from a bare ground zone, gravel content may be from inlet energy dissipation gravels. | | |

| | | |
|---|-----|--|
| HA-3 | | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.2 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
 Cell: Cell #24

Assessed On:
 September 11, 2023



| | |
|---|---|
| HA-3 | |
| to Native Soil: | |
| to Import/Underdrain: | 1.7 |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Medium, dense, moist, dark brown fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| ISHS 24 HA-3.JPG | |
| Additional Details | |

| | |
|---|---|
| HA-4 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | 1.6 |
| Total Depth: | 1.6 |
| Rain/Garden Mix Soil Texture: Medium, dense, moist, dark brown fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| ISHS 24 HA-4.JPG | |
| Additional Details | |

Infiltration Test

| | |
|--|--|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell #24

Assessed On:
September 11, 2023



| | |
|------------------------------|--------|
| AESI Meter# FM-7 | |
| Wetted Pond Area (sq. ft) | 1,188 |
| Ponded Depth (ft) | 0.15 |
| Total Gallons | 60,333 |
| Steady State Flow Rate (GPM) | 154 |

Additional Details:

Groundwater was measured via the two piezometers, water depths provided in this report are shallowest depths to water during the test below ground surface. Additional test details can be found in the executive summary.



IT_Photo-20230911-224409.jpg



IT_Photo-20230911-224436.jpg



IT_Photo-20230911-224507.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)

Cell: Cell #24

Assessed On:
September 11, 2023



SITE: ISSAQUAH HIGH SCHOOL (ISHS) CELL: CELL #24



LEGEND

- HAND AUGER
- INLET
- OVERFLOW STRUCTURE
- DIFFUSER
- OTHER
- TOP OF FACILITY
- BASE OF FACILITY
- WETTED AREA

N
1 in = 20 ft
LOCATION AND DISTANCES ARE APPROXIMATE.



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Exploration Boring

ISHS-24-HA-3

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/5/23

Logged By: APJ

20150387H008

Ending Date: 9/5/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.7

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

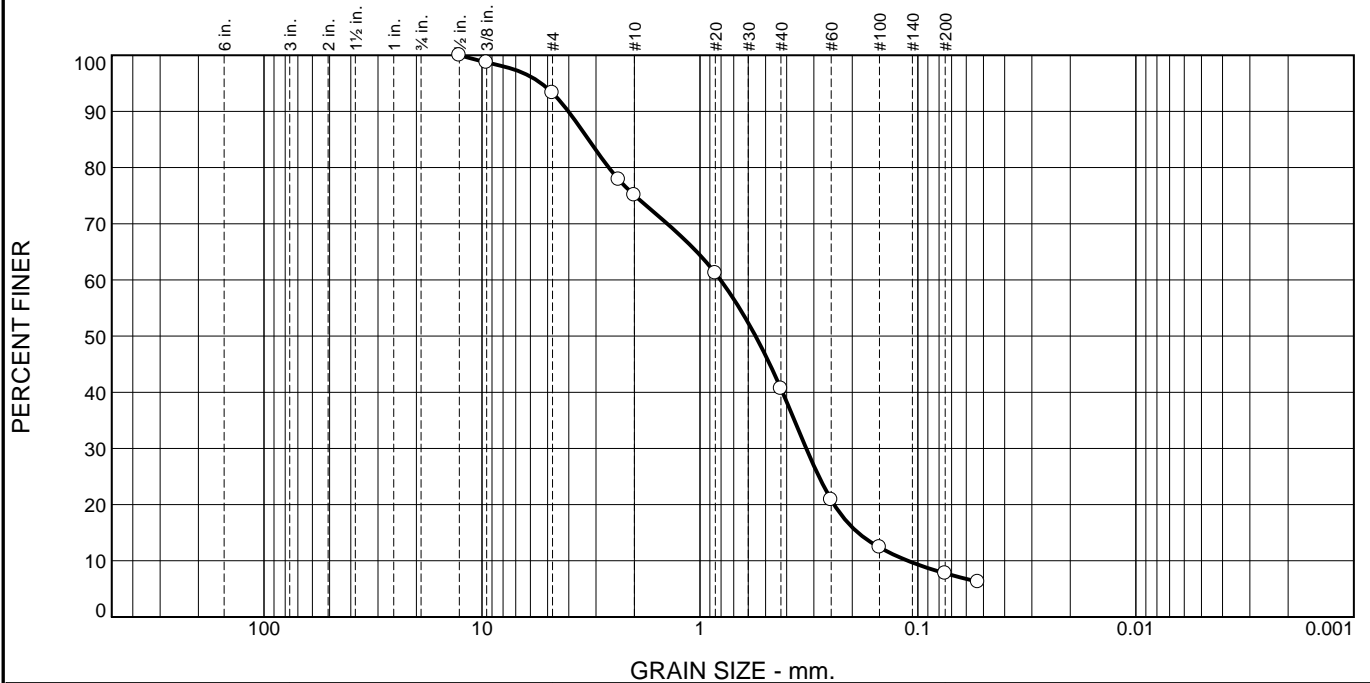
Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | | | | Mulch | | | | | | | | | |
| | Hand | 1 | | | Loose grasses and organic debris. | | | | | | | | | |
| | Hand | 2 | | | Bioretention Soil Mix Medium dense to loose, slightly moist, dark brown, fine to medium SAND, some gravel, some silt, some coarse sand; abundant organics (SW-SM). As above, trace gravel. | | | | | | | | | |
| 1 | | | | | | | | | | | | | | |
| 2 | | | | | No groundwater encountered. Terminated due to Presence of gravel and moderate caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 6.7 | 18.2 | 34.4 | 32.9 | 7.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 98.7 | | |
| #4 | 93.3 | | |
| #8 | 77.9 | | |
| #10 | 75.1 | | |
| #20 | 61.2 | | |
| #40 | 40.7 | | |
| #60 | 20.9 | | |
| #100 | 12.4 | | |
| #200 | 7.8 | | |
| #270 | 6.2 | | |

Material Description
SAND some gravel some silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 4.0147 D₈₅= 3.2449 D₆₀= 0.8052
 D₅₀= 0.5558 D₃₀= 0.3252 D₁₅= 0.1883
 D₁₀= 0.1113 C_u= 7.24 C_c= 1.18

Remarks

Date Received: 9-12-2023 Date Tested: 11-13-2023

Tested By: FEW

Checked By: APJ/JHS

Title: _____

* (no specification provided)

Location: Onsite - ISHA Cell 24
 Sample Number: HA-1

Depth: 0.1-0.7'

Date Sampled: 9-11-2023



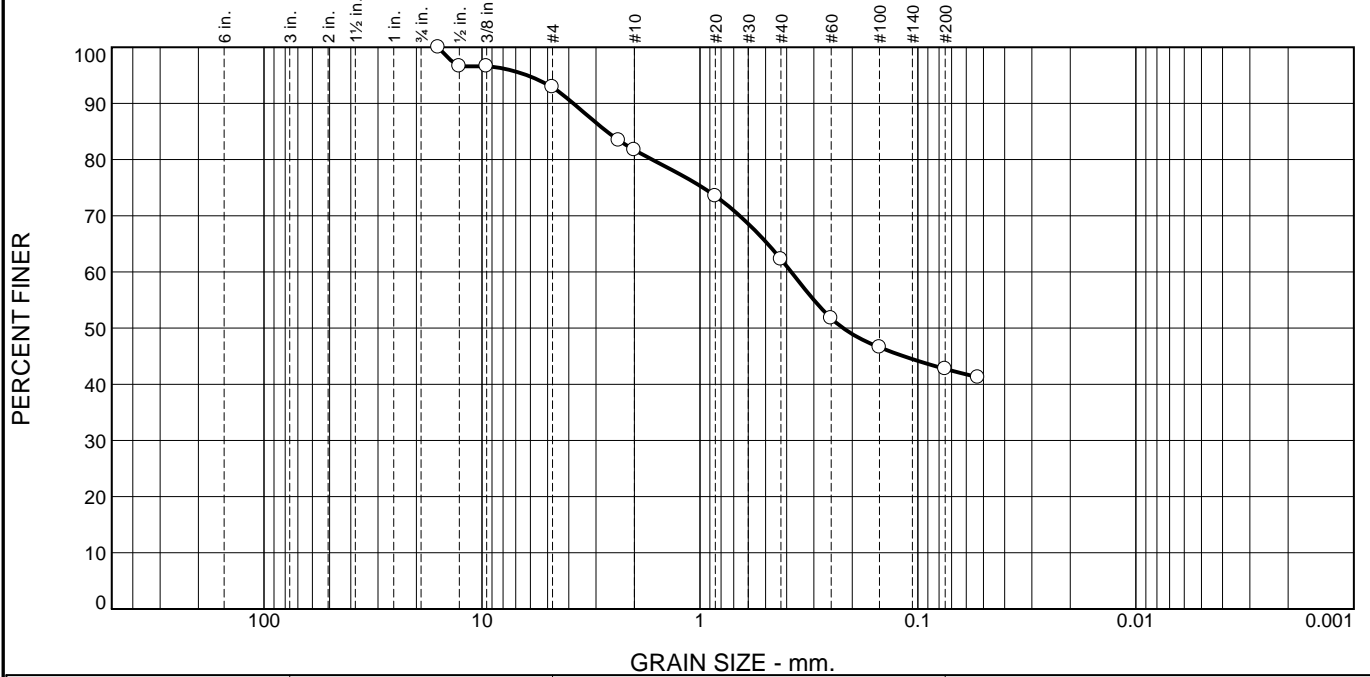
associated
 earth sciences
 incorporated

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 7.1 | 11.2 | 19.4 | 19.6 | 42.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 96.6 | | |
| 3/8" | 96.6 | | |
| #4 | 92.9 | | |
| #8 | 83.4 | | |
| #10 | 81.7 | | |
| #20 | 73.5 | | |
| #40 | 62.3 | | |
| #60 | 51.7 | | |
| #100 | 46.6 | | |
| #200 | 42.7 | | |
| #270 | 41.2 | | |

* (no specification provided)

Material Description

very silty SAND some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-4(0)

Coefficients

D₉₀= 3.8094 D₈₅= 2.6750 D₆₀= 0.3813
D₅₀= 0.2203 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 9-12-2023 Date Tested: 11-9-2023

Tested By: FEW

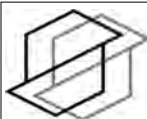
Checked By: APJ/JHS

Title: _____

Location: Onsite - ISHS Cell 24
Sample Number: HA-2

Depth: 0-0.2'

Date Sampled: 9-11-2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|------------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/11/2023 | Project BHPS-ISHS-Cell24 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Issaquah, WA | EB/EP No. ISHS-24-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.1-0.7' | HA-2 @ 0-0.2' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 709.5 | 570.1 |
| Dry Weight + Pan | 632.3 | 491.7 |
| Weight of Pan | 247.6 | 247.1 |
| Weight of Moisture | 77.2 | 78.4 |
| Dry Weight of Soil | 384.8 | 244.6 |
| % Moisture | 20.1 | 32.0 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 632.3 | 491.7 |
| Dry Soil After Burn + Pan | 599.5 | 457.3 |
| Weight of Pan | 247.6 | 247.1 |
| Wt. Loss Due to Ignition | 32.8 | 34.4 |
| Actual Wt. Of Soil After Burn | 351.9 | 210.2 |
| % Organics | 8.5 | 14.1 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-------------------------------|--------------------------------|----------------------------------|
| Project Name: | Issaquah High School-Cell #24 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-7 (50-300) |
| Date: | 9/11/2023 | Wetted Area (sq. feet): | 12:35:167 ft^2 / 14:05: 188 ft^2 |
| Weather: | Clear | Underdrain: | Dispersal Pipe |
| Test No.: | IT-1 | Test Depth (feet): | 0.15 |
| Performed By: | SNCF | Receptor Soils: | Qvr |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Outfall (ft) | P24-2 | P24-1 | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|--------------|-------|-------|---------------------|------------------------------------|
| 10:05 | 63 | 0 | 5.19 | | | | Water on; CB-NW = 2.4' |
| 10:07 | 79 | 0 | | | | 176 | |
| 10:10 | 79 | 0 | | | | 415 | |
| 10:15 | 79 | 0 | | | | 800 | |
| 10:30 | 78 | 0 | | | | 1,979 | Increase flow |
| 10:45 | 114.6 | 0 | 5.15 | 10.3 | | 3,640 | |
| 11:01 | 115 | 0 | 4.75 | 8.64 | | 5,487 | |
| 11:15 | 116 | 0 | 4.67 | 7.8 | | 7,098 | |
| 11:30 | 116 | 0 | 4.65 | 7.04 | | 8,823 | Increase flow |
| 11:45 | 142 | 0 | 4.53 | 6.28 | | 10,865 | Pond made it to base of overflow |
| 12:00 | 141 | 0.01 | 4.52 | 5.65 | | 13,037 | Increase flow; water at base of SG |
| 12:15 | 155 | 0.08 | 4.49 | 5.24 | | 15,217 | |
| 12:35 | 156 | 0.09 | 4.47 | 4.97 | | 18,343 | |
| 12:45 | 153 | 0.1 | | | | 19,873 | |
| 13:00 | 154 | 0.1 | 4.47 | 4.67 | | 22,274 | |
| 13:15 | 154 | 0.11 | 4.46 | 4.57 | | 24,628 | |
| 13:30 | 155 | 0.11 | 4.46 | 4.49 | | 26,887 | |
| 13:45 | 155 | 0.11 | 4.45 | 4.41 | | 29,264 | |
| 14:05 | 156 | 0.12 | 4.45 | 4.34 | | 32,323 | |
| 14:15 | 155 | | | | | 33,866 | |
| 14:30 | 154 | 0.12 | 4.45 | 4.22 | | 36,253 | |
| 14:45 | 157 | 0.12 | 4.44 | 4.19 | | 38,530 | |
| 15:01 | 157 | | 4.43 | 4.1 | | 41,077 | |
| 15:30 | 156 | 0.13 | 4.43 | 4.07 | | 45,554 | |
| 15:46 | 155 | 0.13 | 4.42 | 4.02 | 6.02 | 48,027 | |
| 16:02 | 156 | 0.14 | 4.43 | 3.99 | 5.96 | 50,407 | |
| 16:15 | 157 | 0.14 | 4.43 | 3.95 | | 52,575 | |
| 16:25 | 158 | 0.14 | 4.43 | 3.94 | 5.84 | 54,033 | |
| 16:37 | 156 | 0.14 | | 3.93 | | 55,924 | |
| 16:45 | 154 | | | | 5.76 | 57,213 | |
| 16:55 | 154 | 0.15 | 4.42 | 3.9 | | 58,763 | |
| 17:05 | 154 | 0.15 | | | | 60,333 | Water Off |
| 17:07 | | 0 | | | | | |
| 17:09 | | | | 3.95 | | | |
| 17:10 | | | 4.55 | 3.98 | | | |
| 17:20 | | | 4.79 | 4.91 | | | |
| 17:31 | | | 4.83 | 5.56 | | | |
| 17:40 | | | 4.85 | 5.97 | | | |
| 17:50 | | | 4.87 | 6.24 | | | |

| | | | | | | |
|-------|--|--|------|------|------|--|
| 18:05 | | | 4.87 | 6.69 | 7.14 | |
|-------|--|--|------|------|------|--|

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 80.5 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 54.0 |

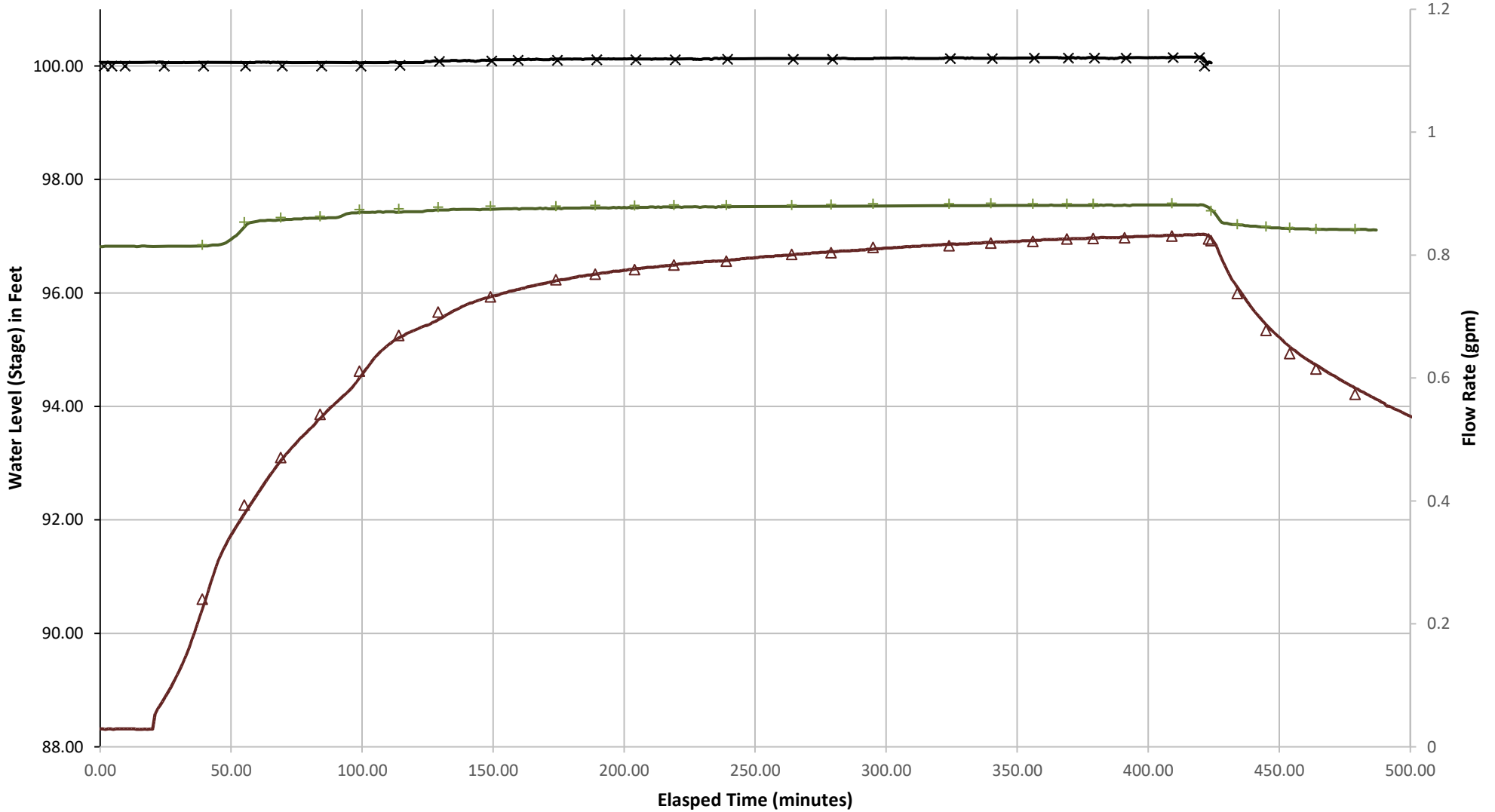
| | |
|---|------|
| P24-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 80.9 |
| P24-2 Average Infiltration Rate (in/hr) during falling head: | 67.0 |

| | |
|--|------|
| P24-2 Average Infiltration Rate (in/hr) during falling head (17:19-18:22): | 25.2 |
| P24-2 Average Infiltration Rate (in/hr) during falling head (20:05-08:00): | 2.0 |

| | |
|---|-----|
| Outfall Average Change in Head (in/hr) during falling head (20:05-08:00): | 6.8 |
|---|-----|

Issaquah High School Cell #24 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)

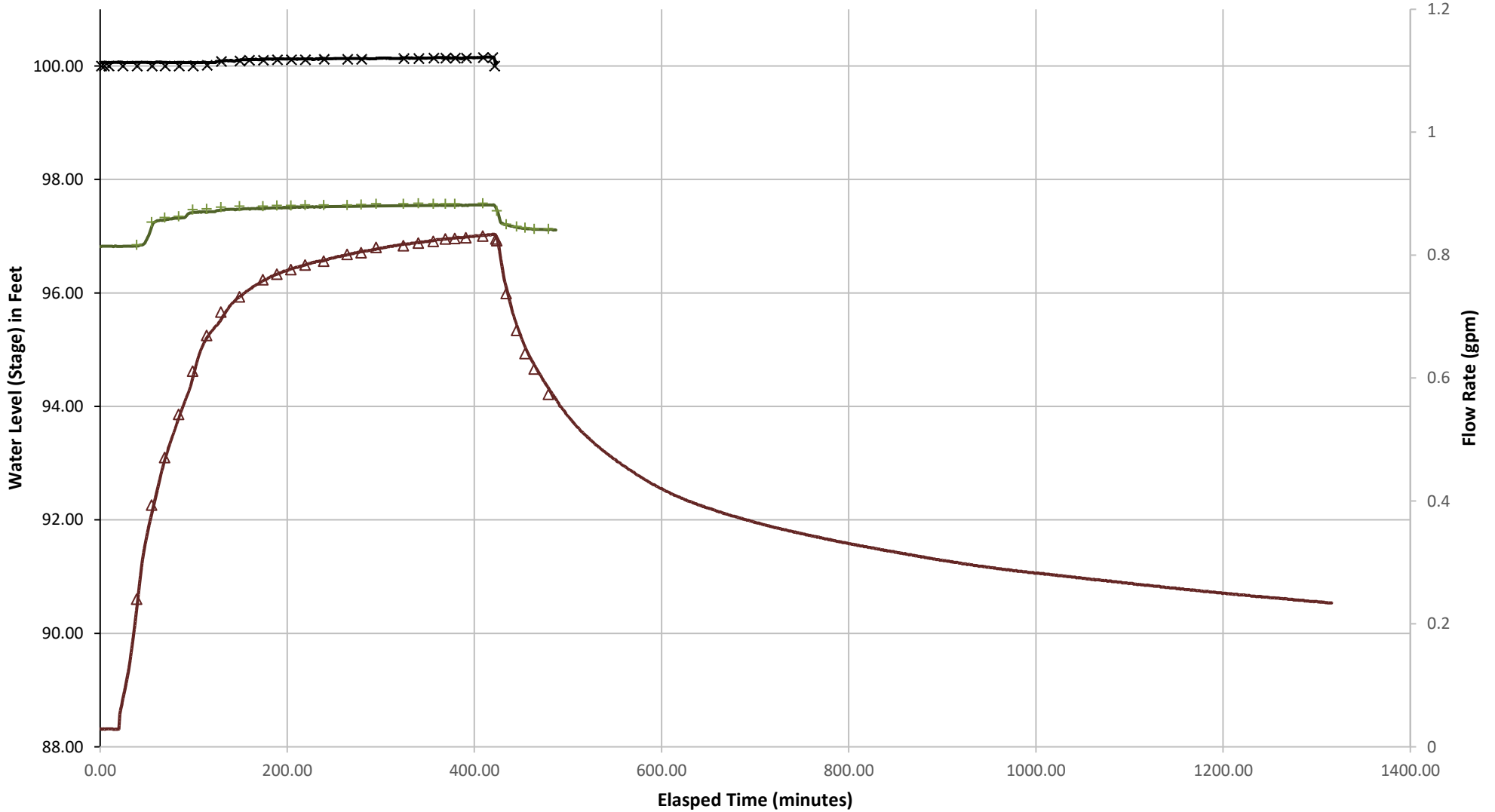


Notes: Elevations are not surveyed and should be used for relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- △ P-24-2 Hand
- + Catch Basin Hand
- Staff Gauge #1 Logger
- P-24-2 Logger
- Catch Basin Logger

Issaquah High School Cell #24 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used for relative reference. Elevation 100 represents ground surface. Datalogger left in piezometer to record full falling head response.

- × Staff Gauge #1 Hand Data
 - △ P-24-2 Hand
 - + Catch Basin Hand
- Staff Gauge #1 Logger
 - P-24-2 Logger
 - Catch Basin Logger

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell 1

Assessed On:
September 12, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This bioretention cell is one of 24 bioretention cells constructed in 2011 and collects runoff from the surrounding school parking lot. The cell design calls for bioretention soil overlying 1-1/2" to 3/4" washed rock with a dispersion pipe. The dispersion pipe is in two sections, with a catch basin in the center, which connect to two 10+ ft pit drains that assist in infiltrating the water into the underlying native soil. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 0.5-2.2 ft

The apparent thickness of loose bioretention soil based on probe data and hand augers ranged from 0.5-2.2 ft, with an average thickness of 1.5 ft. On the cell edges the thickness of the soil tapered to less than 1 ft.

Composition:

The plans call for rain garden amended soil for WQ treatment, but no specification was received. In comparison to the 2019 Ecology bioretention soil specifications, the tested material matches the grain size distribution closely with only a minor deviation of less fine to medium sand percentages. Organic matter content was slightly below the 2019 Ecology specifications.

Organic Matter Content (% by weight): 3.6

Percent passing #200 sieve: 3.6

Coefficient of Uniformity (Cu): 5.6

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Moist, light brown, fine to medium SAND, few fine to coarse sand, subrounded gravel, few subrounded cobbles, few silt (SM)

Subgrade soil was not encountered during testing, previous AESI geotechnical exploration logs (2007) provide descriptions of native soil.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plan.

GROUNDWATER CONDITIONS:

No groundwater was observed during the excavation of hand augers. The piezometer (Pit Drain 1-2), with slots at 11.74 ft below ground surface, and adjacent to the tested portion of the cell, was also dry prior to the test. The piezometer responded to the test 30 minutes after the test began, the shallowest water level recorded was 10.36 ft below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 81.6

Subgrade Soil Rate (in/hr): >81.6

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
 Cell: Cell 1

Assessed On:
 September 12, 2023



The field rate represents the bioretention soil due to the presence of the underlying gravels and dispersion pipe. The infiltration rate of the subgrade soils is estimated to be greater than the bioretention soil due to the rapid falling head response in the piezometer.

A nearby cell (Cell #24) which was constructed in 2011 at the same time as Cell #1 was tested during phase one of this study. The infiltration rate of Cell #24 was measured at 61 in/hr.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Pit-Drain 1-1 was inaccessible due to thick rose bushes, consider maintaining access to this observation port. Otherwise, the cell was generally found to be in working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | Overcast | | |
| Recent Rainfall | Today: 1.21" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230912-162529.jpg



Site Photo: FA_SitePhotos-20230912-162536.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)

Cell: Cell 1

Assessed On:
September 12, 2023



Site Photo: FA_SitePhotos-20230912-162606.jpg



Site Photo: FA_SitePhotos-20230912-162737.jpg



Site Photo: FA_SitePhotos-20230912-162615.jpg



Site Photo: FA_SitePhotos-20230912-162756.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell 1

Assessed On:
September 12, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Several small sprinkler heads were observed around the perimeter of the cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 6' Full Width Width 10' Dispersion pipe is two 6" perforated pipe, spanning the length of cell with a catch basin located in the center of the two pipes, with a cleanout present on the southern end. The dispersion pipe is surrounded by 1-1/2" to 3/4" washed rock, the width of which varies based on cell base dimensions. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments Water is conveyed into the cell through sheet flow from the surrounding parking lot. Water is designed to infiltrate through the bioretention soil before reaching one of the dispersal pipes, which are designed for greater infiltration area. Two piezometers are installed in finger drains in this cell, the washed gravels surrounding the dispersion pipe facilitate groundwater flow to the finger drains. The finger drains are over 10feet deep and also aid in infiltration into the surrounding native substrate. The overflow structure is a catch basin that channels overflow to the dispersal pipes which facilitate water infiltration to the finger drains. The catch basin is not connected to a storm drain network. | |

Cleanouts

| | |
|------------------------------------|---|
| CL-1 | |
| Condition | Accessible: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Distance from overflow/outlet: 44' | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell 1

Assessed On:
September 12, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 96'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230912-221230.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: No energy dissipation feature was observed.


BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell 1

Assessed On:
September 12, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.8' Width: 2.2' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.9 Relative from staff gauge: 1.2 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| FA_DOPhoto-20230912-221414.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|--|-----------------------------------|-----------------------------------|---|-----------------|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | | | | | Depth (ft): 0.5 |
| Cell Coverage | | | | | | |
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% | |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: A couple of rodent burrows were observed. | | | | | | |
| Vegetation Description | | | | | | |
| There are dense and healthy rose bushes, low shrubs and conifers present in the cell. Rose bushes limit access to northern observation port and dense low shrubs limit accuracy for ponded water measurements. | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 0.9-1.8' of bioretention soil, with an average of 1.4', before encountering the underdrain gravels. Bioretention soil depth was designed to be 1.5'. On the cell edges, less than 1 foot of soil was encountered above native soils. This is consistent with the cell design sides which show a 3:1 slope with no bioretention soil above the existing subgrade. No zones of compaction were observed. Some areas of the cell could not be probed due to thick, thorny vegetation. | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
Cell: Cell 1

Assessed On:
September 12, 2023



Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.5 |
| to Native Soil: | |
| to Import/Underdrain: | 1.8 |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown medium to coarse SAND, some fine sand, trace gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
| Additional Details | |



ISHS 1 HA-1.JPG

| | |
|---|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | |
| to Import/Underdrain: | 1.4 |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown medium to coarse SAND, some fine sand, trace gravel, trace silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
 Cell: Cell 1

Assessed On:
 September 12, 2023



HA-2



ISHS 1 HA-2.JPG

Additional Details

HA-3

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.5

to Native Soil:

to Import/Underdrain:

Total Depth: 1.8

Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown medium to coarse SAND, some fine sand, trace gravel, trace silt, abundant organics (SP)

Native Soil Texture:

Liner Present:

Yes No

Filter Fabric Present:

Yes No

BIORETENTION CELL FIELD ASSESSMENT

Site: Issaquah High School (ISHS)
 Cell: Cell 1

Assessed On:
 September 12, 2023



HA-3



ISHS 1 HA-3.JPG

Additional Details

Infiltration Test

IT-1

| | |
|--|--------|
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 10-100 | |
| Wetted Pond Area (sq. ft) | 146 |
| Ponded Depth (ft) | 0.27 |
| Total Gallons | 39,052 |
| Steady State Flow Rate (GPM) | 97 |

Additional Details:

Groundwater was measured via the accessible piezometer, water depth provided in this report is the shallowest depth to water during the test, below ground surface. Additional test details can be found in the executive summary.



BIORETENTION CELL FIELD ASSESSMENT

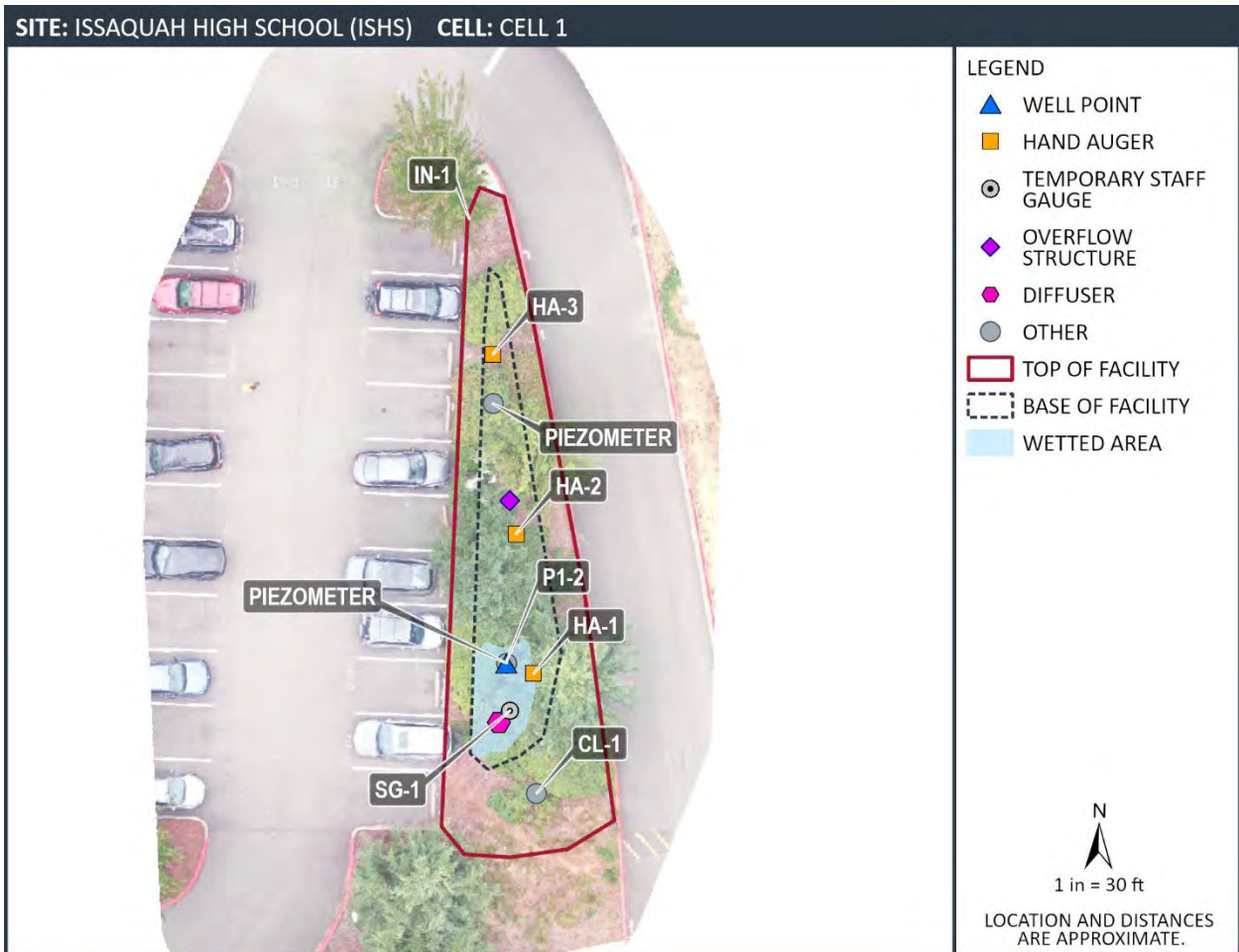
Site: Issaquah High School (ISHS)

Cell: Cell 1

Assessed On:
September 12, 2023



Additional Comments





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Exploration Boring

ISHS-1-HA-3

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/11/23

Logged By: SNCF

20150387H008

Ending Date: 9/11/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.8

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

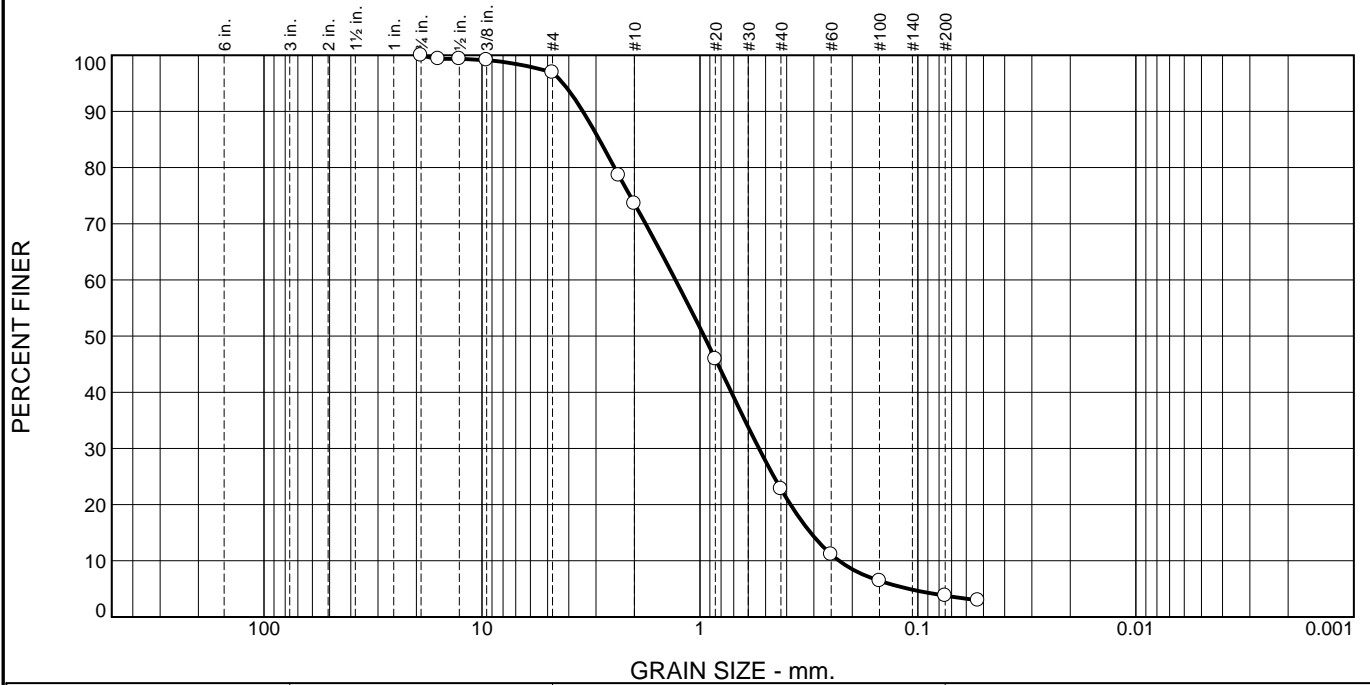
Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | | | | Mulch Natural mulch, moss, pine needles, bark chips. | | | | | | | | | |
| 1 | Hand | 1 | | | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some silt, trace gravel, trace silt; abundant organics (SP). | | | | | | | | | |
| 2 | Hand | 2 | | | No groundwater encountered. Terminated due to moderate caving and presence of gravel. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 3.1 | 23.3 | 50.8 | 19.0 | 3.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 99.4 | | |
| 1/2" | 99.4 | | |
| 3/8" | 99.1 | | |
| #4 | 96.9 | | |
| #8 | 78.6 | | |
| #10 | 73.6 | | |
| #20 | 45.9 | | |
| #40 | 22.8 | | |
| #60 | 11.1 | | |
| #100 | 6.4 | | |
| #200 | 3.8 | | |
| #270 | 3.0 | | |

Material Description
SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 3.4427 D₈₅= 2.8991 D₆₀= 1.2944
 D₅₀= 0.9570 D₃₀= 0.5363 D₁₅= 0.3106
 D₁₀= 0.2299 C_u= 5.63 C_c= 0.97

Remarks

Date Received: 9-12-2023 Date Tested: 11-13-2023

Tested By: FEW

Checked By: APJ/JHS

Title: _____

* (no specification provided)

Location: Onsite - ISHS Cell 1
Sample Number: HA-1

Depth: 0.2-0.9'

Date Sampled: 9-11-2023



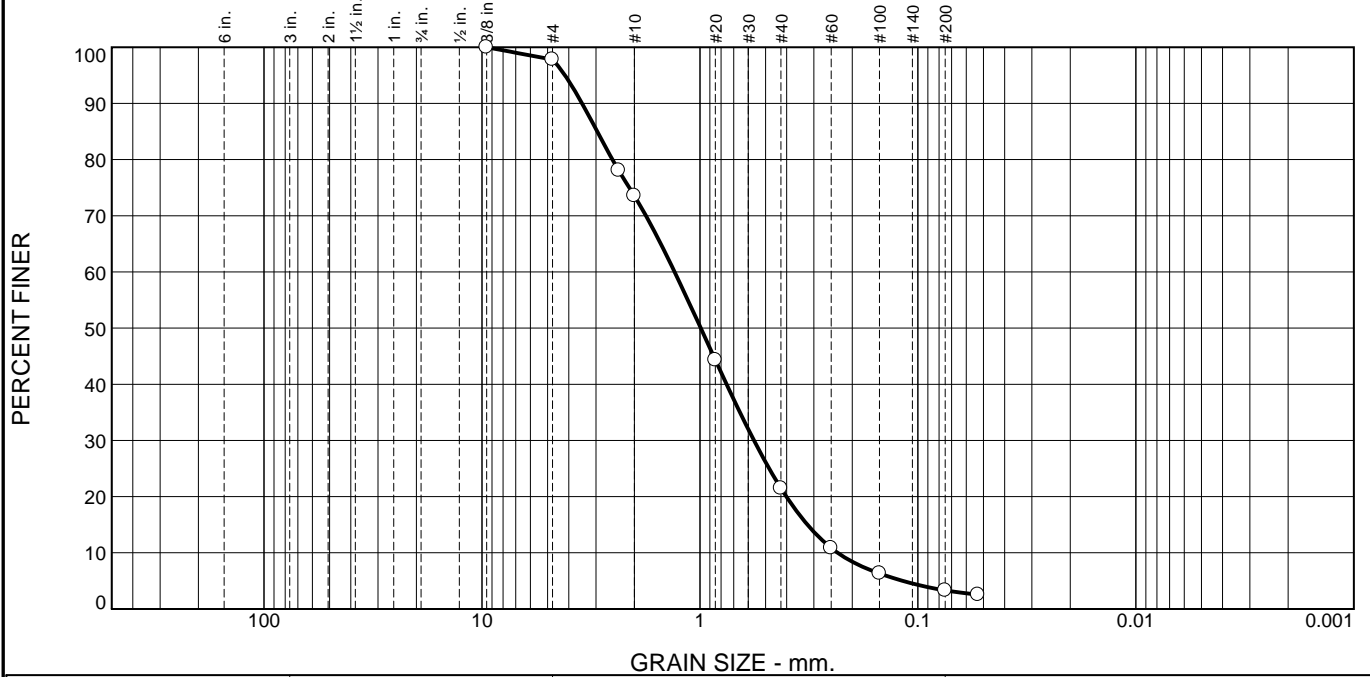
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incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.2 | 24.2 | 52.1 | 18.2 | 3.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 97.8 | | |
| #8 | 78.1 | | |
| #10 | 73.6 | | |
| #20 | 44.3 | | |
| #40 | 21.5 | | |
| #60 | 10.9 | | |
| #100 | 6.3 | | |
| #200 | 3.3 | | |
| #270 | 2.5 | | |

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.4733 | D ₈₅ = 2.9606 | D ₆₀ = 1.3070 |
| D ₅₀ = 0.9915 | D ₃₀ = 0.5652 | D ₁₅ = 0.3212 |
| D ₁₀ = 0.2336 | C _u = 5.60 | C _c = 1.05 |

Remarks

Date Received: 9-12-2023 Date Tested: 11-9-2023

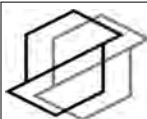
Tested By: FEW

Checked By: APJ/JHS

Title: _____

* (no specification provided)

Location: Onsite - ISHS Cell 1 Date Sampled: 9-11-2023
 Sample Number: HA-2 Depth: 0.5-0.9'

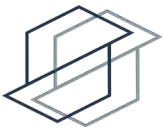


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Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/11/2023 | Project BHPS-ISHS-Cell1 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Issaquah, WA | EB/EP No. ISHS-1-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.2-0.9' | HA-2 @ 0.5-0.9' |
|--------------------|-----------------|-----------------|
| Wet Weight + Pan | 1578.4 | 1335.7 |
| Dry Weight + Pan | 1520.8 | 1293.7 |
| Weight of Pan | 392.0 | 358.0 |
| Weight of Moisture | 57.6 | 42.0 |
| Dry Weight of Soil | 1128.8 | 935.7 |
| % Moisture | 5.1 | 4.5 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 1520.8 | 1293.7 |
| Dry Soil After Burn + Pan | 1476.9 | 1263.0 |
| Weight of Pan | 392.0 | 358.0 |
| Wt. Loss Due to Ignition | 43.9 | 30.7 |
| Actual Wt. Of Soil After Burn | 1084.9 | 905.0 |
| % Organics | 3.9 | 3.3 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--------------------------------|--------------------------------|---|
| Project Name: | Issaquah High School (Cell #1) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 9/12/2023 | Wetted Area (sq. feet): | 09:30: 112 ft^2 / 10:45: 110 ft^2 / 12:45: 127 ft^2 |
| Weather: | Clear, 60's | Underdrain: | Dispersal Pipe |
| Test No.: | IT-1 | Test Depth (feet): | 0.28 |
| Performed By: | SNCF | Receptor Soils: | Qvr |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Piezometer P1-2 (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|---|
| 8:55 | 46.1 | 0 | 2.81 | | 0 | Water On |
| 9:00 | 46.1 | 0 | | | 203 | |
| 9:05 | 46.8 | 0 | | | 439 | |
| 9:10 | 46.9 | 0 | 2.81 | | 680 | Move staff gauge |
| 9:15 | 46.02 | 0.14 | | | 906 | Flow up to 70 gpm |
| 9:30 | 70.7 | 0.16 | 2.81 | 11.92 | 1,928 | |
| 9:45 | 70.4 | 0.18 | | 11.88 | 2,995 | |
| 10:00 | 68.6 | 0.18 | 2.8 | 11.85 | 4,030 | |
| 10:15 | 96.2 | 0.2 | 2.8 | 11.56 | 5,289 | |
| 10:30 | 97.8 | 0.21 | | 11.36 | 6,818 | |
| 10:45 | 96.7 | 0.21 | | 11.33 | 8,228 | |
| 11:01 | 97.7 | 0.22 | | 11.27 | 9,801 | |
| 11:15 | 97.1 | 0.22 | 2.81 | 11.25 | 11,195 | |
| 11:32 | 98.3 | 0.22 | | 11.21 | 12,797 | |
| 11:48 | 97.9 | 0.22 | | 11.21 | 14,396 | |
| 12:00 | 96.7 | 0.24 | 2.81 | 11.18 | 15,555 | |
| 12:17 | 97.6 | 0.24 | | 11.17 | 17,167 | |
| 12:30 | 98.3 | 0.24 | | 11.18 | 18,474 | |
| 12:45 | 96.3 | 0.24 | | 11.19 | 19,938 | No water flowing from dispersal pipe to catch basin |
| 13:04 | 97.8 | 0.24 | | 11.23 | 21,786 | Lateral flow has stopped |
| 13:18 | 98.3 | 0.24 | 2.81 | 11.22 | 23,183 | Ponding more to the NW |
| 13:30 | 97.6 | 0.24 | | 11.21 | 24,338 | |
| 13:46 | 97.5 | 0.24 | | 11.2 | 25,928 | |
| 14:00 | 99.6 | 0.24 | | 11.18 | 27,263 | |
| 14:15 | 97.9 | 0.25 | | 11.17 | 28,743 | Flow into HA-1 |
| 14:31 | 98.1 | 0.25 | | 11.18 | 30,330 | |
| 14:45 | 98.7 | 0.25 | 2.81 | 11.17 | 31,688 | Adjusted Staff Gauge |
| 15:00 | 98.4 | 0.27 | | 11.17 | 33,154 | |
| 15:15 | 97.9 | 0.27 | | 11.14 | 34,755 | Rain begins |
| 15:30 | 98.6 | 0.27 | | 11.16 | 36,270 | Rain intensifies |
| 15:45 | 97.8 | 0.28 | | 11.18 | 37,573 | |
| 16:00 | 98.1 | 0.28 | 2.81 | 11.18 | 39,052 | |
| 16:05 | | 0.28 | | 11.18 | 40,160 | Water off |
| 16:06 | | 0.16 | | | | |

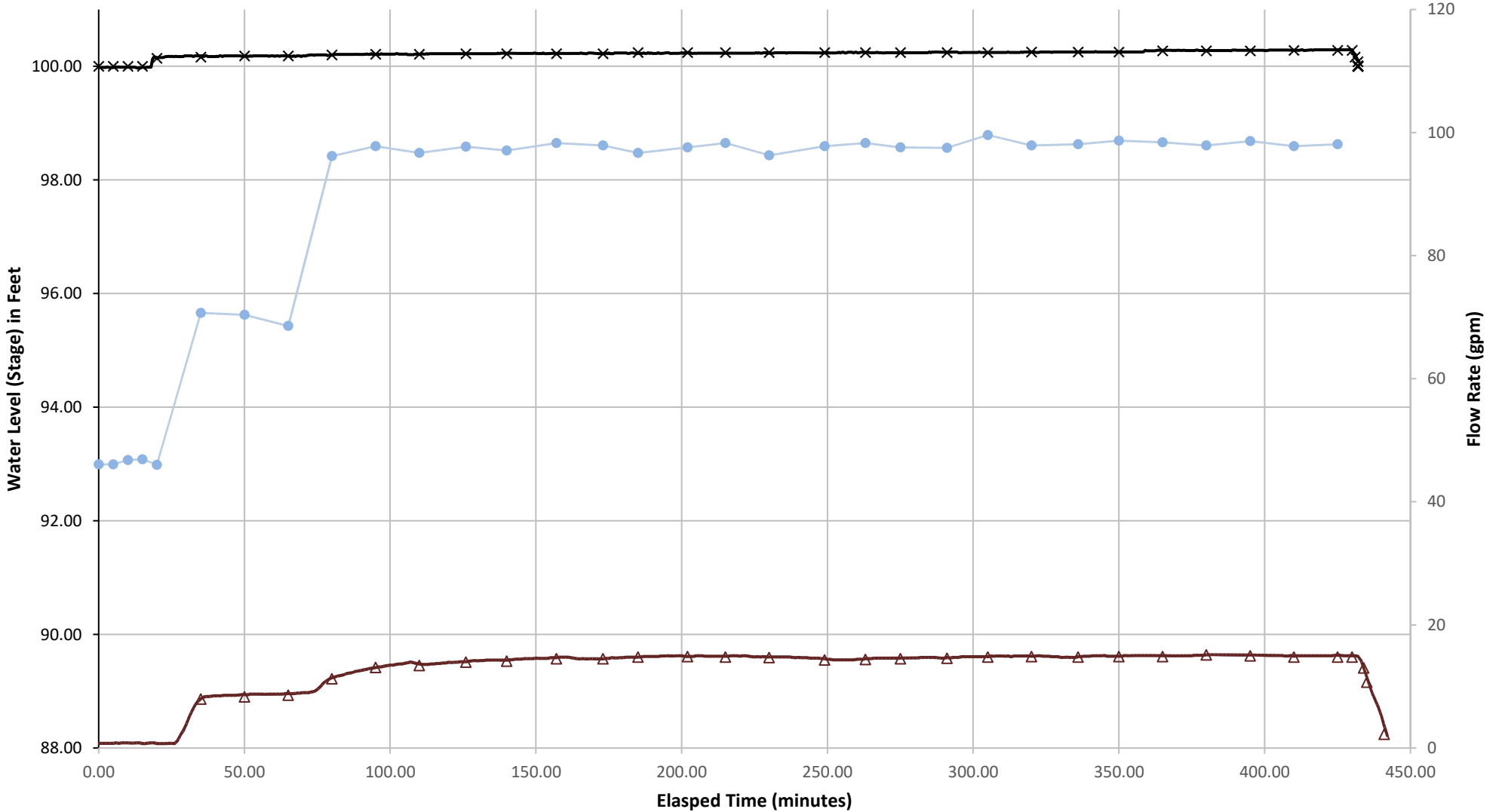
| | | | | | |
|-------|--|------|--|-------|--|
| 16:07 | | 0.08 | | | |
| 16:08 | | 0.01 | | | |
| 16:09 | | 0 | | 11.37 | |
| 16:10 | | | | 11.62 | |
| 16:16 | | | | 12.54 | |
| 16:20 | | | | Dry | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 81.6 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 64.8 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 81.6 |
| WP Average Infiltration Rate (in/hr) during falling head: | 89.0 |

Issaquah High School-Cell #1 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)
Cell: Raingarden

Assessed On:
September 6, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This bioretention cell was constructed in 2011 and designed to collect stormwater runoff from the surrounding parking lot. The cell was designed to be constructed with 2 feet of bioretention soil above native soil, with a perforated underdrain pipe set in 1x1.5 ft of washed rock set along the centerline, at the base of the bioretention soil. The south end of the underdrain pipe design has a cleanout feature. The underdrain pipe is not designed to be set in a trench as is observed with other bioretention facilities with underdrain features. Water enters the cell through sheet flow from the surrounding pavement. Water is designed to infiltrate through the bioretention soil before reaching either the native soil and infiltrating, or if water perches on the native soil layer, water will enter the underdrain pipe and be conveyed to the catch basin and the storm drain network. The catch basin plans indicate a stick-up height of 0.5 ft before water will overflow into it.

BIORETENTION SOIL:

Thickness: 1.4-2.7 ft

The apparent thickness of the bioretention soils from probe data and hand augers ranged from 1.4-2.7 ft of bioretention soil, with an average depth of 2.2 ft. Probe depths tapered towards the edges of the cell.

Composition:

The provided design plans do not state specifications for bioretention soil. In comparison to the 2019 Ecology specifications for bioretention soil, the sand gradation generally fell within the specified range and the organic matter content met the standard. The fines content exceeded the standard.

Organic Matter Content (% by weight): 7.2

Percent passing #200 sieve: 6.6

Coefficient of Uniformity (Cu): 8.7

Coefficient of Curvature (Cc): 0.8

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Lodgement Till

Soil Description: N/A Subgrade soil not encountered.

BUILT PER PLAN:

Observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

Groundwater was encountered at 0.7 ft below ground surface. The temporary WellPoint, screened from 1.4-1.9 ft below ground surface, responded to testing and the shallowest WellPoint water level was 0.38 ft below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 18.4

Subgrade Soil Rate (in/hr): N/A

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)
 Cell: Raingarden

Assessed On:
 September 6, 2023



The subgrade soil rate could not be determined due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:
 Significant trash observed in the cell.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | Clear, 60's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0.01" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Parkland |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230906-161716.jpg



Site Photo: FA_SitePhotos-20230906-161741.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)

Cell: Raingarden

Assessed On:
September 6, 2023



Site Photo: FA_SitePhotos-20230906-161828.jpg



Site Photo: FA_SitePhotos-20230906-161849.jpg



Site Photo: FA_SitePhotos-20230906-185830.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)
Cell: Raingarden

Assessed On:
September 6, 2023



Cell Construction

| | |
|-----------------------------|--|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Partial Width Width 2' 100 feet of perforated pipe is surrounded by washed 1 1/2" - 3/4" rock, wrapped in filter blanket per plans, down center of cell. Underdrain is not a trench, the drain rock and pipe are set in the bioretention soil and share the same base depth. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments | Water is conveyed to the cell by sheet flow from the surrounding parking lot. Water is designed to infiltrate through the bioretention soil before reaching the underdrain pipe where it flows to a catch basin and out to the storm drain network. |

Cleanouts

| | |
|-------------------------------------|--|
| CL-1 | |
| Condition | Accessible: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Standing Water: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Distance from overflow/outlet: 100' | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)
 Cell: Raingarden

Assessed On:
 September 6, 2023



Inlets

| | |
|---|--|
| IN-1 | |
| <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: ' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230906-161958.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation feature was observed. | |

Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round Dimensions: <input checked="" type="checkbox"/> Rectangular Length: 1.8' <input type="checkbox"/> Other Width: 2.2' |  <p>FA_DOPhoto-20230906-162104.jpg</p> |
| Additional Details: | |
| Stickup (ft) From Ground: 0.3 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked Additional Details: Dead vegetation partially blocks trash rack. | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

Cell Surface and Geotech Probe Observations

| |
|---|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.3 |
|---|

BIORETENTION CELL FIELD ASSESSMENT


Site: Central Park Pad 3 (ISP3)
 Cell: Raingarden

Assessed On:
 September 6, 2023



| | | | | | |
|---|---|--------------------------------|-----------------------------------|-----------------------------------|---|
| Cell Coverage | | | | | |
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Natural mulch layers over bark mulch. There is abundant trash littered across the cell. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Additional Details: Rodents and mouse tunnels were observed. | | | | | |
| Vegetation Description | | | | | |
| Cattails & shrubs cover 50% of the cell, trees and grasses are also present. Some dense vegetation limits easy access to the cell. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.4-2.7' of bioretention soil, with an average depth of 2.2', before encountering the underdrain gravels or the subgrade soils. This is more than the 2' specified by the plans. On the cell edges, less than 1 foot of soil was encountered above native soils. This is consistent with the cell design which shows a 4:1 slope with the bioretention soil tapering off above the existing subgrade as it reached the edges. No zones of compaction were observed. Some areas of the cell could not be probed due to utilities. | | | | | |

Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Medium dense, moist to wet, dark brown fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Depth to water from TOC (ft): 0.77 | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0.38 | |
|  | |
| IMG_1758.JPG | |
| Additional Details | |
| Depth of hand auger limited by excessive caving at depths below groundwater, no returns. | |

BIORETENTION CELL FIELD ASSESSMENT


Site: Central Park Pad 3 (ISP3)

Cell: Raingarden

Assessed On:

September 6, 2023



| | |
|---|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Medium dense, moist to wet, dark brown fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| | |
| Additional Details Depth of hand auger limited by excessive caving at depths below groundwater, no returns. Groundwater at 0.9 feet below ground surface. | |

| | |
|--|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.1 |
| Rain/Garden Mix Soil Texture: Medium dense, moist to wet, dark brown fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SP-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Depth of hand auger limited by excessive caving at depths below groundwater, no returns. Groundwater level 1.0 feet below ground surface. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)

Cell: Raingarden

Assessed On:
September 6, 2023



Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# Water truck meter 3-50gpm

Wetted Pond Area (sq. ft) 129

Ponded Depth (ft) 0.11

Total Gallons 7,589

Steady State Flow Rate (GPM) 24.5

Additional Details:

Two batches of test water were used with the water truck, recorded as IT#1 and IT#2, diffuser was not moved, ponded area and infiltration rate roughly the same between tests. Total gallons is for both tests combined. Additional test details can be found in the executive summary.



IT_Photo-20230906-211337.jpg



IT_Photo-20230906-211425.jpg



IT_Photo-20230906-212011.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Park Pad 3 (ISP3)

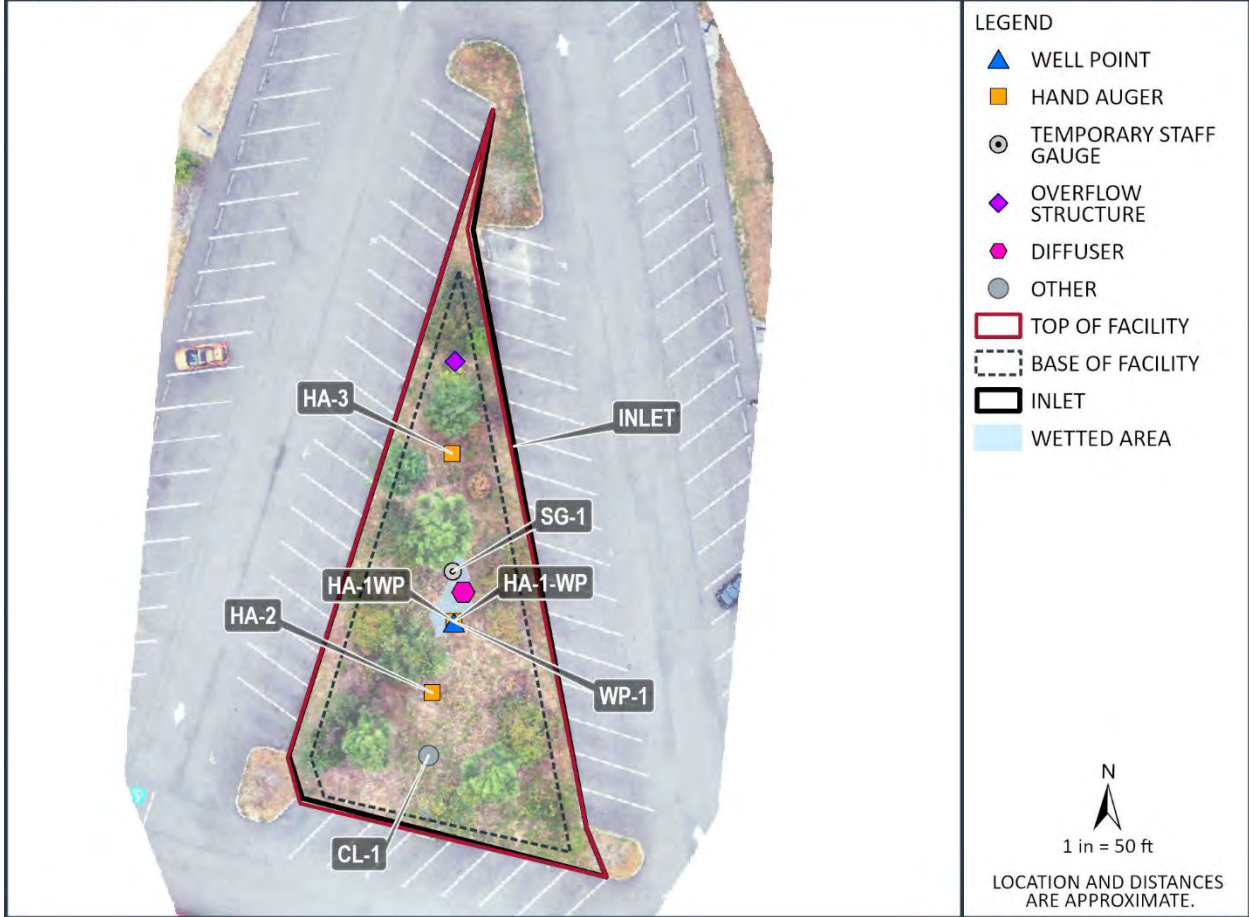
Cell: Raingarden

Assessed On:

September 6, 2023



SITE: CENTRAL PARK PAD 3 (ISP3) CELL: RAINGARDEN





associated
earth sciences
incorporated

Well Point

ISCP-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/6/23

Logged By: CSI/SNCF

20150387H008

Ending Date: 9/6/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.9

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.5

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.1

Water Level Elevation (ft): 99.3

Datum: Project Datum

∇ Groundwater Depth ATD (ft): 0.7

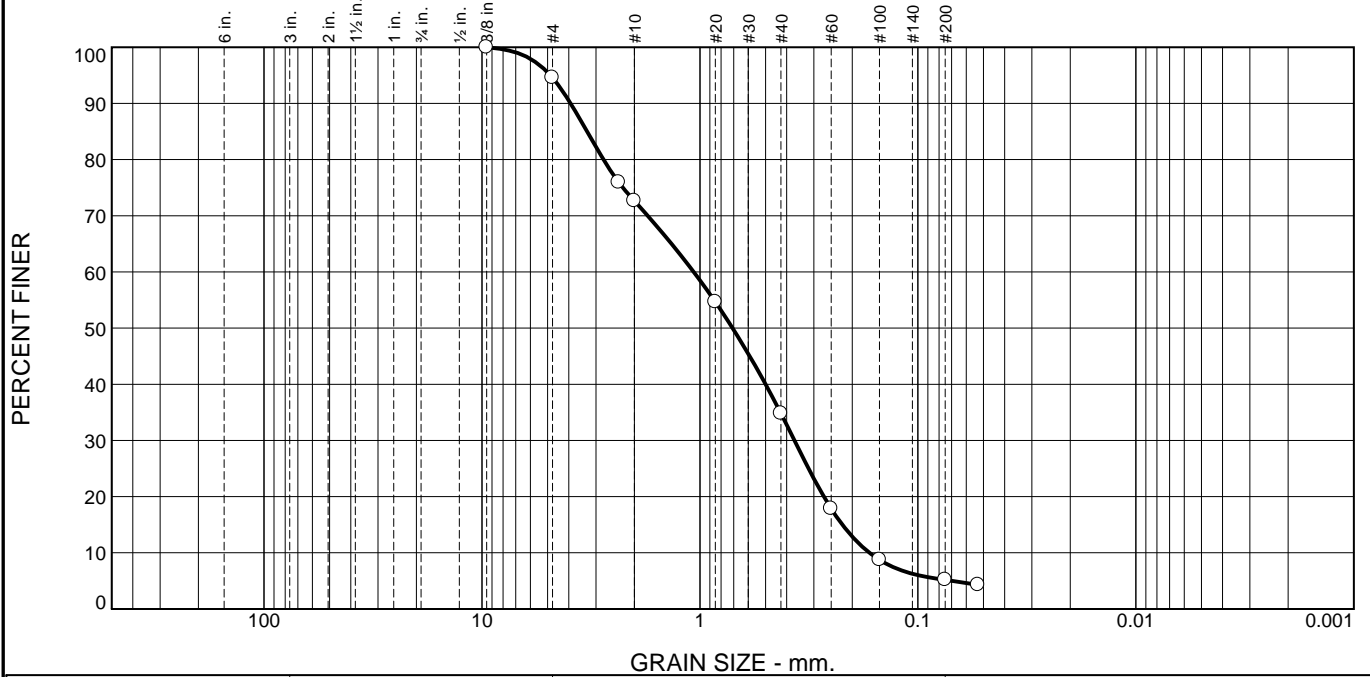
∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Loose, moist, dark brown, medium SAND; abundant organics (SP). | | | | | | | <p>Stick up -5.1 to 0 feet Existing bioretention soils 0 to 1.1 feet 1.25-inch I.D. threaded galvanized steel casing -5.1 to -0.6 feet; duct tape covers screen -0.6 to 1.4 feet Medium grained silica sand 1.1 to 1.9 feet 1.25-inch I.D. stainless steel jacket over #60 gauze welded to perforated steel 1.4 to 1.9 feet Cast iron endcap 1.9 to 2.2 feet Cast iron drivepoint 2.2 to 2.5 feet</p> |
| 1 | | | | Bioretention Soil Mix Medium dense, moist, brownish gray, fine to medium SAND, some gravel, some silt; some organics (SP-SM). Loose to medium dense, wet, brownish gray, medium to coarse SAND, some silt, trace gravel at bottm (SP-SM). | ∇ | | | | | | |
| 2 | | | | Seepage encountered at 0.7 feet. Moderate caving. Potential underdrain encountered. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.4 | 21.9 | 37.9 | 29.6 | 5.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 94.6 | | |
| #8 | 76.0 | | |
| #10 | 72.7 | | |
| #20 | 54.7 | | |
| #40 | 34.8 | | |
| #60 | 17.9 | | |
| #100 | 8.7 | | |
| #200 | 5.2 | | |
| #270 | 4.3 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.9211 D₈₅= 3.2937 D₆₀= 1.0684
 D₅₀= 0.7086 D₃₀= 0.3683 D₁₅= 0.2222
 D₁₀= 0.1668 C_u= 6.41 C_c= 0.76

Remarks

Date Received: 9-06-2023 Date Tested: 11-14-2023

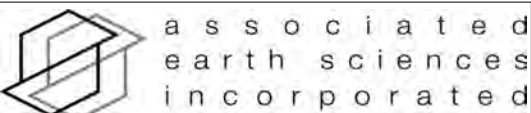
Tested By: FEW

Checked By: CSI/JHS

Title: _____

* (no specification provided)

Location: Onsite - ISCP Sample Number: HA-1 Depth: 0.2-0.7' Date Sampled: 9-06-2023

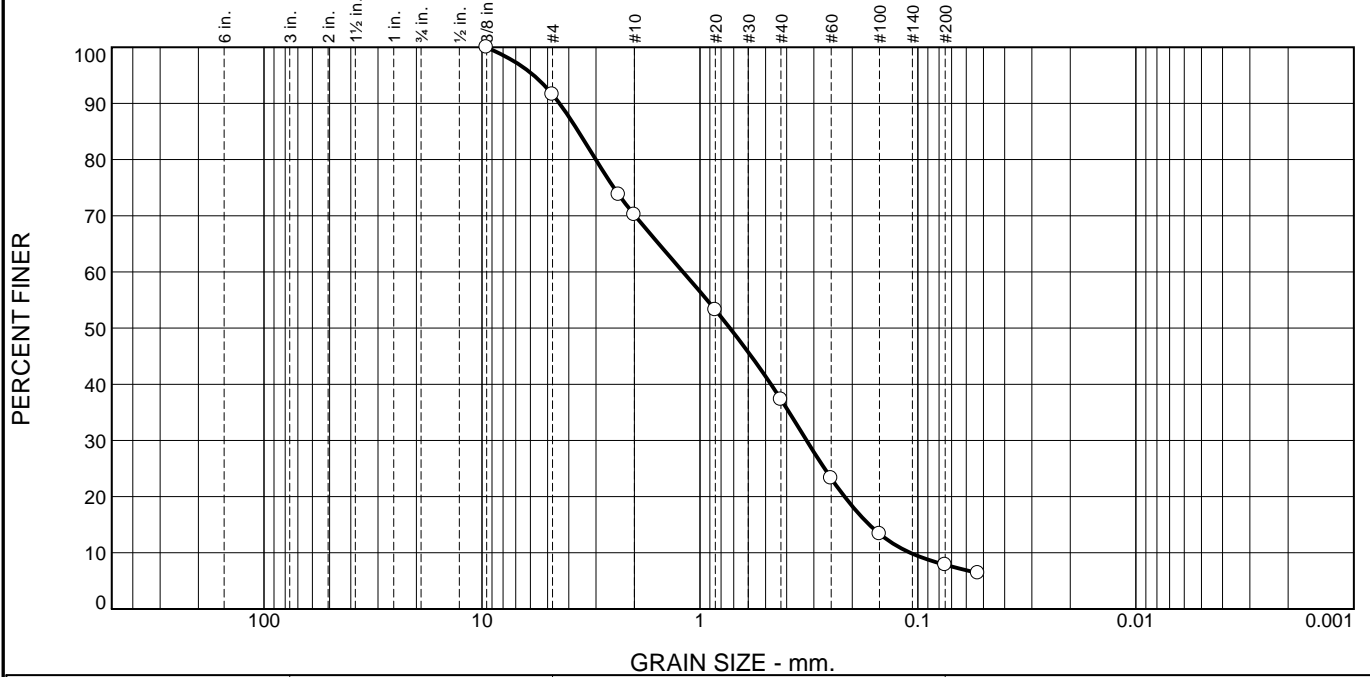


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 8.4 | 21.4 | 32.9 | 29.4 | 7.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 91.6 | | |
| #8 | 73.8 | | |
| #10 | 70.2 | | |
| #20 | 53.2 | | |
| #40 | 37.3 | | |
| #60 | 23.3 | | |
| #100 | 13.4 | | |
| #200 | 7.9 | | |
| #270 | 6.4 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 4.4100 D₈₅= 3.6116 D₆₀= 1.1956
D₅₀= 0.7287 D₃₀= 0.3240 D₁₅= 0.1671
D₁₀= 0.1085 C_u= 11.02 C_c= 0.81

Remarks

Date Received: 9-06-2023 Date Tested: 11-8-2023

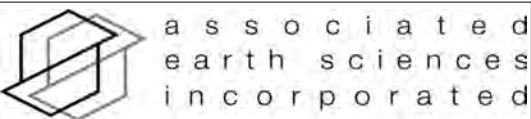
Tested By: FEW

Checked By: JHS

Title: _____

* (no specification provided)

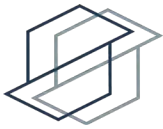
Location: Onsite - ISCP Sample Number: HA-3 Depth: 0-0.4' Date Sampled: 9-06-2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|---------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/6/2023 | Project BHPS-ISP3 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Issaquah, WA | EB/EP No. ISP3-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.2-0.7' | HA-3 @ 0-0.4' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 1525.8 | 527.1 |
| Dry Weight + Pan | 1198.5 | 456.3 |
| Weight of Pan | 358.0 | 259.4 |
| Weight of Moisture | 327.3 | 70.8 |
| Dry Weight of Soil | 840.5 | 196.9 |
| % Moisture | 38.9 | 36.0 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|-------|
| Dry Soil Before Burn + Pan | 1198.5 | 456.3 |
| Dry Soil After Burn + Pan | 1159.8 | 437.2 |
| Weight of Pan | 358.0 | 259.4 |
| Wt. Loss Due to Ignition | 38.7 | 19.1 |
| Actual Wt. Of Soil After Burn | 801.8 | 177.8 |
| % Organics | 4.6 | 9.7 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--------------------|--------------------------------|--------------------------------------|
| Project Name: | Central Park Pad 3 | Water Source: | Water Truck |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) |
| Date: | 9/6/2023 | Wetted Area (sq. feet): | 10:15: 117.75 ft^2 / 13:15: 129 ft^2 |
| Weather: | Clear | Underdrain: | Yes |
| Test No.: | IT-1 / IT-2 | Test Depth (feet): | 0.12 |
| Performed By: | SNCF | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Catch Basin (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|------------------|---------------------|---------------------------------------|
| 8:25 | 12.00 | | 6.06 | 1.17 | | Water on. IT-1 Start |
| 8:30 | 12.16 | 0.04 | | | 65 | |
| 8:35 | 12.14 | 0.05 | 5.88 | 1.03 | 133 | Flow rate increased to 24 gpm at 8:40 |
| 8:45 | 24.96 | 0.1 | 5.83 | 0.97 | 309 | |
| 9:00 | 24.93 | 0.1 | 5.7 | 0.96 | 686 | |
| 9:15 | 24.7 | 0.11 | 5.69 | | 1,050 | |
| 9:31 | 24.6 | 0.11 | 5.69 | 0.97 | 1,454 | |
| 9:45 | 24.4 | 0.11 | 5.7 | 0.97 | | |
| 10:00 | 24.21 | 0.11 | 5.71 | | 1,783 | |
| 10:15 | 24.06 | 0.11 | 5.7 | 0.96 | 2,514 | |
| 10:30 | 23.9 | 0.11 | 5.69 | | 2,871 | |
| 10:45 | 24.86 | 0.11 | | | 3,263 | Water off, Truck Re-filling |
| 11:00 | | 0.11 | | | 3,611 | |
| 11:01 | | 0.04 | 5.7 | | | |
| 11:02 | | 0 | 5.75 | | | |
| 11:03 | | | 5.78 | | | |
| 11:04 | | | 5.79 | | | |
| 11:05 | | | 5.81 | | | |
| 11:06 | | | 5.85 | | | |
| 11:07 | | | 5.85 | | | |
| 11:08 | | | 5.86 | | | |
| 11:09 | | | 5.86 | | | |
| 11:10 | | | 5.86 | 1.02 | | |
| 11:14 | | | 5.89 | | | |
| 11:24 | | | 5.89 | 1.04 | | |
| 11:45 | | | | | 3,611 | Water on. IT-2 Start |
| 11:46 | 25.13 | 0.06 | | | | |
| 11:47 | | 0.08 | 5.87 | 0.99 | | |
| 12:00 | 25.2 | 0.11 | 5.7 | | 4,003 | |
| 12:15 | 25.12 | 0.11 | 5.69 | | 4,363 | |
| 12:30 | 24.88 | 0.11 | 5.68 | | 4,745 | |
| 12:45 | 25.16 | 0.11 | 5.68 | 0.96 | 5,109 | |
| 13:00 | 24.9 | 0.11 | 5.68 | | 5,487 | |
| 13:15 | 24.75 | 0.12 | 5.69 | | 5,865 | |

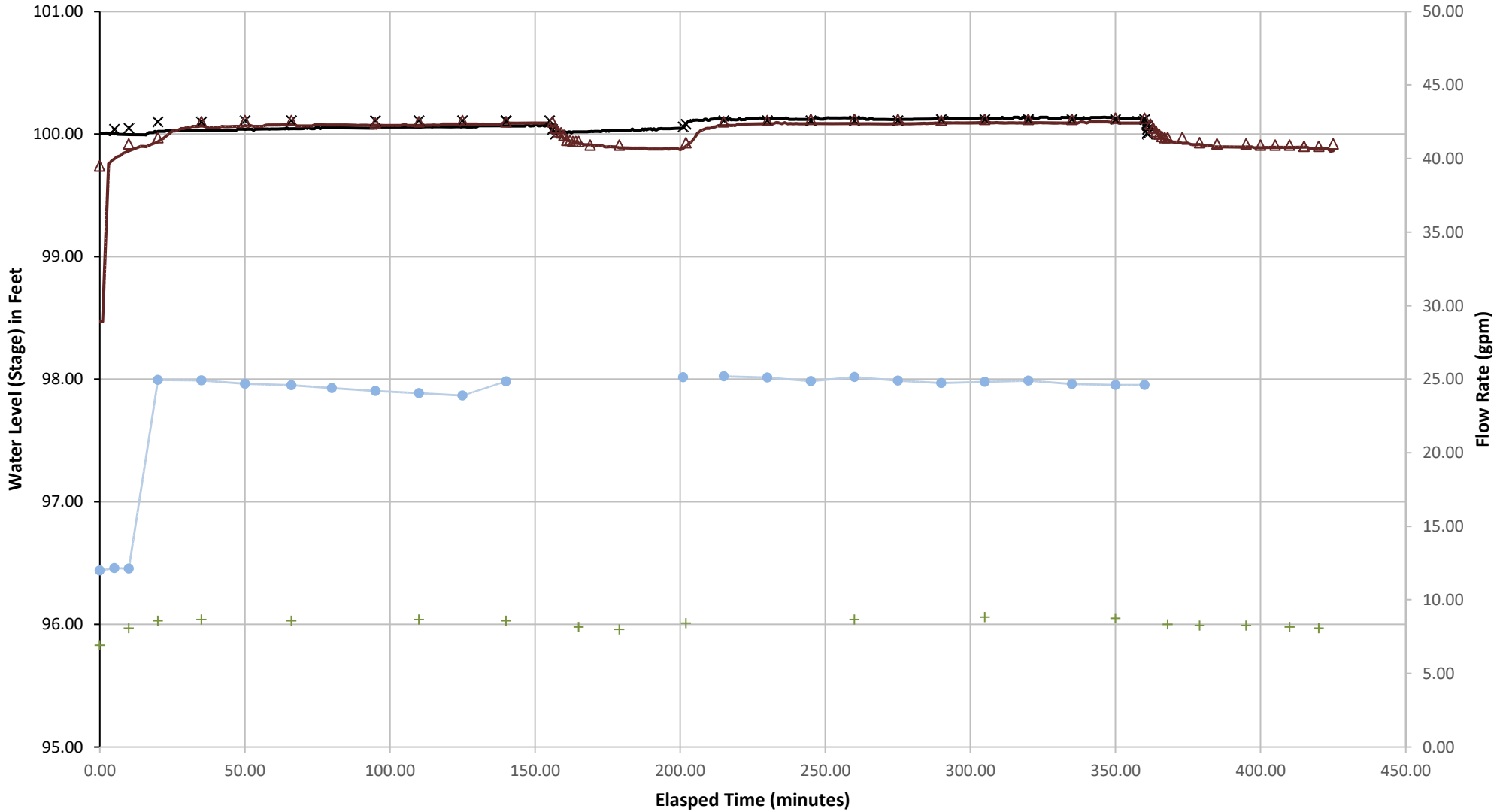
| | | | | | | |
|----------|-------|------|------|------|-------|-----------|
| 13:30 | 24.83 | 0.12 | 5.68 | 0.94 | 6,227 | |
| 13:45 | 24.9 | 0.12 | 5.68 | | 6,609 | |
| 14:00 | 24.68 | 0.12 | 5.68 | | 6,991 | |
| 14:15 | 24.61 | 0.12 | 5.67 | 0.95 | 7,352 | |
| 14:25 | 24.61 | 0.12 | 5.67 | | 7,589 | Water off |
| 14:25:30 | | 0.08 | | | | |
| 14:26 | | 0.07 | | | | |
| 14:26 | | 0.04 | | | | |
| 14:27 | | 0.01 | 5.72 | | | |
| 14:28 | | 0 | 5.75 | | | |
| 14:29 | | | 5.78 | | | |
| 14:30 | | | 5.8 | | | |
| 14:31 | | | 5.82 | | | |
| 14:32 | | | 5.83 | | | |
| 14:33 | | | 5.83 | 1 | | |
| 14:38 | | | 5.83 | | | |
| 14:44 | | | 5.87 | 1.01 | | |
| 14:50 | | | 5.88 | | | |
| 15:54 | | | 5.88 | | | |
| 15:00 | | | 5.88 | 1.01 | | |
| 15:05 | | | 5.89 | | | |
| 15:10 | | | 5.89 | | | |
| 15:15 | | | 5.89 | 1.02 | | |
| 15:20 | | | 5.9 | | | |
| 15:25 | | | 5.9 | 1.03 | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 18.4 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 39.6 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 18.6 |
| WP Average Infiltration Rate (in/hr) during falling head: | 16.5 |

Central Park Pad 3 Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface. Gap in flow rate due to refill of water truck.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- + Catch Basin Hand
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell is one of two rain gardens constructed in 2007 and collects run off from Rainier Boulevard. The cell is designed to be constructed with 1.5 ft of amended soil above native soil. Water is designed to enter the cell via two curb cuts, each with an energy dispersion feature consisting of 2-4" washed gravel, 1.5 ft deep bounded by two rows deep of 8x8x16" concrete blocks spaced 1" apart, before water reaches the amended soil of the facility. Water is designed to infiltrate through the washed gravel before reaching the native subgrade, or laterally flowing through the concrete blocks to the amended soil before infiltrating to the native soil. An overflow catch basin is designed to convey excess water to the existing storm drain network.

BIORETENTION SOIL:

Thickness: 1.2-2.0 ft

The apparent thickness of the bioretention soils from probe data and hand augers ranged from 1.2-2.0 feet below ground surface, with an average thickness of 1.8 ft. Some areas of the cell could not be probed due to buried utilities.

Composition:

The plans call for amended soil to be "vegetable garden mix" supplied by Cedar Grove Composting of Washington but did not provide a specific specification. In comparison to the 2019 Ecology specification, the tested soil had a sand gradation finer than the specifications, organic matter content which exceeded the specifications, and a fines content which exceeded the specifications.

Organic Matter Content (% by weight): 11.4

Percent passing #200 sieve: 10.3

Coefficient of Uniformity (Cu): 8.8

Coefficient of Curvature (Cc): 1.7

SUBGRADE CONDITIONS:

Geologic Unit: Recent Alluvium

Soil Description: N/A

Subgrade soil was not encountered due to buried utilities.

BUILT PER PLAN:

Inlet #1 is set at an elevation below the overflow catch basin so water will flood into the street near inlet #1 before it overflows into the catch basin. Infiltration test water was observed to be laterally flowing out of the cell under cracks in the side of the adjacent roadway, it appears mitigation measures have been attempted with black plastic barriers to reduce lateral flow under the road. Additional gas, cable, and water buried utilities cross under the facility, more than the one storm drainpipe called out on the plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered during excavations of hand augers.

INFILTRATION TEST RESULTS:

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



Bioretention Soil Rate (in/hr): 21.6
Subgrade Soil Rate (in/hr): N/A

Due to the multiple buried utilities, a wellpoint was not installed to observe groundwater conditions during the test. Due to the observation of lateral flow leaving the cell through the adjacent pervious pavement the falling head rate is presented.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Road subgrade in the northeast corner of the cell was observed to be cracked and the preferred direction of water flow from the cell during the test.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------------------|---------------------|
| Weather | Overcast | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.01" | Two Days Ago: 0.27" |
| Field Reps | Full Day: Sarah Faubion | Half Day: Catherine Ikeda | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 2 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)

Cell: Cell 1

Assessed On:
September 5, 2023



Site Photo: FA_SitePhotos-20230905-145730.jpg

Site Photo: FA_SitePhotos-20230905-145848.jpg



Site Photo: FA_SitePhotos-20230905-145901.jpg



Site Photo: FA_SitePhotos-20230905-161434.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)

Cell: Cell 1

Assessed On:

September 5, 2023



Cell Construction

| | |
|-----------------------------|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Additional Comments

Water is conveyed to the cell from the adjacent street through two curb cuts. Partially buried concrete blocks, designed to be spaced 1' apart, separate the inlet's stream cobble energy dispersion from the main section of the cell. Water is designed to infiltrate through the bioretention soil before infiltrating into the underlying native soil. Overflow flows into the catch basin that connects to the storm drain network. Inlet 1 appears to be at a lower elevation than the designed overflow, by 0.1 or 0.2 feet. Water was observed leaving the cell test area via a non-engineered crack under the pavement of the street on the NE side of the cell. Relative height of the inlet elevation and overflow catch basin was difficult to determine due to reducing the test pond depth to limit unquantified flow out of the cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.5'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: Buried
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230905-155027.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Dry leaf litter was observed blocking the inlet.



FA_INBLPhoto-20230905-161227.jpg

Additional Details: 8"x8"x16" concrete blocks with 1" gaps, placed 2 rows deep, and with the top designed to be 4" above the ground were installed between the stream cobbles and the main cell. These blocks were mostly buried by mulch and soil.

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)

Cell: Cell 1

Assessed On:

September 5, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230905-160255.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Dry leaf litter



FA_INBLPhoto-20230905-160243.jpg

Additional Details: 8"x8"x16" concrete blocks with 1" gaps, placed 2 rows deep, and with the top designed to be 4" above the ground were installed between the stream cobbles and the main cell. These blocks were mostly buried by mulch and soil.


BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



Design Overflow/Outlet

| | |
|--|---|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.1' Width: 1.8' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.14 Relative from staff gauge: 0.5 |  |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No The stick up of the overflow is above the elevation of inlet 1, so water will flood into the street near inlet 1 before it will overflow into the catch basin. | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 5% blocked Additional Details: Some dead leaves caught in spiderwebs slightly block overflow. | |


FA_DOPhoto-20230905-160506.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



| | |
|---|--|
| DO - 2 | |
| Shape: <input type="checkbox"/> Round Dimensions: <input type="checkbox"/> Rectangular <input checked="" type="checkbox"/> Other: Non engineered overflow |  |
| Additional Details: Cracks under the street were observed at the perimeter of the stream cobble energy dispersion feature for Inlet 1 for a width of 3 feet. | |
| Stickup (ft) From Ground: 0.1 Relative from staff gauge: 0.22 | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Water was observed flowing into cracks under the street pavement on the NE edge of the cell during testing. Some past mitigation efforts were observed by means of a short plastic barrier, this was ineffectual at the time of testing. | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

FA_DOPhoto-20230905-235831.jpg

Cell Surface and Geotech Probe Observations

| | |
|---|--|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.4 | |
| Cell Coverage | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other cell coverage consists of the stream cobble energy dispersion feature from both inlets that take up about 25% of the cell. Some trash was observed in the cell. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |
| Vegetation Description Shrubs and a small tree were observed, all vegetation appears healthy. | |
| Additional Details Geotech Probe Observations: At the cell base, probe measurements found 1.2-2.0' of bioretention soil, with an average depth of 1.8', before encountering the underlying substrate. This is more than the 1.5' specified by the plans. On the cell edges, probe depths were 1-3" due to stream cobble energy dispersion features. This is consistent with the cell design. No zones of compaction were observed. Some areas of the cell could not be probed due to buried utilities. | |


BIORETENTION CELL FIELD ASSESSMENT


Site: Rainier Blvd (ISRB)
Cell: Cell 1

Assessed On:
September 5, 2023



Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.4 |
| to Native Soil: | |
| to Import/Underdrain: | 1 |
| Total Depth: | 1 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| FA_FPhoto-20230905-110725.jpg | |
| Additional Details | |
| Hand auger hole was kept shallow due to proximity to buried utilities. | |

| | |
|---|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.4 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.2 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| FA_FPhoto-20230905-111302.jpg | |
| Additional Details | |
| Hand auger hole was kept shallow due to proximity to buried utilities. | |

Infiltration Test

| | |
|--|-----------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# | FM-4 3-50 |
| Wetted Pond Area (sq. ft) | 44 |
| Ponded Depth (ft) | 0.61 |
| Total Gallons | 6,701 |
| Steady State Flow Rate (GPM) | 12.4 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)

Cell: Cell 1

Assessed On:
September 5, 2023



Additional Details:

Field staff reduced flow rate due to lateral flow under the street at ponded depth of 0.54 or greater. No WellPoint was installed due to the proximity of buried utilities. Additional test details can be found in the executive summary.



IT_Photo-20230905-182000.jpg



IT_Photo-20230905-231446.jpg



IT_Photo-20230905-231522.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Rainier Blvd (ISRB)

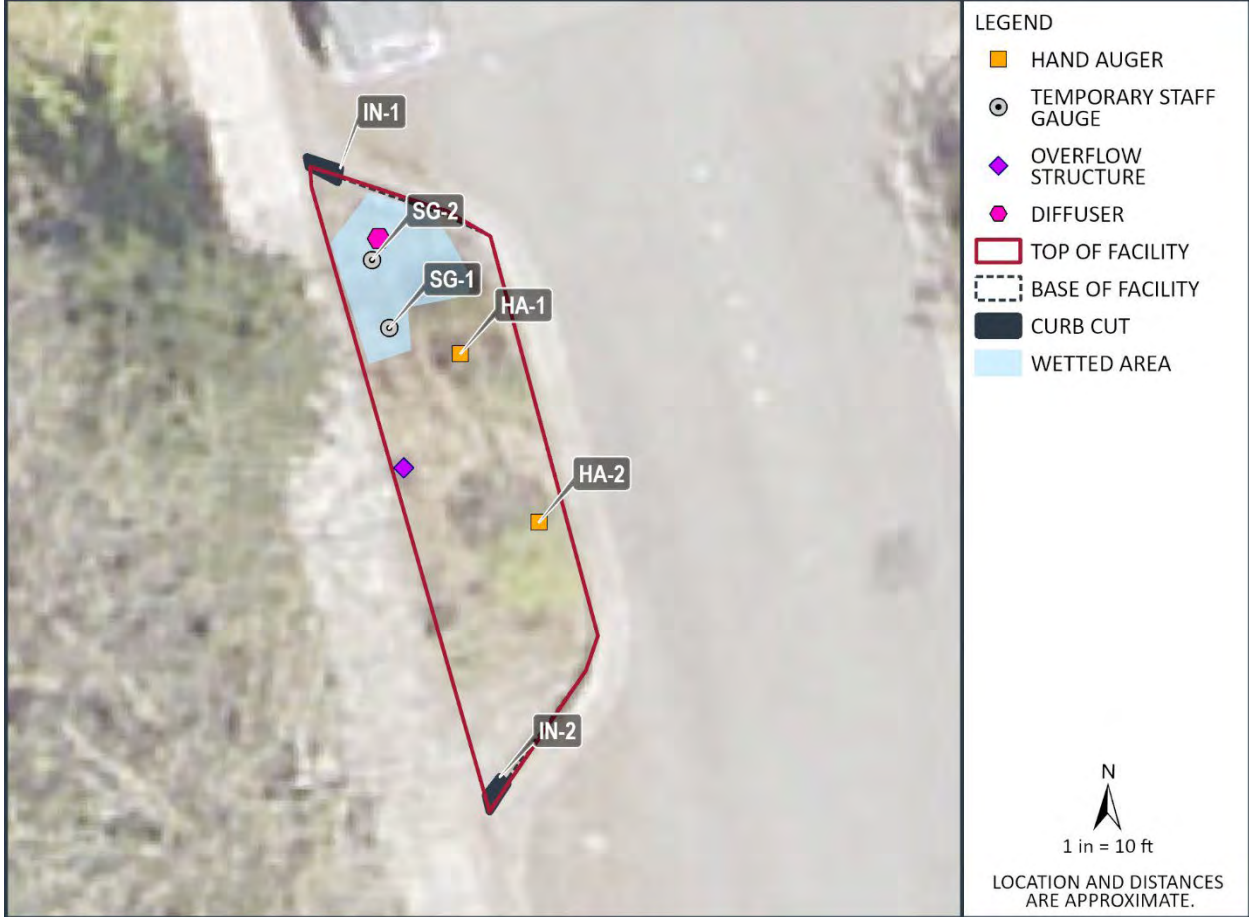
Cell: Cell 1

Assessed On:

September 5, 2023



SITE: RAINIER BLVD (ISRB) CELL: CELL 1





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Exploration Boring

ISR-B-HA-1

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/5/23

Logged By: APJ

20150387H008

Ending Date: 9/5/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

∇ Groundwater Depth ATD (ft): Not encountered

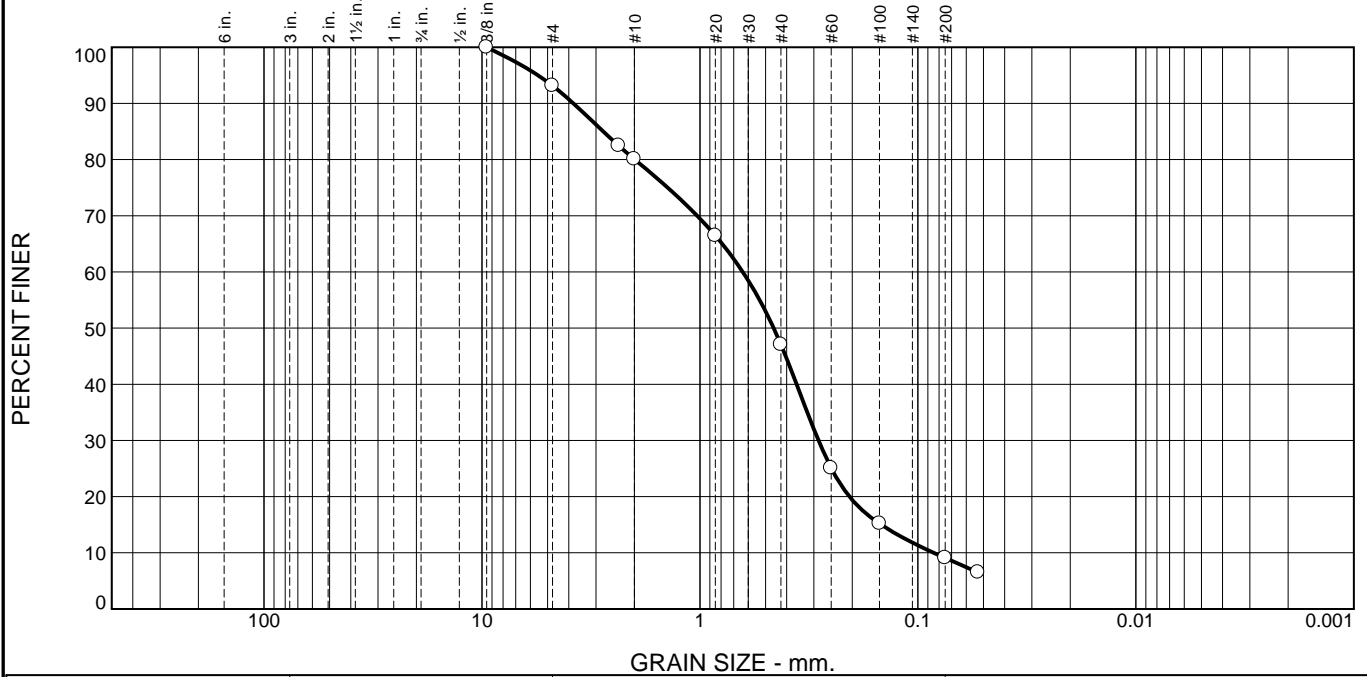
∇ Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | | <p>Mulch Maintenance mulch, fine mulch, shredded bark.</p> | | | | | | | | |
| | | | | | <p>Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some silt, some gravel, some coarse sand; abundant organics (SW-SM).</p> | | | | | | | | |
| 1 | | | | | <p>No groundwater encountered. Terminated due to utilities and moderate caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 6.8 | 13.1 | 33.0 | 38.0 | 9.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 93.2 | | |
| #8 | 82.5 | | |
| #10 | 80.1 | | |
| #20 | 66.5 | | |
| #40 | 47.1 | | |
| #60 | 25.1 | | |
| #100 | 15.2 | | |
| #200 | 9.1 | | |
| #270 | 6.5 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.8074 D₈₅= 2.7778 D₆₀= 0.6361
D₅₀= 0.4590 D₃₀= 0.2858 D₁₅= 0.1472
D₁₀= 0.0846 C_u= 7.52 C_c= 1.52

Remarks

Date Received: 9-05-2023 Date Tested: 11-16-2023

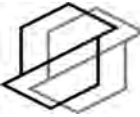
Tested By: FEW

Checked By: CSI/JHS

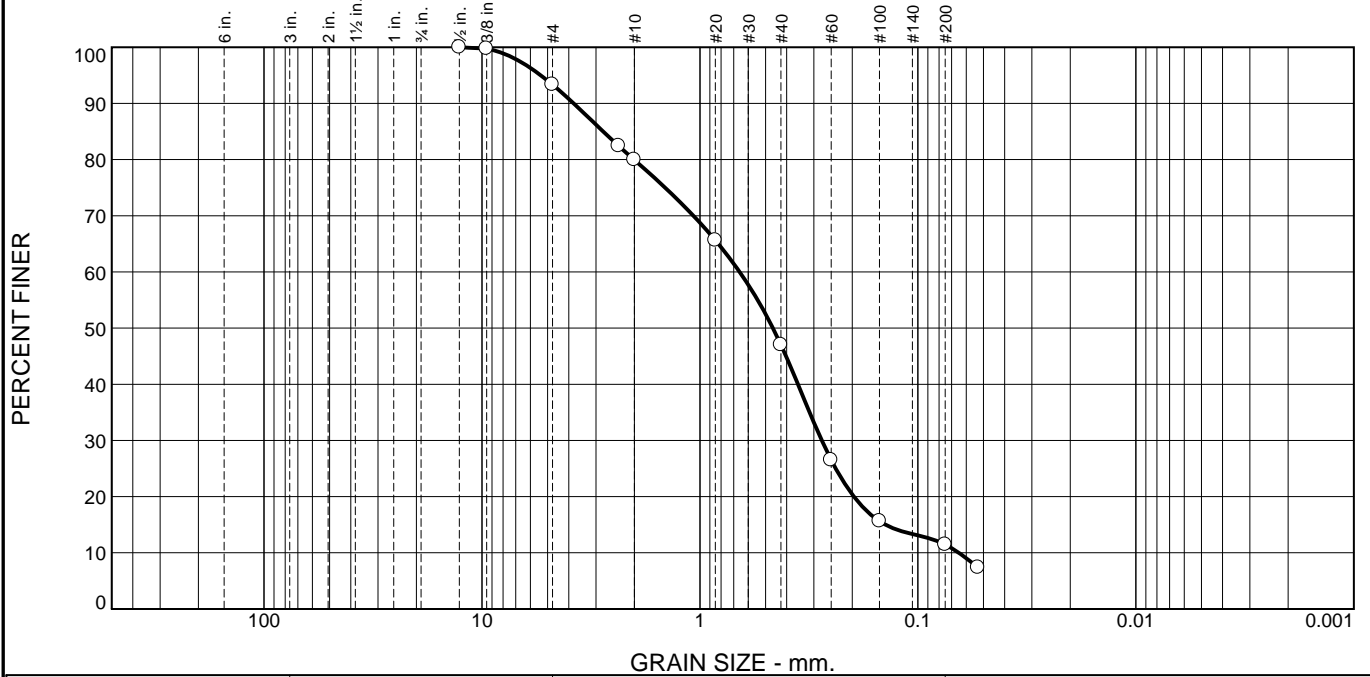
Title: _____

* (no specification provided)

Location: Onsite - ISRB Date Sampled: 9-05-2023
Sample Number: HA-1 Depth: 0.4-1'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 |
|---|--|--|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 6.6 | 13.5 | 32.9 | 35.5 | 11.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.8 | | |
| #4 | 93.4 | | |
| #8 | 82.4 | | |
| #10 | 79.9 | | |
| #20 | 65.6 | | |
| #40 | 47.0 | | |
| #60 | 26.5 | | |
| #100 | 15.6 | | |
| #200 | 11.5 | | |
| #270 | 7.4 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.7979 | D ₈₅ = 2.7812 | D ₆₀ = 0.6574 |
| D ₅₀ = 0.4628 | D ₃₀ = 0.2760 | D ₁₅ = 0.1409 |
| D ₁₀ = 0.0649 | C _u = 10.13 | C _c = 1.78 |

Remarks

Date Received: 9-05-2023 Date Tested: 11-9-2023

Tested By: FEW

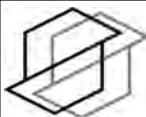
Checked By: CSI/JHS

Title: _____

Location: Onsite - ISRB
 Sample Number: HA-2

Depth: 0.4-1.2'

Date Sampled: 9-05-2023



associated
 earth sciences
 incorporated

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|-----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 10/27/2023 | Project BHPS-ISRIB | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Issaquah, WA | EB/EP No. ISRIB-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.4-1' | HA-2 @ 0.4-1.2' |
|--------------------|---------------|-----------------|
| Wet Weight + Pan | 533.2 | 757.6 |
| Dry Weight + Pan | 497.6 | 692.9 |
| Weight of Pan | 261.5 | 247.4 |
| Weight of Moisture | 35.6 | 64.7 |
| Dry Weight of Soil | 236.1 | 445.5 |
| % Moisture | 15.1 | 14.5 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 497.6 | 692.9 |
| Dry Soil After Burn + Pan | 474.5 | 635.3 |
| Weight of Pan | 261.5 | 247.4 |
| Wt. Loss Due to Ignition | 23.1 | 57.6 |
| Actual Wt. Of Soil After Burn | 213.0 | 387.8 |
| % Organics | 9.8 | 12.9 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-------------------|--------------------------------|---|
| Project Name: | Rainier Boulevard | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) |
| Date: | 9/5/2023 | Wetted Area (sq. feet): | 11:30: 44 ft ² / 13:30: 33.3 ft ² |
| Weather: | 60's Clear | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.52 |
| Performed By: | SNCF / CSI | Receptor Soils | Qa |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|---------------------|---|
| 10:30 | | | | | Water On |
| 10:32 | 43.25 | 0.06 | | 69 | Water at SG |
| 10:35 | 41.36 | 0.21 | | 208 | Flow down to 21 gpm |
| 10:40 | 21.29 | 0.2 | | 329 | |
| 11:00 | 21.26 | 0.24 | | 760 | Catch basin readings maybe inaccurate |
| 11:15 | 21.19 | 0.25 | | 1,071 | WL hits bottom of catch basin |
| 11:30 | 21.06 | 0.26 | | 1,390 | |
| 11:45 | 21.28 | 0.27 | | 1,710 | |
| 12:00 | 21.12 | 0.27 | | 2,035 | |
| 12:10 | 21.18 | 0.28 | 0.6 | 2,232 | SG-2 added |
| 12:15 | 20.9 | 0.28 | 0.6 | 2,341 | |
| 12:30 | 21.01 | 0.29 | 0.61 | 2,655 | Notice lateral flow toward understreet surface |
| 12:43 | | 0.25 | 0.58 | | Flow down to 11 gpm |
| 12:45 | 11.14 | 0.22 | 0.54 | 2,936 | |
| 12:55 | | 0.18 | 0.48 | | Flow up to 15 gpm |
| 13:00 | 15.39 | 0.2 | 0.51 | 3,135 | Flow down to 13 gpm |
| 13:06 | 13.06 | 0.18 | 0.5 | 3,259 | |
| 13:15 | 13.02 | 0.16 | 0.48 | 3,338 | |
| 13:30 | 14.03 | 0.18 | 0.5 | 3,545 | |
| 13:45 | 14.16 | 0.19 | 0.52 | 3,755 | |
| 14:00 | 13.7 | 0.2 | 0.52 | 3,968 | |
| 14:15 | 13.75 | 0.2 | 0.52 | 4,178 | |
| 14:30 | 13.78 | 0.2 | 0.52 | 4,380 | |
| 14:45 | 13.77 | 0.2 | 0.52 | 4,586 | |
| 15:00 | 13.77 | 0.21 | 0.52 | 4,794 | |
| 15:15 | 13.6 | 0.21 | 0.53 | 5,000 | |
| 15:30 | 13.5 | 0.21 | 0.53 | 5,202 | |
| 15:45 | 13.5 | 0.22 | 0.54 | 5,404 | Lateral flow started again, flow down to 11 gpm |
| 15:50 | 10.83 | 0.2 | 0.52 | 5,463 | |
| 15:54 | 12.4 | 0.18 | 0.5 | 5,518 | |
| 16:00 | 12.38 | 0.18 | 0.5 | 5,578 | |
| 16:17 | 12.36 | 0.18 | 0.5 | 5,796 | |
| 16:30 | 12.44 | 0.19 | 0.51 | 5,955 | |
| 16:42 | 12.42 | 0.19 | 0.51 | 6,103 | |
| 16:50 | 12.44 | 0.19 | 0.51 | 6,197 | |
| 17:00 | 12.42 | 0.2 | 0.52 | 6,320 | |

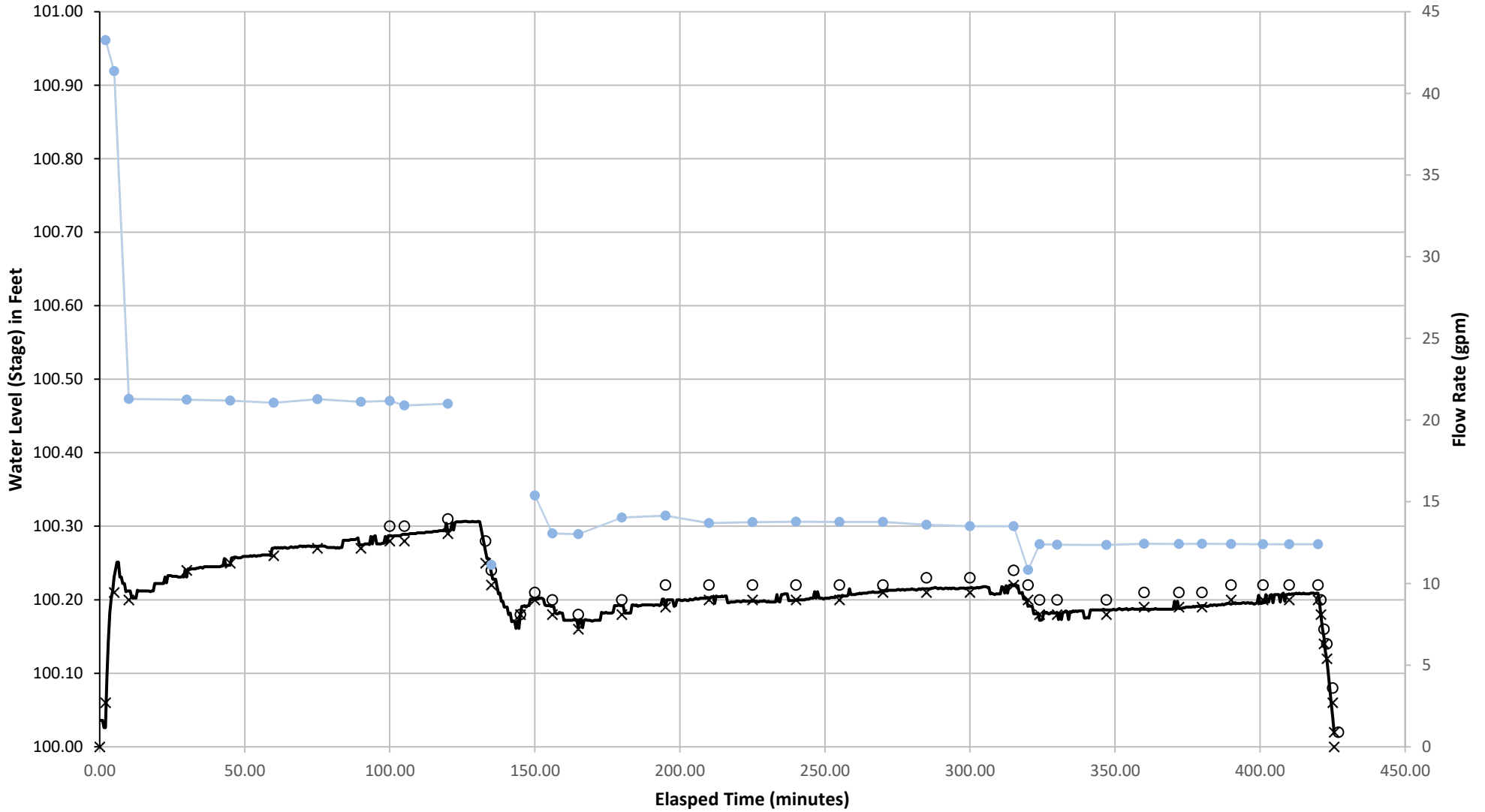
| | | | | | |
|-------|------|------|------|-------|-----------|
| 17:11 | 12.4 | 0.2 | 0.52 | 6,466 | |
| 17:20 | 12.4 | 0.2 | 0.52 | 6,569 | |
| 17:30 | 12.4 | 0.2 | 0.52 | 6,701 | Water off |
| 17:31 | | 0.18 | 0.5 | | |
| 17:32 | | 0.14 | 0.46 | | |
| 17:33 | | 0.12 | 0.44 | | |
| 17:35 | | 0.06 | 0.38 | | |
| 17:37 | | 0.02 | 0.32 | | |
| 17:39 | | 0 | 0.26 | | |
| 17:42 | | | 0.18 | | |
| 17:45 | | | 0 | | Dry |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 35.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 21.6 |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 35.9 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 20.9 |

Rainer Boulevard Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

× Staff Gauge #1 Hand Data

— Staff Gauge #1 Logger

○ Staff Gauge #2 Hand Data

● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

No design plans were received for this site. The cell appears to receive runoff from multiple parts of the site. No underdrain was observed though there were several pipes which flowed into the catch basin at the northern end of the cell. Our interpretation of the cell construction is that all water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 3.5'

The full soil column was only evaluated in HA-1-WP. Other hand augers and probes encountered partial soil depths due to excavation difficulties and probes encountering gravels within the bioretention soil.

Composition: No design soil specifications were received. In comparison to the 2019 Ecology specifications, the sand gradation, silt content, and organic matter content fell far below the specified range. The soil mix was the coarsest of all 50 sites.

Organic Matter Content (% by weight): 2.6

Percent passing #200 sieve: 4.2

Coefficient of Uniformity (Cu): 19.6

Coefficient of Curvature (Cc): 3.5

SUBGRADE CONDITIONS:

Geologic Unit: Pre-Fraser Fine Grained Deposits

Soil Description: Moist, medium stiff, light brown, sandy, SILT, trace gravel; medium plasticity (ML)

BUILT PER PLAN:

No design plans were received for this site. It is unclear if the cell was built to plan due to the unique soil encountered and pipes observed in the catch basin. Water was observed entering the catch basin through leaks in the joint between the PVC pipe and the cement catch basin.

GROUNDWATER CONDITIONS:

No groundwater was encountered hand auger explorations in the cell base. The temporary wellpoint was screened from 3.4-4.4' below ground surface. The wellpoint responded to testing after approximately 45 minutes of inflow and rose to the same elevation as the surface water after approximately 100 minutes.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >1000

Subgrade Soil Rate (in/hr): N/A

The bioretention soil rate was calculated from the first hour of testing before the storage in the bioretention soil was full. This rate was calculated to be greater than 1000 in/hr due to the gravelly texture of the bioretention soil. Once the storage was full, the flow rate was gradually turned down so water did not overflow into the catch basin. The subgrade rate is was not presented as due to unaccounted flow lost into the catch basin through leaky joints and the possibility of lateral flow.

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
 Cell: North Rain Garden

Assessed On:
 May 26, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Abundant saplings were observed in the cell base which may become denser without maintenance efforts. The catch basin was also observed to contain leaks.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | Clear, 80s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 3 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: Sitepic1.jpg



Site Photo: sitepic2.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



Cell Construction

| | |
|-----------------------------|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No An irrigation line was observed running down the western side of the cell. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width 0.5' Three pipe openings are observed looking into the catch basin through the overflow beehive grate. Facing north, there is an outflow pipe which leads out to the street. Water was observed flowing out through this pipe during testing. Also facing north, there is a pipe that appears to be entering the catch basin at an angle from the northwest. Water was observed flowing through this pipe at what appeared to be a small crack at the connection between the PVC pipe and the concrete catch basin. Facing west, there is a pipe from which water was observed flowing through both in the pipe bed and in a joint between the catch basin and the pipe. No design plans were received for this site and it is unclear where these pipes originate or how they function. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | Water is conveyed to the cell by three inlets from the adjacent parking lot and possibly the roof of the nearby building. Bioretention soil media is angular gravel mixed with organics to a depth of 3.5 ft for full cell width. No design plans were received for this site and it is unclear how the bioretention cell was designed to function, where the pipes originate or how they function. |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



20230526-184015.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



Erosion Present? Yes No

Severity: Minor

Stream cobbles exist up to 15 feet beyond inlet on parking lot side of the cell. Similar rocks sit on park side of cell and thus may be designed and not eroded from original source area near the inlet.

Blockage Present? Yes No

Approximately 10% blocked

Types:

Sediment Organic Rock

Trash Vegetation

Additional Details: Heavy leaf litter exists near grate of inlet but it is not a substantial blockage of flow.



20230526-183955.jpg

Additional Details: Stream cobbles are up to 6" diameter and clustered around inlet, and are dispersed up to 15 feet away.

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



20230526-184341.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Inlet sits approximately 1 foot above cell base. Inlet sits on angular rocks and rocks that diffuse flow.

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: Functioning

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



20230526-185027.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Fine leaf litter was observed at the bottom of pipe, It appears to be sourced from the pipe's flow.



20230526-185002.jpg

Additional Details: Angular rock between cell base and inlet.


BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
 Cell: North Rain Garden

Assessed On:
 May 26, 2023



Design Overflow/Outlet

| | |
|---|---|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.65' Width: 1.5' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.18 Relative from staff gauge: 0.56 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| 20230526_210958325_iOS.jpg | |

Cell Surface and Geotech Probe Observations

| | | |
|--|--|-----------------|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | Depth (ft): 0.1 |
| Cell Coverage | | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Other | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| The cell is covered in fine mulch with abundant tree saplings from the tree in the center of cell. | | |
| Pest Evidence | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | | |
| Vegetation Description | | |
| One large tree and dozens of smaller woody trees are located within the cell. Foliage covers ~50% of the cell. | | |
| Additional Details | | |
| Geotech Probe Observations: At the cell base, probe measurements found 0.4 to 3+ feet of bioretention soil. This range is likely so high due to the probes encountering gravels within the bioretention soil. No design plans were received for this site and it is unclear how thick the bioretention cell was designed to be, and if there is a designed underdrain. | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
 Cell: North Rain Garden

Assessed On:
 May 26, 2023



Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 3.5 |
| to Import/Underdrain: | |
| Total Depth: | 5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, very sandy GRAVEL, trace silt. Abundant organics. (GP) Native Soil Texture: Soft, medium stiff, slightly moist, light brown, sandy SILT, trace gravel. Silt of medium plasticity.(ML) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details Unusual Bioretention soil mix. Gravels are angular with an average diameter of 0.5-1". Shallowest depth to water during the test was above the ground surface. | |



HA-1W.jpg

| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 3 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, very sandy GRAVEL, trace silt. Abundant organics. Gravels angular, average diameter 0.5-1". (GP) Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
 Cell: North Rain Garden

Assessed On:
 May 26, 2023



HA-2



HA-2w.jpg

Additional Details

Field staff note difficult auguring in gravels, did not penetrate the native.

HA-3

| | |
|--|---|
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, sandy GRAVEL, trace silt. Abundant organics. Gravels angular, average diameter 0.5-1".(GP) Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
 Cell: North Rain Garden

Assessed On:
 May 26, 2023



HA-3



HA-3.jpg

Additional Details

Field staff note stopped excavation at 1.5' depth below ground surface due to time limitations.

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# 50-300

| | |
|---------------------------|-----|
| Wetted Pond Area (sq. ft) | 979 |
|---------------------------|-----|

| | |
|-------------------|------|
| Ponded Depth (ft) | 0.51 |
|-------------------|------|

| | |
|---------------|--------|
| Total Gallons | 35,524 |
|---------------|--------|

| | |
|------------------------------|----|
| Steady State Flow Rate (GPM) | 55 |
|------------------------------|----|

Additional Details:

No ponding was observed for the first hour of testing (~6000 gallons). Pond filled after 100 minutes (12,050) gallons. Field staff tapered the flow rate down over the course of the test to avoid water entering catch basin. Additional test details can be found in the executive summary.



BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)
Cell: North Rain Garden

Assessed On:
May 26, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Rosehill Community Center (MKRH)

Cell: North Rain Garden

Assessed On:

May 26, 2023



SITE: ROSEHILL COMMUNITY CENTER (MKRH) CELL: NORTH RAIN GARDEN





associated
earth sciences
incorporated

Well Point

MKRH-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 05/25/2023

Logged By: APJ

20150387H008

Ending Date: 05/25/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 5

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 102.5

Water Level Elevation (ft): N/A

Datum: Project Datum

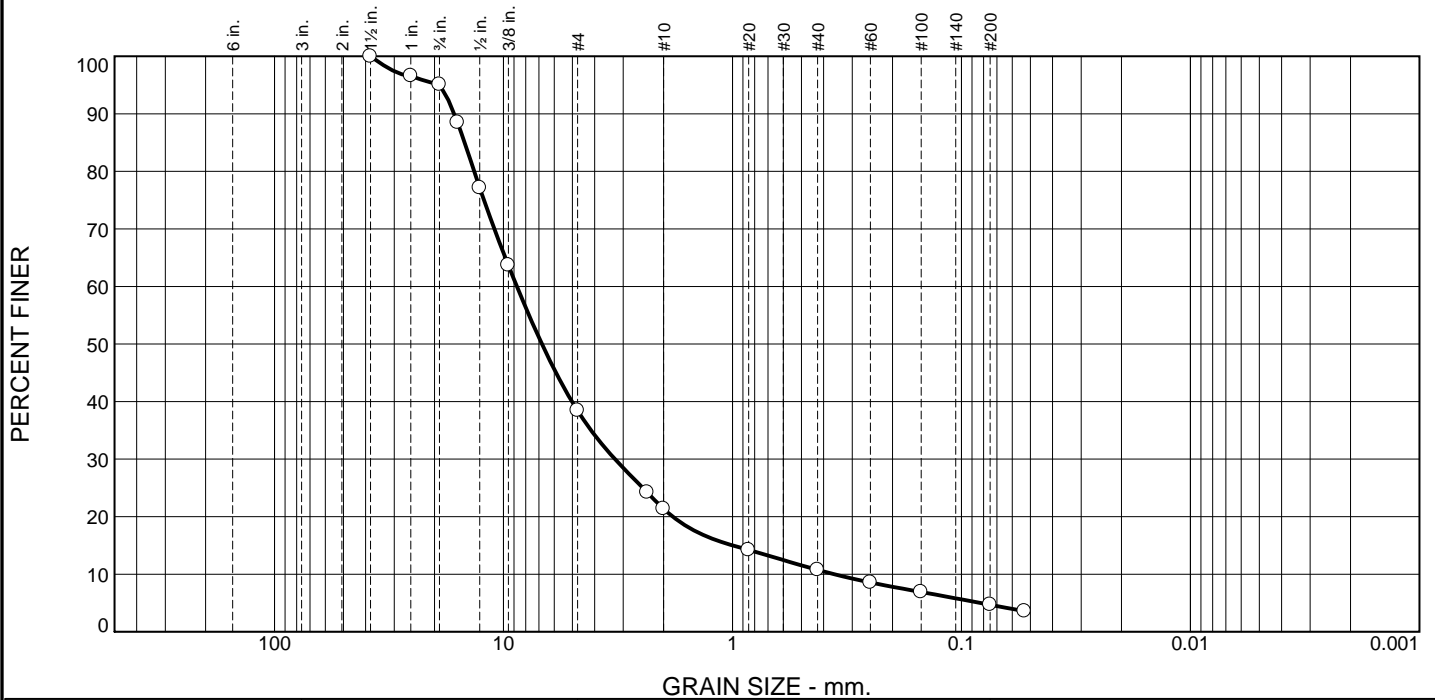
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Rectangular bark chunks, leaf litter. | | | | | | | Stick up -2.5 to 0 feet Existing bioretention soils 0 to 3.3 feet |
| 0 to 3 | | | | Bioretention Soil Mix Loose, slightly moist, dark brown, very sandy, GRAVEL, trace silt; abundant fine organics; gravel angular (GP). | | | | | | | |
| 3 | | | | Import Fill Loose, slightly moist, light brown, medium SAND, some to trace gravel, trace silt (SP). As above, becomes lightly oxidized. | | | | | | | 3/8-inch bentonite chips 3.3 to 3.5 feet Medium grain silica sand 3.5 to 5.0 feet |
| 3 to 4 | | | | Pre-Fraser Fine Grained Deposits Soft, medium stiff, light brown, sandy, SILT, trace gravel; medium plasticity (ML). | | | | | | | |
| 4 to 5 | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 4.9 | 56.7 | 17.0 | 10.6 | 6.1 | 4.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 96.6 | | |
| 3/4" | 95.1 | | |
| 5/8" | 88.5 | | |
| 1/2" | 77.1 | | |
| 3/8" | 63.7 | | |
| #4 | 38.4 | | |
| #8 | 24.2 | | |
| #10 | 21.4 | | |
| #20 | 14.2 | | |
| #40 | 10.8 | | |
| #60 | 8.6 | | |
| #100 | 6.9 | | |
| #200 | 4.7 | | |
| #270 | 3.6 | | |

* (no specification provided)

Material Description

very sandy GRAVEL, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

| | | |
|---------------------------|---------------------------|--------------------------|
| D ₉₀ = 16.4147 | D ₈₅ = 14.7863 | D ₆₀ = 8.7406 |
| D ₅₀ = 6.7948 | D ₃₀ = 3.2588 | D ₁₅ = 0.9967 |
| D ₁₀ = 0.3592 | C _u = 24.33 | C _c = 3.38 |

Remarks

Date Received: 5/26/2023 Date Tested: 8/25/2023

Tested By: FEW

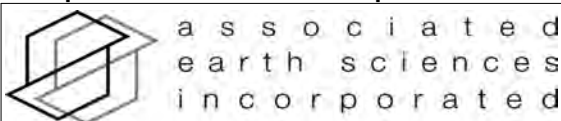
Checked By: APJ/JHS

Title: _____

Location: Onsite - Rosehill CC
 Sample Number: HA-1

Depth: 1'

Date Sampled: 5/26/2023

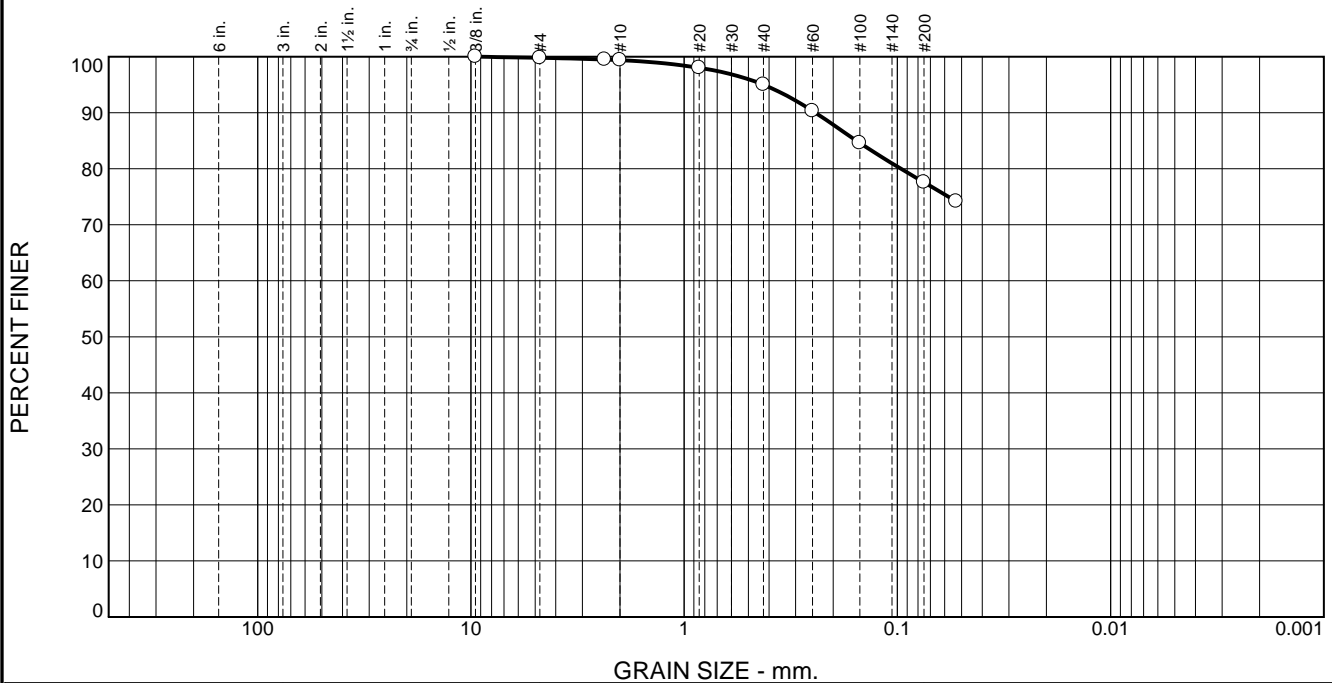


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.2 | 0.4 | 4.4 | 17.4 | 77.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 99.8 | | |
| #8 | 99.5 | | |
| #10 | 99.4 | | |
| #20 | 98.0 | | |
| #40 | 95.0 | | |
| #60 | 90.3 | | |
| #100 | 84.6 | | |
| #200 | 77.6 | | |
| #270 | 74.2 | | |

Material Description

sandy SILT, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= ML AASHTO (M 145)= A-4(0)

Coefficients

D₉₀= 0.2426 D₈₅= 0.1557 D₆₀=

D₅₀= D₃₀= D₁₅=

D₁₀= C_u= C_c=

Remarks

Date Received: 5/26/2023 Date Tested: 6/27/2023

Tested By: EW

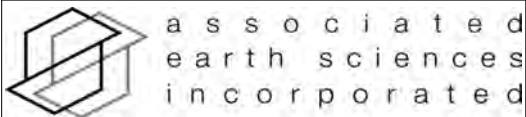
Checked By: APJ/JHS

Title: _____

* (no specification provided)

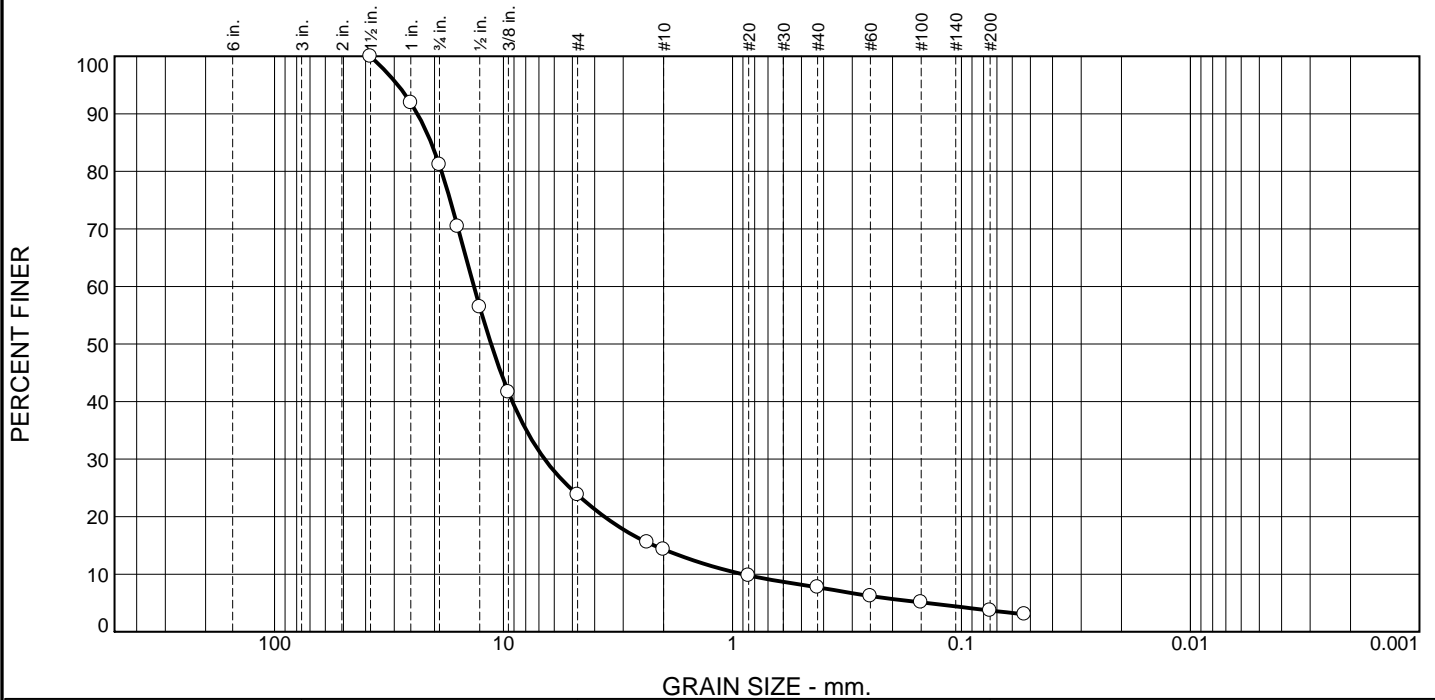
Location: Onsite - Rosehill CC
 Sample Number: HA-1 Depth: 4'

Date Sampled: 5/26/2023



Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study
 Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 18.8 | 57.4 | 9.5 | 6.6 | 4.0 | 3.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 91.9 | | |
| 3/4" | 81.2 | | |
| 5/8" | 70.4 | | |
| 1/2" | 56.4 | | |
| 3/8" | 41.7 | | |
| #4 | 23.8 | | |
| #8 | 15.5 | | |
| #10 | 14.3 | | |
| #20 | 9.8 | | |
| #40 | 7.7 | | |
| #60 | 6.2 | | |
| #100 | 5.1 | | |
| #200 | 3.7 | | |
| #270 | 3.0 | | |

* (no specification provided)

Material Description

sandy GRAVEL, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 23.7720 D₈₅= 20.6930 D₆₀= 13.4681
D₅₀= 11.3327 D₃₀= 6.6169 D₁₅= 2.2011
D₁₀= 0.9008 C_u= 14.95 C_c= 3.61

Remarks

Date Received: 5/26/2023 Date Tested: 9/05/2023

Tested By: FEW

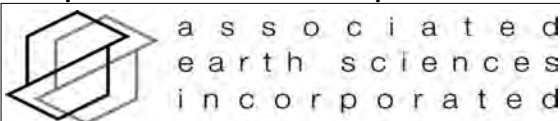
Checked By: APJ/JHS

Title: _____

Location: Onsite - RCC
Sample Number: HA-3

Depth: 1'

Date Sampled: 5/26/2023

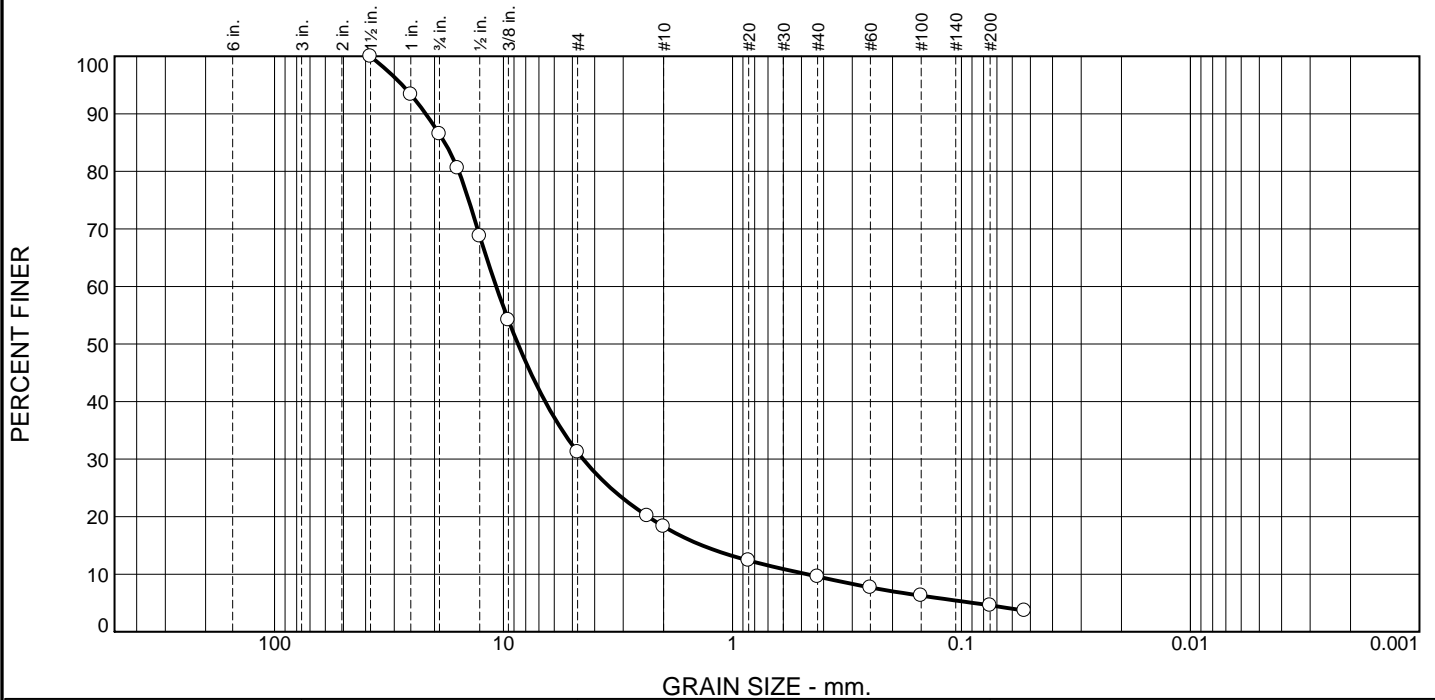


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 13.5 | 55.3 | 12.9 | 8.7 | 5.0 | 4.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 93.4 | | |
| 3/4" | 86.5 | | |
| 5/8" | 80.6 | | |
| 1/2" | 68.8 | | |
| 3/8" | 54.2 | | |
| #4 | 31.2 | | |
| #8 | 20.1 | | |
| #10 | 18.3 | | |
| #20 | 12.4 | | |
| #40 | 9.6 | | |
| #60 | 7.7 | | |
| #100 | 6.3 | | |
| #200 | 4.6 | | |
| #270 | 3.7 | | |

* (no specification provided)

Material Description

BSM
sandy GRAVEL, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 21.8577 D₈₅= 18.0483 D₆₀= 10.7670
D₅₀= 8.6481 D₃₀= 4.4894 D₁₅= 1.3558
D₁₀= 0.4736 C_u= 22.73 C_c= 3.95

Remarks

Date Received: 5/26/2023 Date Tested: 9/7/2023

Tested By: FEW

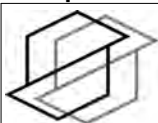
Checked By: APJ/JHS

Title: _____

Location: Onsite - RCC
Sample Number: HA-3

Depth: 1-1.5'

Date Sampled: 5/26/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 5/26/2023 | Project BHPS - MKRH | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Mukilteo, WA | EB/EP No. MKRH-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 1' | HA-3 @ 1' | HA-3 @ 1-1.5' |
|--------------------|-----------|-----------|---------------|
| Wet Weight + Pan | 3611.10 | 2016.10 | 541.35 |
| Dry Weight + Pan | 3399.90 | 1954.55 | 519.80 |
| Weight of Pan | 749.89 | 392.05 | 100.70 |
| Weight of Moisture | 211.20 | 61.55 | 21.55 |
| Dry Weight of Soil | 2650.01 | 1562.50 | 419.10 |
| % Moisture | 7.97 | 3.94 | 5.14 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|---------|---------|---------|
| Dry Soil Before Burn + Pan | 3399.90 | 1954.55 | 1050.00 |
| Dry Soil After Burn + Pan | 3328.95 | 1916.09 | 1037.05 |
| Weight of Pan | 749.89 | 392.05 | 247.50 |
| Wt. Loss Due to Ignition | 70.95 | 38.46 | 12.95 |
| Actual Wt. Of Soil After Burn | 2579.06 | 1524.04 | 789.55 |
| % Organics | 2.68 | 2.46 | 1.61 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---|--------------------------------|----------------------------------|
| Project Name: | Rosehill Community Center (North Rain Garden) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | 50-300 |
| Date: | 5/26/2023 | Wetted Area (sq. feet): | 08:45: 4 ft^2 /14:00 979 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Unknown |
| Test No.: | IT-1 | Test Depth (feet): | 0.55 |
| Performed By: | APJ | Receptor Soils: | Pre-Fraser Fine Grained Deposits |

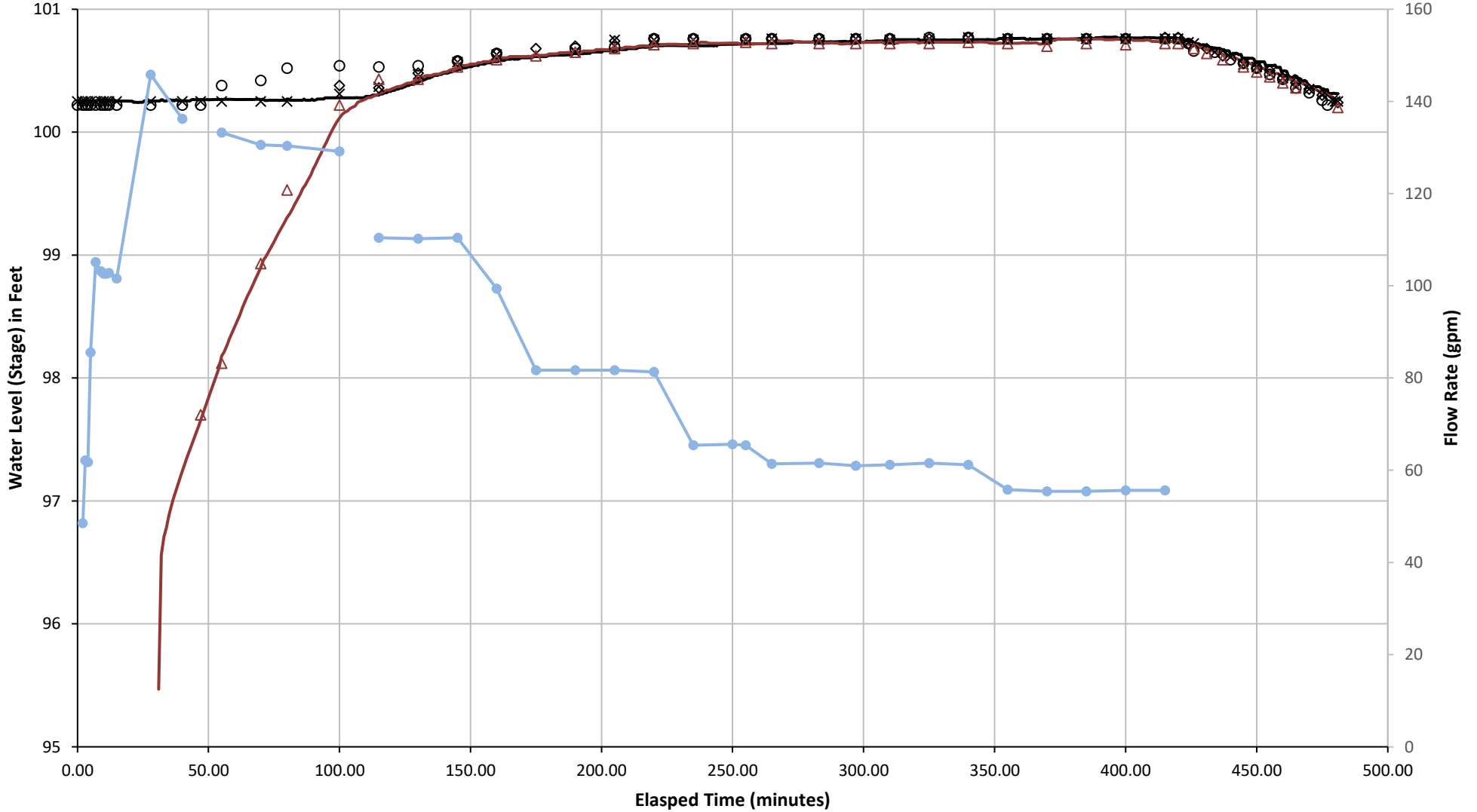
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (feet) | Staff Gauge #2 (feet) | Staff Gauge #3 (feet) | Wellpoint (feet btoc) | Catch Basin (feet btor) | Totalizer (gallons) | Comments |
|--------------|-----------------|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------|---------------------|---|
| 8:35 | | 0 | | | | 3.82 | | Water on, leaky non-collapse hose. Water off. |
| 8:37 | 48.52 | 0 | | | | | | Water on |
| 8:38 | 62.11 | 0 | | | | | 110 | |
| 8:39 | 61.74 | 0 | | | | | 134 | |
| 8:40 | 85.55 | 0 | | | | | 245 | |
| 8:42 | 105.12 | 0 | | | | | 441 | |
| 8:44 | 103.16 | 0 | | | | | 558 | |
| 8:45 | 102.62 | 0 | | | | | 688 | |
| 8:46 | 102.62 | 0 | | | | | 796 | |
| 8:47 | 102.8 | 0 | | | | | 933 | |
| 8:50 | 101.6 | 0 | | | | | 1,195 | |
| 9:03 | 145.8 | 0 | | | | | 2,595 | No flow in underdrain, wellpoint dry |
| 9:15 | 136.24 | 0 | | | | | 3,925 | |
| 9:22 | | 0 | | | 4.78 | | | |
| 9:30 | 133.25 | 0 | 0.16 | | 4.36 | | 5,880 | |
| 9:45 | 130.56 | 0 | 0.2 | | 3.55 | | 8,120 | |
| 9:55 | 130.38 | 0 | 0.3 | | 2.95 | 3.66 | 10,091 | Flow entering catch basin at 09:49 |
| 10:15 | 129.16 | 0.06 | 0.32 | 0.38 | 2.26 | 3.65 | 12,050 | |
| 10:21 | | | | | | | | Tapering flow rate down |
| 10:30 | 110.4 | 0.12 | 0.31 | 0.36 | 2.05 | 3.63 | 13,810 | |
| 10:45 | 110.22 | 0.22 | 0.32 | 0.48 | 2.05 | 3.63 | 15,468 | |
| 11:00 | 110.4 | 0.32 | 0.36 | 0.58 | 1.95 | | 17,089 | Flow rate down to 100 |
| 11:15 | 99.38 | 0.38 | 0.42 | 0.64 | 1.89 | 3.63 | | Flow rate down to 80 |
| 11:30 | 81.7 | | | 0.68 | 1.86 | | 20,021 | |
| 11:45 | 81.7 | 0.4 | 0.46 | 0.7 | 1.83 | | 21,169 | |
| 12:00 | 81.7 | 0.5 | 0.47 | 0.74 | 1.8 | | 22,368 | |
| 12:15 | 81.3 | 0.5 | 0.54 | 0.76 | 1.77 | | 23,567 | |
| 12:30 | 65.44 | 0.5 | 0.54 | 0.76 | 1.76 | | 24,582 | |
| 12:45 | 65.63 | | | | | | 25,550 | |
| 12:50 | 65.44 | 0.5 | 0.54 | 0.76 | 1.75 | | 26,005 | |
| 13:00 | 61.36 | 0.51 | 0.54 | 0.76 | 1.76 | | 26,464 | |
| 13:18 | 61.54 | 0.5 | 0.54 | 0.76 | 1.76 | | 27,567 | |
| 13:32 | 60.98 | 0.51 | 0.54 | 0.76 | 1.76 | | 28,459 | |
| 13:45 | 61.16 | 0.5 | 0.54 | 0.76 | 1.76 | | 29,351 | |
| 14:00 | 61.54 | 0.51 | 0.55 | 0.76 | 1.76 | | 30,164 | |
| 14:15 | 61.16 | 0.52 | 0.55 | 0.77 | 1.75 | | 31,090 | |
| 14:30 | 55.8 | 0.51 | 0.54 | 0.76 | 1.76 | | 32,034 | Flow down to 55 for fear of overflowing CB |
| 14:45 | 55.42 | 0.51 | 0.54 | 0.76 | 1.78 | | 32,754 | |
| 15:00 | 55.42 | 0.51 | 0.54 | 0.76 | 1.76 | 3.63 | 33,582 | |
| 15:15 | 55.62 | 0.51 | 0.54 | 0.76 | 1.77 | | 34,436 | |
| 15:30 | 55.62 | 0.51 | 0.54 | 0.77 | 1.76 | | 35,252 | |
| 15:35 | | 0.51 | 0.54 | 0.77 | 1.76 | | 35,524 | Water off |
| 15:38 | | | 0.5 | | | | | |
| 15:39 | | 0.48 | 0.5 | 0.72 | | | | |
| 15:41 | | 0.47 | 0.44 | | 1.8 | | | |
| 15:43 | | | | | | | | |
| 15:46 | | | | 0.68 | 1.84 | | | |
| 15:49 | | 0.4 | 0.43 | | | | | |

| | | | | | | | | |
|-------|--|------|------|------|------|--|--|--|
| 15:52 | | | | 0.62 | 1.89 | | | |
| 15:55 | | 0.36 | 0.37 | | | | | |
| 16:00 | | 0.3 | 0.34 | 0.56 | 1.95 | | | |
| 16:05 | | 0.28 | 0.3 | 0.52 | 1.99 | | | |
| 16:10 | | 0.23 | 0.25 | 0.5 | 2.03 | | | |
| 16:15 | | 0.19 | 0.21 | 0.44 | 2.08 | | | |
| 16:20 | | 0.12 | 0.14 | 0.4 | 2.12 | | | |
| 16:25 | | 0.1 | 0.1 | 0.35 | | | | |
| 16:30 | | 0.05 | 0.04 | 0.3 | 2.22 | | | |
| 16:32 | | | 0 | | | | | |
| 16:34 | | 0.01 | | | | | | |
| 16:35 | | 0 | | | | | | |
| 16:36 | | | | 0.24 | 2.28 | | | |

| Full facility Infiltration Rates | |
|--|--------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 5.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 6.0 |
| | |
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 5.3 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 6.3 |
| | |
| SG-3 Average Infiltration Rate (in/hr) during last hour of inflow: | 5.2 |
| SG-3 Average Infiltration Rate (in/hr) during falling head: | 6.3 |
| | |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 5.3 |
| WP Average Infiltration Rate (in/hr) during falling head: | 6.1 |
| | |
| Bioretention Soil Infiltration Rate | |
| SG-1 Average Infiltration Rate (in/hr) during inflow from 08:45-09:45: | 2980.4 |

Rosehill Community Center Field Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Elevations are not referenced and should be used as a relative reference. Elevation 100 represents ground surface.

- SG #1 Logger
- Wellpoint Logger
- × Staff Gauge #1 Hand
- Staff Gauge #2 Hand
- ◇ Staff Gauge #3 Hand
- △ Wellpoint Hand
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)
Cell: Plat 2

Assessed On:
August 29, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This tested cell is one of four bioretention cells, constructed in 2005, which collect rainwater from adjacent residential roofs. This cell was designed to be constructed with 1.5 ft of bioretention soil mix above native soils. Water enters the cell through an inlet that conveys water from the roof of the Baron family residence and overland flow that is conveyed by an armored swale on the south end of the cell. Water is designed to infiltrate through the bioretention soil before reaching the native soils. An emergency overflow is designed to overflow at ponded depth of 1.3 ft above base of the cell and connects to the existing stormwater network.

BIORETENTION SOIL:

Thickness: 0.8-1.4 ft

The apparent thickness of the bioretention soils ranged from 0.8-1.4 ft with an average depth of 1.1 ft.

Composition:

Design plans call for the bioretention soil mix to be 50-60% clean sand meeting ASTM C-33, 20-30% leaf compost, and 20-30% topsoil, with maximum clay content not to exceed 5% and minimum organic content of 10% by weight. The tested soil did not meet these recommendations. The organic matter content fell below the specified percent and the fines content greatly exceeded the specified range. In comparison to the 2019 Ecology bioretention soil mix specifications, the tested soil did not meet the recommended guidelines for grain size distribution but did meet the organic matter content recommendations. The tested soil had a higher percentage of gravels, and of fines passing the #200 sieve.

Organic Matter Content (% by weight): 5.5

Percent passing #200 sieve: 23.5

Coefficient of Uniformity (Cu): 49.2

Coefficient of Curvature (Cc): 1.6

SUBGRADE CONDITIONS:

Geologic Unit: Olympia Nonglacial Deposits / Vashon Till

Soil Description: Very dense, slightly moist, brown, silty, gravelly, fine SAND; thin layers of grey, SILT; few organics (rootlets) (SM)

The site is mapped as Vashon lodgement till near the contact with Olympia nonglacial interval (MIS 2-3, sand and silt by Allen, Mavor, & Tepper et. al. (2017). AESI interprets the subgrade material as Olympia nonglacial deposits though they may be interfingered with Till deposits.

BUILT PER PLAN:

Bioretention soil mix does not meet design plan specifications. The catch basin shown in the design plans was not located, presumably buried as the one found in the Manry residence bioretention cell to the north. A pressure transducer water level monitoring device was left in the Wellpoint overnight due to the remaining standing water after water shut-off and an hour of monitoring falling head. Water was still ponded through the next day indicating the pond may not infiltrate at designed rates.

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)
Cell: Plat 2

Assessed On:
August 29, 2023



GROUNDWATER CONDITIONS:

No groundwater was encountered during excavations of hand augers. The temporary wellpoint, screened from 0.2-0.9 ft below ground surface, responded to testing and the shallowest Wellpoint water level was above the ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): N/A
Subgrade Soil Rate (in/hr): 1.1

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying subgrade soils infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

This cell and adjacent cells are heavily overgrown with blackberries and shrubs. The catch basin is presumably buried under vegetation and possibly soil. Comments from homeowners indicated they were instructed not to alter anything in the bioretention cells but expressed a desire to assist with maintenance to have a more aesthetically pleasing entrance to their homes and reduce the invasive blackberry presence.

Field Conditions

| | | | |
|-----------------|-------------------------|-------------------------|------------------|
| Weather | OC/50s-60s | | |
| Recent Rainfall | Today: 0.38" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Stan Thompson | Half Day: Sarah Faubion | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)
 Cell: Plat 2

Assessed On:
 August 29, 2023



Site Photo: FA_SitePhotos-20230829-174728.jpg



Site Photo: FA_SitePhotos-20230829-174800.jpg



Site Photo: FA_SitePhotos-20230829-174743.jpg



Site Photo: FA_SitePhotos-20230829-174834.jpg

Cell Construction

| | |
|-----------------------------|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Additional Comments

Water is conveyed to the cell from roof runoff via a 6" roof drain pipe, and sheet flow through an armored swale channel on the south side of the cell. Water is designed to infiltrate through the bioretention soil before infiltrating into the native substrate. Plans indicate a catch basin for overflow, but none was located in the field, likely due to thick vegetative overgrowth and burial. The catch basin design shows a connection to the storm drain network.



BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)
 Cell: Plat 2

Assessed On:
 August 29, 2023



Inlets

| | | |
|---|--|--|
| <p>IN-1</p> <p> <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: </p> <p>Pipe: Material <input checked="" type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.5'</p> <p>Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> | |  <p>FA_INphoto-20230829-175101.jpg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | | <p>Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> |
| <p>Additional Details: Angular rock is buried about 0.5' below ground surface, as described in HA-3.</p> | | |
| <p>IN-2</p> <p> <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input checked="" type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: </p> <p>Width: 4'</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> | |  <p>DrainageSwale.jpeg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | | <p>Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> |
| <p>Additional Details: Design plans state armoring along drainage swale, this was buried in grasses and thick vegetation.</p> | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)
Cell: Plat 2

Assessed On:
August 29, 2023



Design Overflow/Outlet

| | |
|--|--------------------------------------|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: ' Width: ' |
| Additional Details: | |
| Stickup (ft) From Ground: Relative from staff gauge: | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Field staff were unable to locate catch basin, assumed 100% buried. | |
| Trash Rack: <input type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 100% blocked Additional Details: Unable to locate yard drain catch basin identified in plans, nearby cell had a yard drain that was 100% buried and was located by chance, the assumption is that this cell's yard drain is also buried. | |

Cell Surface and Geotech Probe Observations

| | |
|---|--|
| S1A Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S1B Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S1C Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S2 Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S3 Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| Cell Coverage | |
| Mulch | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% |
| Natural mulch covers all of the cell base. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |
| Vegetation Description Over 50% of cell is covered by shrubs, blackberries and grasses. Vegetation limits access, could not locate yard drain as described on plans. | |
| Additional Details | |

BIORETENTION CELL FIELD ASSESSMENT



Site: Baron Residence Monroe (MOBR)
 Cell: Plat 2

Assessed On:
 August 29, 2023



Geotech Probe Observations: At the cell base, probe measurements found 0.8-1.4' of bioretention soil, with an average of 1.1', before encountering the underlying native substrate. This is less than the 1.5' specified by the plans. On the cell edges, less than 1 foot of soil was encountered above native soils. This is consistent with the cell design which shows a sharp transition between amended soil and graded existing subgrade. No zones of compaction were observed. Some areas of the cell could not be probed due to thick, thorny vegetation.

Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1 |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, gravelly silty fine to medium SAND, some coarse sand, few organics (SM) Native Soil Texture: Very dense, slightly moist, brown, silty fine SAND, some fine gravel with layers of grey SILT, few organics. (SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
|  <p>FA_FPhoto-20230830-154304.jpg</p>  <p>IMG_0510.jpg</p> | |
| Additional Details | |
| Bioretention soil mix observed in cell is not what is typically observed. Plans state compost amended soil. Assumption is there was once compost mixed in with the native substrate. Shallowest depth to water during the test was above the ground surface. | |

| | |
|---|-----|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.2 |
| to Import/Underdrain: | |
| Total Depth: | 1.4 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)
Cell: Plat 2

Assessed On:
August 29, 2023



HA-2

Rain/Garden Mix Soil Texture: Slightly dense, slightly moist, brown, silty fine to medium SAND, some coarse sand, some fine gravel, few organics. (SM)
Native Soil Texture: Dense, slightly moist, light brown, silty fine SAND, trace fine gravel, thin layers of grey silty SAND, few organics. (SM)

Liner Present:
 Yes No

Filter Fabric Present:
 Yes No



IMG_0515.jpg

Additional Details

Bioretention soil mix is not what is typically observed. Plans state compost amended soil. Assumption is there was once compost mixed in with the native substrate.

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.1

to Native Soil:

to Import/Underdrain:

Total Depth: 0.5

Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, gravelly silty fine to medium SAND, some coarse sand, few organics (SM)
Native Soil Texture:

Liner Present:
 Yes No

Filter Fabric Present:
 Yes No

Additional Details

Bottom of hole 0.5' depth due to refusal at angular gravel from energy dispersion for IN-1.

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)

Cell: Plat 2

Assessed On:

August 29, 2023



Infiltration Test

| | |
|--|-------|
| IT-1 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100), FM-4 (3-50) | |
| Wetted Pond Area (sq. ft) | 281 |
| Ponded Depth (ft) | 1.03 |
| Total Gallons | 3,621 |
| Steady State Flow Rate (GPM) | 3.06 |
| Additional Details: Switched from the 10-100gmp flowmeter to the 3-50gpm flowmeter at 10:15am. When field staff turned the water off, they began recording falling head, but then it began to rain heavily. Field staff conducted a bucket test of inlet 1 from the roof of the adjacent residence with a flow rate of slightly over 3gpm, roughly equal to the flow rate from the test. Additional test details can be found in the executive summary. | |

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Baron Residence Monroe (MOBR)

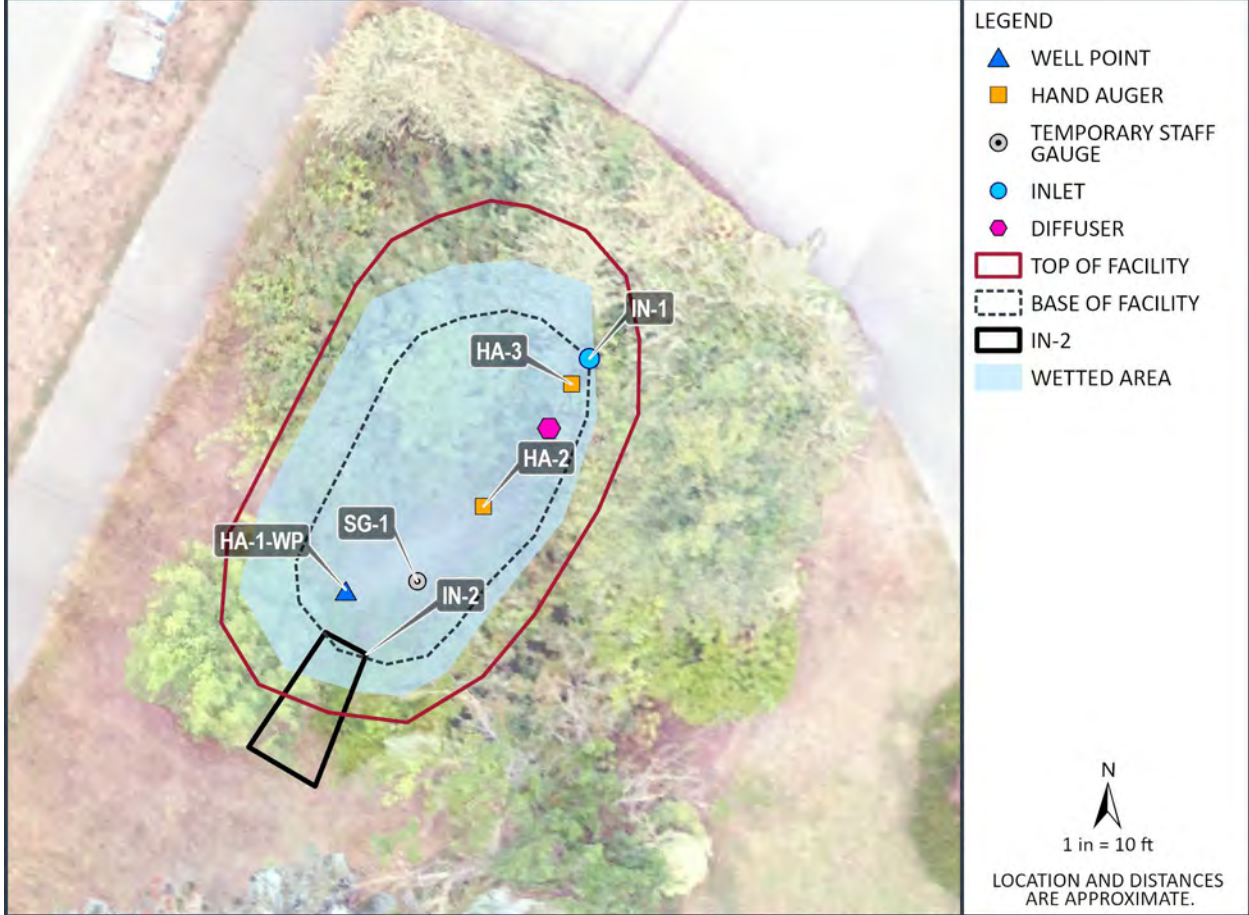
Cell: Plat 2

Assessed On:

August 29, 2023



SITE: BARON RESIDENCE MONROE (MOBR) CELL: PLAT 2





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Well Point

MOBR-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/29/23

Logged By: SNCF/SST

20150387H008

Ending Date: 8/29/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 1.5

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 106.1

Water Level Elevation (ft): N/A

Datum: Project Datum

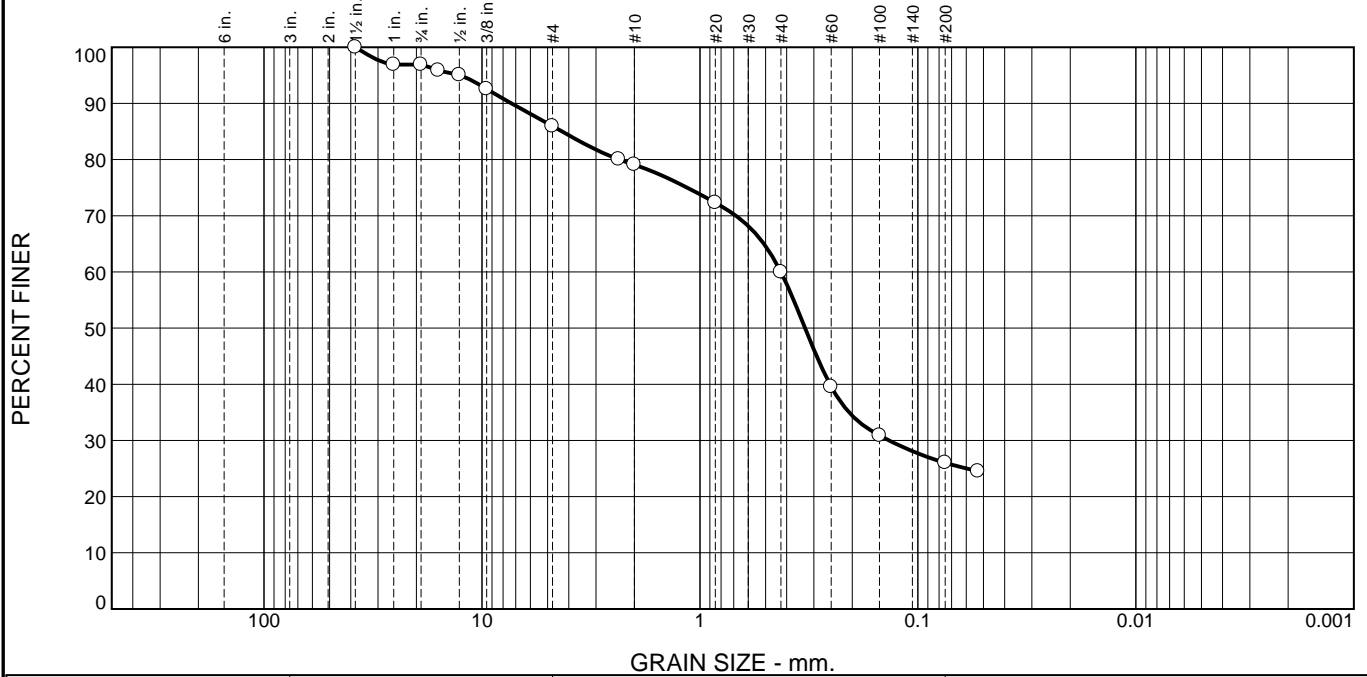
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | 1 | | Natural Mulch | | | | | | | <p>Stick up -6.1 to 0 feet 3/8-inch bentonite chips 0 to 0.1 feet Medium grain silica sand 0.1 to 1.5 feet 1.25-inch I.D. threaded galvanized steel casing -6.1 to -1.9 feet; duct tape covers screen -1.9 to 0.2 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 0.2 to 0.9 feet Cast iron endcap 0.9 to 1.2 feet Cast iron drivepoint 1.2 to 1.5 feet</p> |
| | | 2 | | Bioretention Soil Mix Loose, slightly moist, brown, silty, fine SAND, some coarse sand, some fine gravel; few organics (rootlets) (SM). As above; medium dense layers (SM). | | | | | | | |
| 1 | | 3 | | Olympia Nonglacial Deposits Very dense, slightly moist, brown, silty, gravelly, fine SAND; thin layers of gray, silt; few organics (rootlets) (SM). | | | | | | | |
| 2 | | | | No seepage. No caving. Refusal at rocks. HA located at base of cell, south end. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 3.1 | 10.9 | 6.9 | 19.1 | 34.0 | 26.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.50" | 100.0 | | |
| 1" | 96.9 | | |
| 3/4" | 96.9 | | |
| 5/8" | 95.9 | | |
| 1/2" | 95.0 | | |
| 3/8" | 92.6 | | |
| #4 | 86.0 | | |
| #8 | 80.0 | | |
| #10 | 79.1 | | |
| #20 | 72.3 | | |
| #40 | 60.0 | | |
| #60 | 39.6 | | |
| #100 | 30.9 | | |
| #200 | 26.0 | | |
| #270 | 24.5 | | |

Material Description
gravelly silty SAND

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients
 D₉₀= 7.3204 D₈₅= 4.2905 D₆₀= 0.4253
 D₅₀= 0.3292 D₃₀= 0.1357 D₁₅=
 D₁₀= C_u= C_c=

Remarks

Date Received: 8-30-2023 Date Tested: 10-30-2023

Tested By: FEW

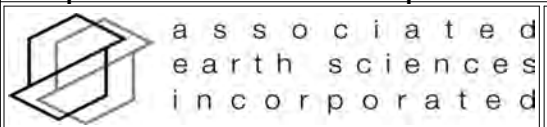
Checked By: SNCF/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Monroe Baron Residence
 Sample Number: HA-1WP Depth: 1.0-1.5'

Date Sampled: 8-29-2023

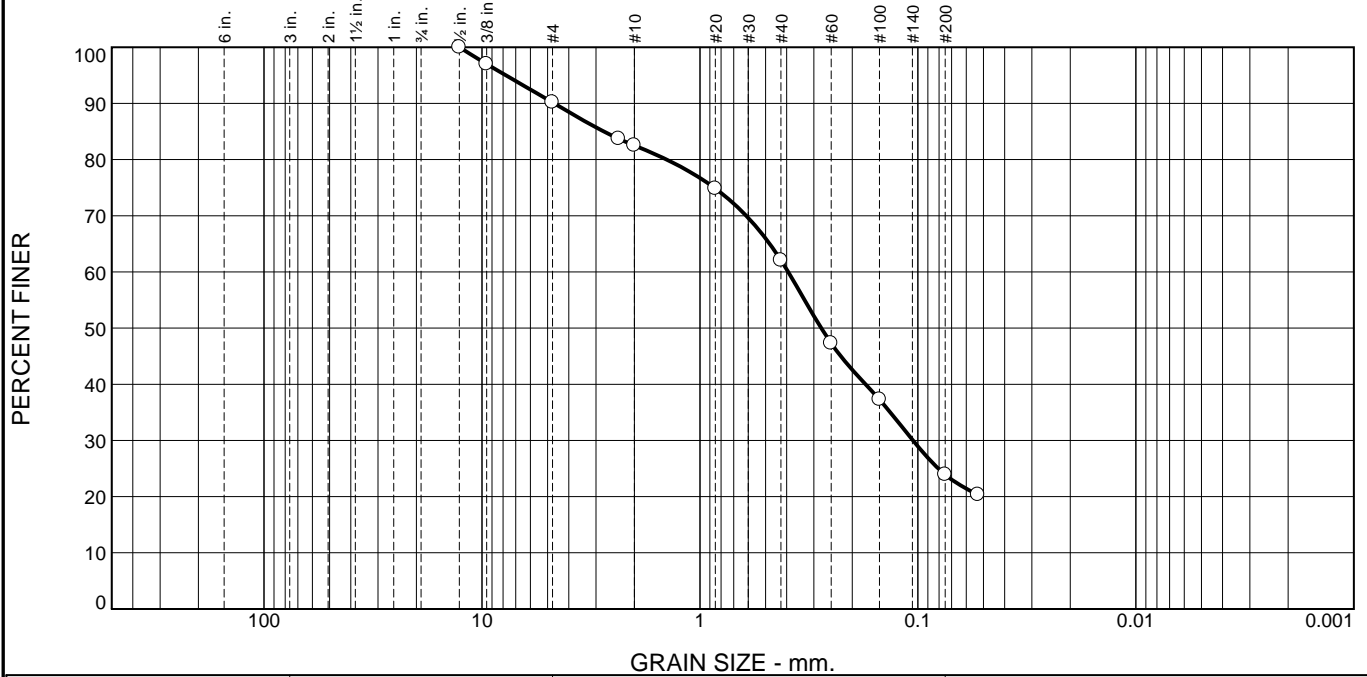


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.8 | 7.7 | 20.4 | 38.2 | 23.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 97.0 | | |
| #4 | 90.2 | | |
| #8 | 83.7 | | |
| #10 | 82.5 | | |
| #20 | 74.8 | | |
| #40 | 62.1 | | |
| #60 | 47.3 | | |
| #100 | 37.3 | | |
| #200 | 23.9 | | |
| #270 | 20.3 | | |

Material Description

silty SAND some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 4.6569 D₈₅= 2.7628 D₆₀= 0.3935
D₅₀= 0.2777 D₃₀= 0.1053 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8-30-2023 Date Tested: 10-27-2023

Tested By: FEW

Checked By: SNCF/JS

Title: _____

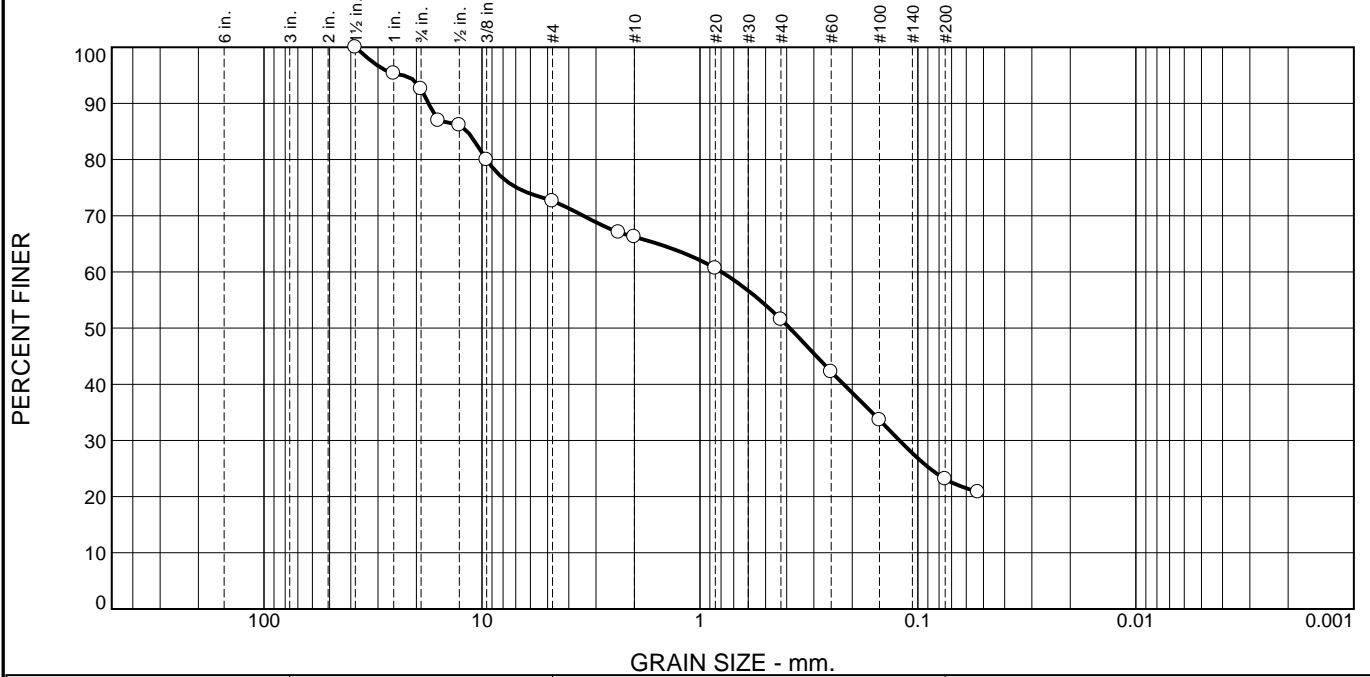
* (no specification provided)

Location: Onsite - BHPS-Monroe Baron Residence Date Sampled: 8-29-2023
Sample Number: HA-2 Depth: 0.1-0.7'

| | |
|--|---|
| | Client: City of Olympia |
| | Project: Bioretention Hydrologic Performance Monitoring Study |
| | Project No: 20150387 H008 |

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 7.4 | 20.0 | 6.4 | 14.7 | 28.4 | 23.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.50" | 100.0 | | |
| 1" | 95.3 | | |
| 3/4" | 92.6 | | |
| 5/8" | 87.0 | | |
| 1/2" | 86.1 | | |
| 3/8" | 80.0 | | |
| #4 | 72.6 | | |
| #8 | 67.1 | | |
| #10 | 66.2 | | |
| #20 | 60.6 | | |
| #40 | 51.5 | | |
| #60 | 42.2 | | |
| #100 | 33.6 | | |
| #200 | 23.1 | | |
| #270 | 20.8 | | |

* (no specification provided)

Material Description

gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 17.5906 D₈₅= 11.6624 D₆₀= 0.7974
D₅₀= 0.3876 D₃₀= 0.1215 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8-30-2023 Date Tested: 10-27-2023

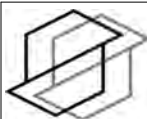
Tested By: FEW

Checked By: SNCF/JS

Title: _____

Location: Onsite - BHPS-Monroe Baron Residence
Sample Number: HA-3 **Depth:** 0.1-0.5'

Date Sampled: 8-29-2023



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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 8/29/2023 | Project BHPS-Baron residence | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Monroe, WA | EB/EP No. MOBR-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0.1-0.7' | HA-3 @ 0.1-0.5' |
|--------------------|-----------------|-----------------|
| Wet Weight + Pan | 1376.73 | 1387.05 |
| Dry Weight + Pan | 1267.73 | 1186.72 |
| Weight of Pan | 358.05 | 392.00 |
| Weight of Moisture | 109.00 | 200.33 |
| Dry Weight of Soil | 909.68 | 794.72 |
| % Moisture | 11.98 | 25.21 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------|---------|
| Dry Soil Before Burn + Pan | 1267.73 | 1186.72 |
| Dry Soil After Burn + Pan | 1224.82 | 1136.66 |
| Weight of Pan | 358.05 | 392.00 |
| Wt. Loss Due to Ignition | 42.91 | 50.06 |
| Actual Wt. Of Soil After Burn | 866.77 | 744.66 |
| % Organics | 4.72 | 6.30 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

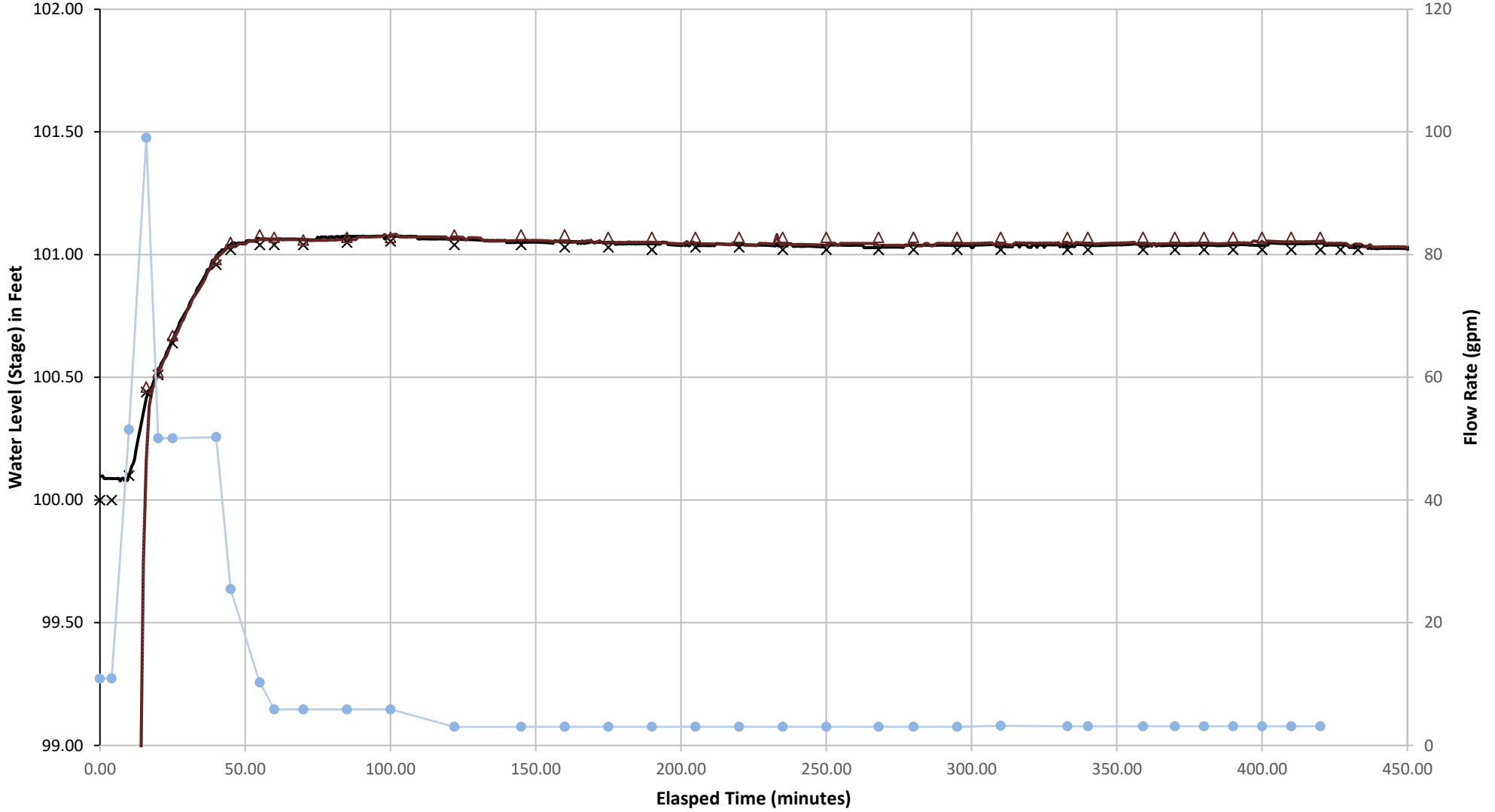
| | | | |
|------------------------|------------------------|--------------------------------|------------------------------|
| Project Name: | Monroe Baron Residence | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) /FM-4 (3-50) |
| Date: | 8/29/2023 | Wetted Area (sq. feet): | Static Pond = 281 ft^2 |
| Weather: | Showers, 60s | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 1.03 |
| Performed By: | ST/SNCF | Receptor Soils: | Olympia Non-Glacial Deposits |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|--|
| 9:20 | 10.9 | 0 | Dry | 0 | Water on |
| 9:24 | 10.94 | 0 | | 83 | |
| 9:30 | 51.48 | 0.1 | | 385 | |
| 9:36 | 99.05 | 0.44 | 5.64 | 922 | |
| 9:40 | 50.09 | 0.51 | 5.58 | 1137 | |
| 9:45 | 50.09 | 0.64 | 5.43 | 1382 | |
| 10:00 | 50.26 | 0.96 | 5.12 | 2132 | Reduce flow to 25.72 |
| 10:05 | 25.5 | 1.02 | 5.05 | 2267 | Reduce flow to 10.88 |
| 10:15 | 10.27 | 1.04 | 5.02 | 2386 | Switch to FM #4 |
| 10:20 | 5.89 | 1.04 | 5.03 | 2403 | Reduce flow to 5.8 gpm |
| 10:30 | 5.87 | 1.04 | 5.04 | 2461 | Final readout on FM-6: 2386.86 |
| 10:45 | 5.89 | 1.05 | 5.03 | 2549 | |
| 11:00 | 5.87 | 1.055 | 5.03 | 2638 | Reduce flow to 3.02 |
| 11:22 | 3.04 | 1.04 | 5.02 | 2705 | |
| 11:45 | 3.04 | 1.04 | 5.02 | 2775 | |
| 12:00 | 3.06 | 1.03 | 5.02 | 2821 | |
| 12:15 | 3.06 | 1.03 | 5.03 | 2867 | |
| 12:30 | 3.06 | 1.02 | 5.03 | 2912 | |
| 12:45 | 3.06 | 1.03 | 5.03 | 2958 | |
| 13:00 | 3.06 | 1.03 | 5.03 | 3004 | |
| 13:15 | 3.06 | 1.02 | 5.03 | 3050 | |
| 13:30 | 3.06 | 1.02 | 5.03 | 3095 | |
| 13:48 | 3.06 | 1.02 | 5.03 | 3150 | |
| 14:00 | 3.06 | 1.02 | 5.03 | 3187 | |
| 14:15 | 3.06 | 1.02 | 5.03 | 3233 | |
| 14:30 | 3.2 | 1.02 | 5.03 | 3281 | Flow fluctuates |
| 14:53 | 3.14 | 1.02 | 5.03 | 3353 | |
| 15:00 | 3.14 | 1.02 | 5.03 | 3375 | |
| 15:19 | 3.12 | 1.02 | 5.03 | 3435 | |
| 15:30 | 3.14 | 1.02 | 5.03 | 3470 | |
| 15:40 | 3.14 | 1.02 | 5.03 | 3501 | |
| 15:50 | 3.14 | 1.02 | 5.03 | 3532 | |
| 16:00 | 3.12 | 1.02 | 5.03 | 3564 | |
| 16:10 | 3.14 | 1.02 | 5.03 | 3595 | |
| 16:20 | 3.14 | 1.02 | 5.03 | 3626 | Flow off, begin falling head. Rain starts falling heavily during falling head. Bucket test from residence slightly over 3 gpm. |
| 16:27 | | 1.02 | | | |
| 16:33 | | 1.02 | | | |
| 16:57 | | 1.03 | | | |
| 17:05 | | 1.03 | | | |
| 6:55 | | 0.51 | 5.55 | | Next day: 8/30/2023 |
| 9:20 | | | 5.63 | | Next day: 8/30/2023 |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 1.1 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | - |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 1.1 |
| WP Average Infiltration Rate (in/hr) during falling head: | - |
| SG-1 Average Infiltration Rate (in/hr) during falling head (Logger): | 0.6 |

Baron Residence Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)

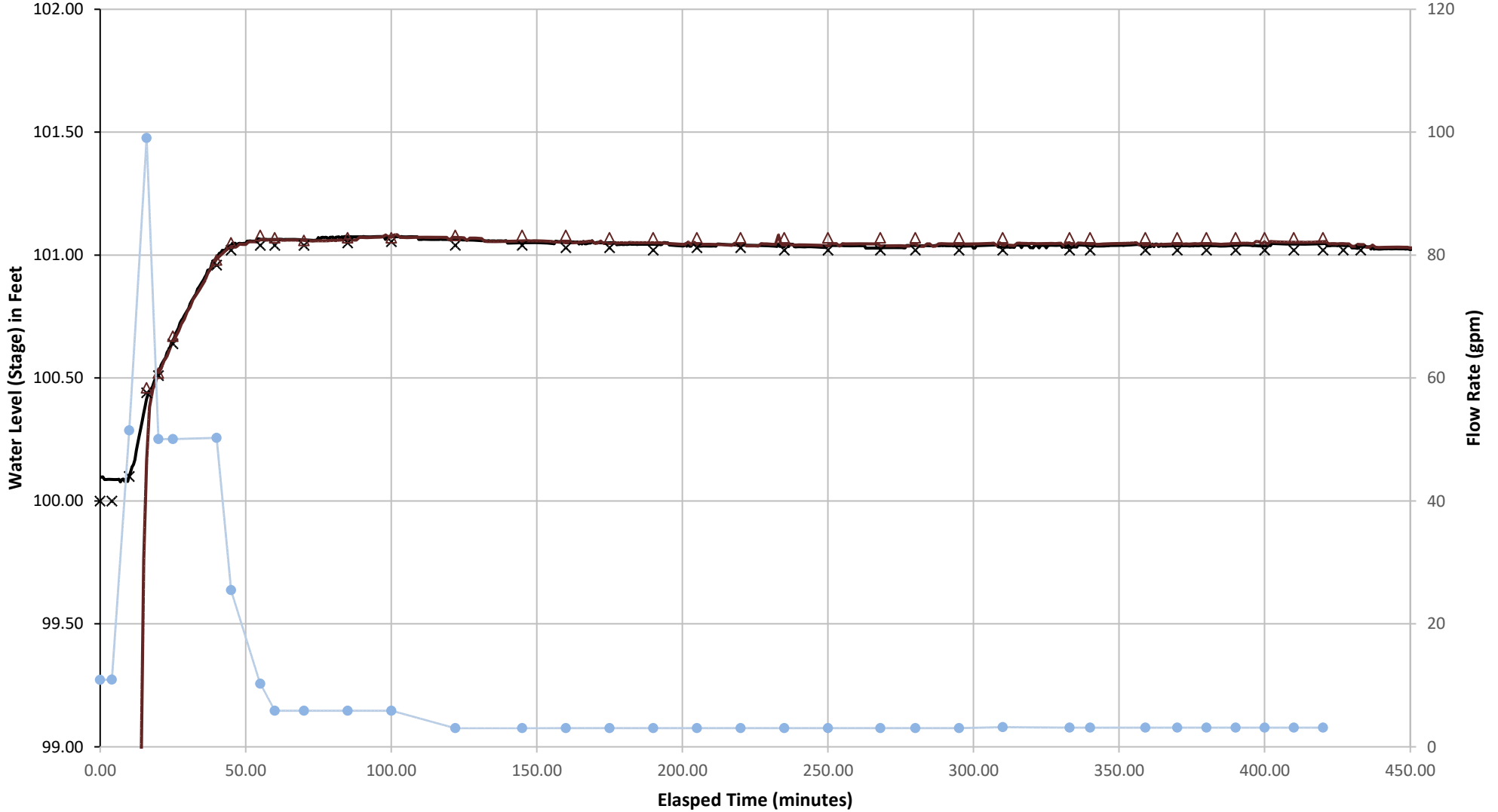


Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

Baron Residence Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
Cell: Plat 3

Assessed On:
August 30, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This tested cell is one of four bioretention cells, constructed in 2005, which collect rainwater from adjacent residential roofs. This cell was designed to be constructed with 1.5 ft of bioretention soil mix above native soils. Water enters the cell through an inlet that conveys water from the roof of the Manry family residence and is designed to infiltrate through the bioretention soil before reaching the native soils. An emergency overflow is designed to overflow at ponded depth of 1.3 ft above base of the cell and connects to the existing stormwater network.

BIORETENTION SOIL:

Thickness: 0.9-1.8 ft

The apparent thickness of bioretention soil based on probe data and hand augers ranged from 0.9-1.8 ft below ground surface with an average thickness of 1.6 ft.

Composition:

Design plans call for the bioretention soil mix to be 50-60% clean sand meeting ASTM C-33, 20-30% leaf compost, and 20-30% topsoil, with maximum clay content not to exceed 5% and minimum organic content of 10% by weight. In comparison to the 2019 Ecology bioretention soil mix specifications, the tested soil did not meet the recommended guidelines for grain size distribution or organic matter content. The tested soil had a higher percentage of gravel, and fines passing the #200 sieve, as well as exceeding the organic matter content recommendation.

Organic Matter Content (% by weight): 9.4

Percent passing #200 sieve: 26.9

Coefficient of Uniformity (Cu): 16.7

Coefficient of Curvature (Cc): 1.4

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Subgrade soil not encountered.

BUILT PER PLAN:

Bioretention soil mix does not meet design specifications. The catch basin was buried in soil and natural mulch, actual stick up height was 0.6 ft above cell base, not the 1.3 ft as stated in the design. The north end of the cell side slope and base overlie a water supply utility pipe that connects to the adjacent house, infiltration test water was observed seeping through the retaining wall that cuts into the berm of the cell to provide access to the utility boxes. Design plans indicate greater space between the side of the bioretention cell and the water utility trench than observed in the field. Otherwise, observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered during excavations of hand augers. The temporary Wellpoint,

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
Cell: Plat 3

Assessed On:
August 30, 2023



screened from 0.6-1.5 ft below ground surface, responded to testing and the shallowest WellPoint water level was at or above the ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): N/A

Subgrade Soil Rate (in/hr): 0.5

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying Vashon Till deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Consider monitoring the retaining wall supporting the northern berm of the cell for seepage after heavy rains to further assess the situation.

This cell and adjacent cells are heavily overgrown with blackberries and shrubs. Comments from home owners indicated they were instructed not to alter anything in the bioretention cells, but expressed a desire to assist with maintenance to have a more aesthetically pleasing entrance to their homes and reduce the invasive blackberry presence.

Field Conditions

| | | | |
|-----------------|-----------------------------|------------------|------------------|
| Weather | Overcast/ intermittent rain | | |
| Recent Rainfall | Today: 0.02" | Yesterday: 0.38" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | Half Day: | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)

Cell: Plat 3

Assessed On:

August 30, 2023



Site Photo: FA_SitePhotos-20230830-180942.jpg



Site Photo: FA_SitePhotos-20230830-181203.jpg



Site Photo: FA_SitePhotos-20230830-181123.jpg



Site Photo: FA_SitePhotos-20230830-190248.jpg



Site Photo: FA_SitePhotos-20230830-181141.jpg



Site Photo: FA_SitePhotos-20230830-190315.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
Cell: Plat 3

Assessed On:
August 30, 2023



Site Photo: FA_SitePhotos-20230830-190337.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from the roof via a 0.5' pipe that runs under the yard and into the side of the cell. water is designed to infiltrate through the bioretention soil before infiltrating into the native subgrade. The yard drain catch basin overflow is designed to be 1.3' above the base of the cell. The actual stick up height of overflow above cell base is about 0.6'. The low retaining wall on the northwest exterior of the cell has a line of seepage occurring at ponded depth of 0.08'. There is a water line utility trench, indicated by locates, that run beneath the retaining wall and the north end of the cell perimeter. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
Cell: Plat 3

Assessed On:
August 30, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.5'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230830-191039.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details:


BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
 Cell: Plat 3

Assessed On:
 August 30, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1' Width: 1' |
| Additional Details: | |
| Stickup (ft) From Ground: 0 Relative from staff gauge: 0.6 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 99% blocked Additional Details: Yard drain catch basin was buried in soil and natural mulch by about 0.2', water was observed seeping out of the side of the cell before it overflows into this structure. | |
| Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 99% blocked Additional Details: See above, the overflow was cleared in order to find it the day before testing. | |
|  | |
| IMG_0519.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|--|-----------------------------------|-----------------------------------|---|-------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | | | | | Depth (ft): |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% | |
| Natural mulch of grasses and blackberry canes cover the cell. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: | | | | | | |
| Vegetation Description | | | | | | |
| Abundant shrubs, wild roses and blackberries greatly hindered access, field staff cut swaths in through vegetation to access edges of cell in the corners and strategic areas to get a accurate understanding of cell structure. | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 0.9-1.8' of bioretention soil, with an average depth of 1.6'. This is consistent with the 1.5' specified by the plans. On the cell edges, less than 1 foot of soil was encountered above native soils. This is consistent with the cell design which shows a hard transition | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
 Cell: Plat 3

Assessed On:
 August 30, 2023



between amended soil and graded existing subgrade. Some areas of the cell could not be probed due to thick, thorny vegetation.

Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1 |
| to Import/Underdrain: | |
| Total Depth: | 1.2 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, silty fine to medium SAND, some coarse sand, some fine gravel, moderate organics (SM) Native Soil Texture: Slightly dense, slightly moist, brown, silty fine to medium SAND, some coarse sand, some gravel, interbedded with slightly stiff, slightly moist, grey, sandy SILT with oxidized edges, trace sand, few organics (SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
 Cell: Plat 3

Assessed On:
 August 30, 2023



HA-1

IMG_0527.jpg



IMG_0528.jpg

Additional Details

Soil does not look like typical bioretention soil mix, plans state compost amended soil. The difference between the "amended" soil and native soil is difficult to discern.

HA-2-WP

- Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | 1.3 |
| to Import/Underdrain: | |
| Total Depth: | 1.7 |

Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, silty fine to medium SAND, some coarse sand, some fine gravel, moderate organics (SM)
 Native Soil Texture: Slightly dense, slightly moist, brown, silty fine to medium SAND, some coarse sand, some gravel, interbedded with slightly stiff, slightly moist, grey, sandy SILT with oxidized edges, trace sand, few organics (SM)

- | | |
|---|---|
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|---|---|

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
 Cell: Plat 3

Assessed On:
 August 30, 2023



HA-2-WP

Well Point Detail

Is the well point dry? Yes No
 Depth to water from TOC (ft):
 Respond to Testing: Yes No
 Shallowest Depth to water during testing from Ground Surface (ft): 0



IMG_0529.jpg

Additional Details

Soil does not look like typical bioretention soil mix, plans state compost amended soil. The difference between the "amended" soil and native soil is difficult to discern. Shallowest depth to water during the test was above the ground surface.

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|---|---|
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.1 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, silty fine to medium SAND, some coarse sand, some fine gravel, moderate organics (SM) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
 Cell: Plat 3

Assessed On:
 August 30, 2023



HA-3



IMG_0538.jpg

Additional Details

Soil does not look like typical bioretention soil mix, plans state compost amended soil. The difference between the "amended" soil and native soil is difficult to discern.

Infiltration Test

IT-1

| | |
|--|-------|
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM 4 and FM 10 | |
| Wetted Pond Area (sq. ft) | 456 |
| Ponded Depth (ft) | 0.43 |
| Total Gallons | 6,275 |
| Steady State Flow Rate (GPM) | 3 |

Additional Details:
 Swapped flow meters to the low flow meter 4 hours into the test due to low infiltration rates and the leaking from side retention wall of cell into the sidewalk. Falling head infiltration rate was 2.9in/hr between switching the flow meters. Additional test details can be found in the executive summary.



BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)
Cell: Plat 3

Assessed On:
August 30, 2023



IMG_0546.jpg



IMG_0549.jpg



IMG_0551.jpg

Additional Comments

Noticed leaking water out of NW side of cell, line of seepage comes out through low concrete block wall above water meter boxes, in line with water pipes marked by utility. Water pools over between sidewalk and edge of wall, then overflows sidewalk into street and down the street gutter to the north for 50+ feet before reaching a catch basin to connect to the storm drain network.

BIORETENTION CELL FIELD ASSESSMENT

Site: Manry Residence Monroe (MOMR)

Cell: Plat 3

Assessed On:

August 30, 2023



SITE: MANRY RESIDENCE MONROE (MOMR) CELL: PLAT 3





associated
earth sciences
incorporated

Well Point

MOMR-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/29/23

Logged By: SNCF

20150387H008

Ending Date: 8/29/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.7

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.1

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

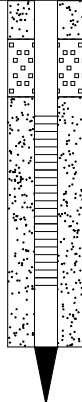
Top of Well Casing Elevation (ft): 104.5

Water Level Elevation (ft): N/A

Datum: Project Datum

∇ Groundwater Depth ATD (ft): N/A

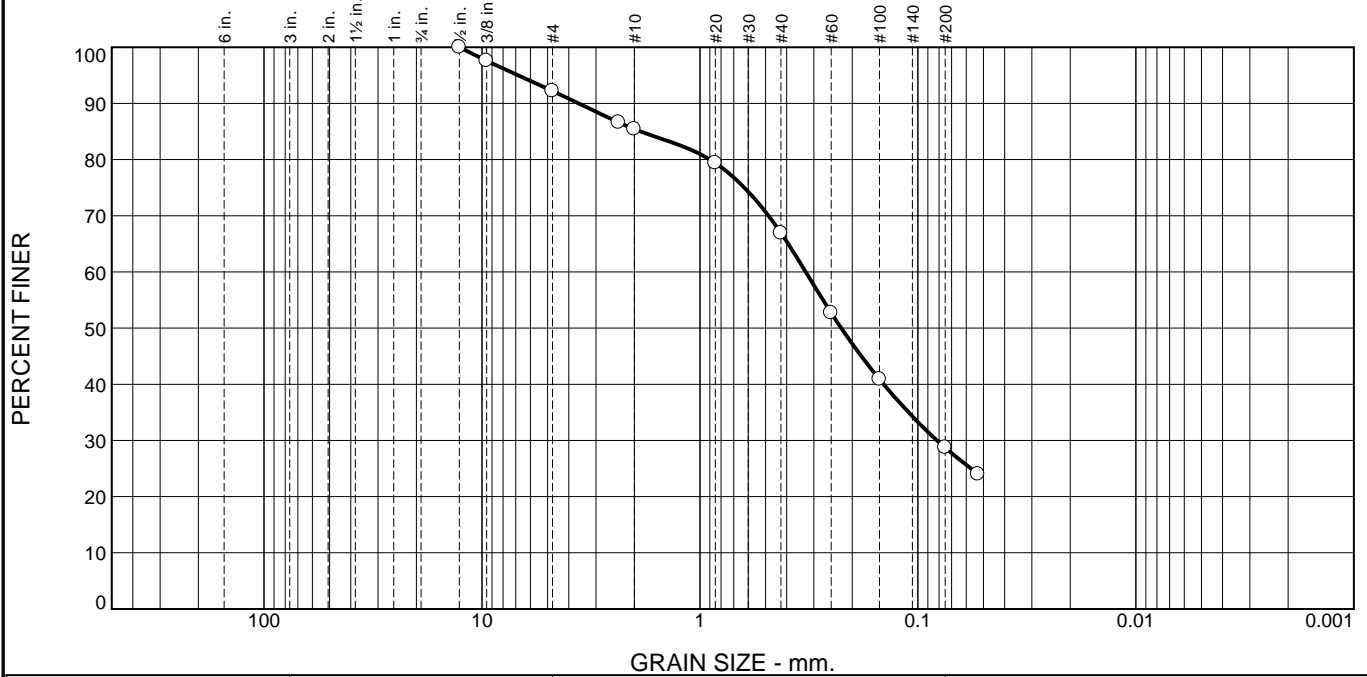
∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Natural mulch; grasses/blackberry canes. | | | | | | |  <p>Stickup -4.5 to 0 feet Native bioretention soil/ mulch 0 to 0.2 feet 3/8-inch bentonite chips 0.2 to 0.5 feet 1.25-inch I.D. threaded galvanized steel casing - 4.5 to -1.5 feet; duct tape covers screen -1.5 to 0.6 feet Medium grain silica sand 0.5 to 1.7 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 0.6 to 1.5 feet Cast iron endcap 1.5 to 1.8 feet Cast iron drivepoint 1.8 to 2.1 feet</p> |
| 1 | Hand | 1 | | Bioretention Soil Mix Slightly loose, slightly moist, brown, silty, fine SAND, some fine gravel; few organics (rootlets) (SM). | | | | | | | |
| | Hand | 2 | | As above. | | | | | | | |
| | Hand | 3 | | As above with layers of stiff, gray, silt (SM). | | | | | | | |
| 2 | | | | No seepage. No caving. Refusal at rock. HA located in base of cell. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/21/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| | 0.0 | 7.8 | 6.8 | 18.5 | 38.2 | 28.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 97.6 | | |
| #4 | 92.2 | | |
| #8 | 86.6 | | |
| #10 | 85.4 | | |
| #20 | 79.4 | | |
| #40 | 66.9 | | |
| #60 | 52.7 | | |
| #100 | 40.9 | | |
| #200 | 28.7 | | |
| #270 | 24.0 | | |

Material Description

silty SAND some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 3.6025 D₈₅= 1.8746 D₆₀= 0.3269
D₅₀= 0.2247 D₃₀= 0.0817 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8-30-2023 Date Tested: 10-27-2023

Tested By: FEW

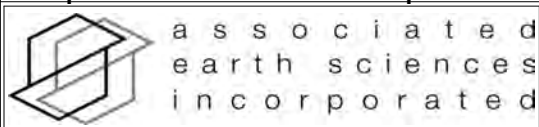
Checked By: SNCF/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Monroe Manry Residence
Sample Number: HA-2WP Depth: 0.3-0.8'

Date Sampled: 8-29-2023

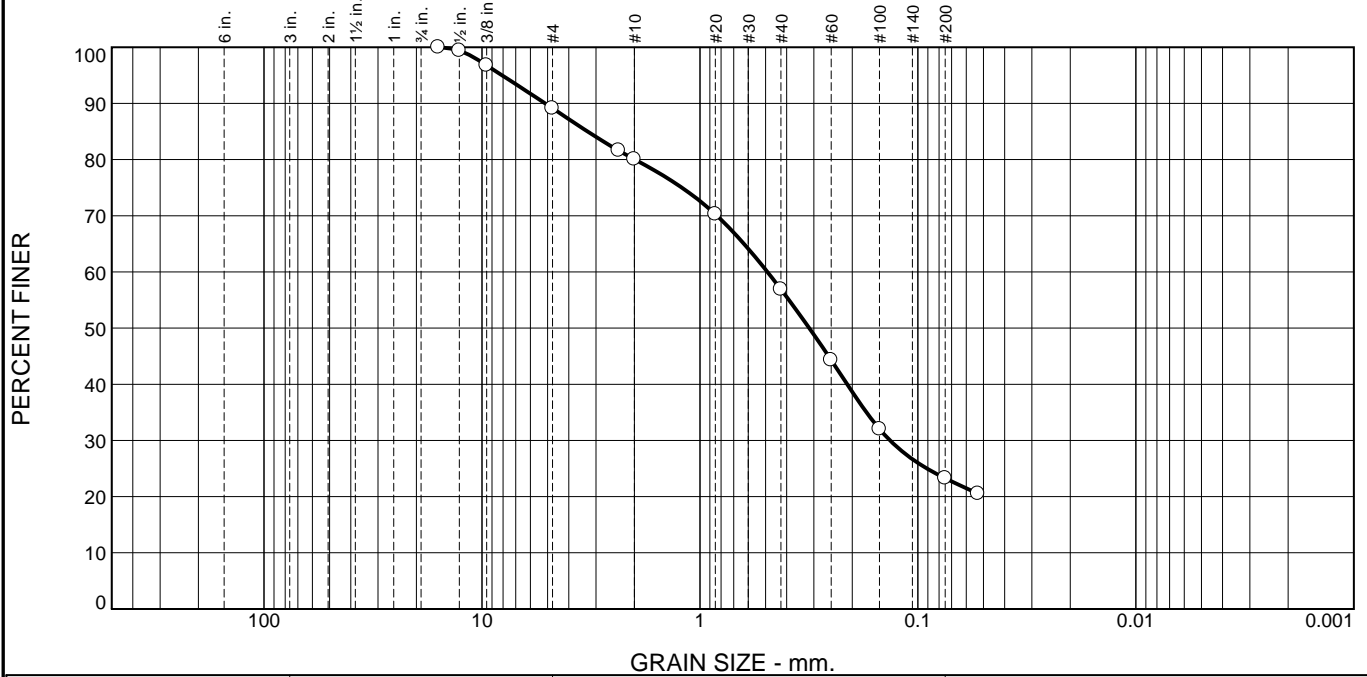


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 10.9 | 9.0 | 23.2 | 33.6 | 23.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 99.4 | | |
| 3/8" | 96.8 | | |
| #4 | 89.1 | | |
| #8 | 81.6 | | |
| #10 | 80.1 | | |
| #20 | 70.3 | | |
| #40 | 56.9 | | |
| #60 | 44.3 | | |
| #100 | 32.0 | | |
| #200 | 23.3 | | |
| #270 | 20.5 | | |

Material Description

silty SAND some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 5.1292 D₈₅= 3.2767 D₆₀= 0.4905
D₅₀= 0.3149 D₃₀= 0.1342 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8-30-2023 Date Tested: 10-30-2023

Tested By: FEW

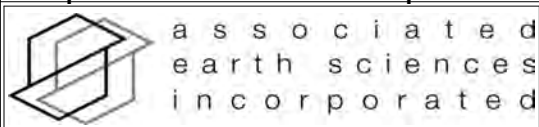
Checked By: SNCF/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Monroe Manry Residence
Sample Number: HA-2WP Depth: 1.3-1.7'

Date Sampled: 8-29-2023

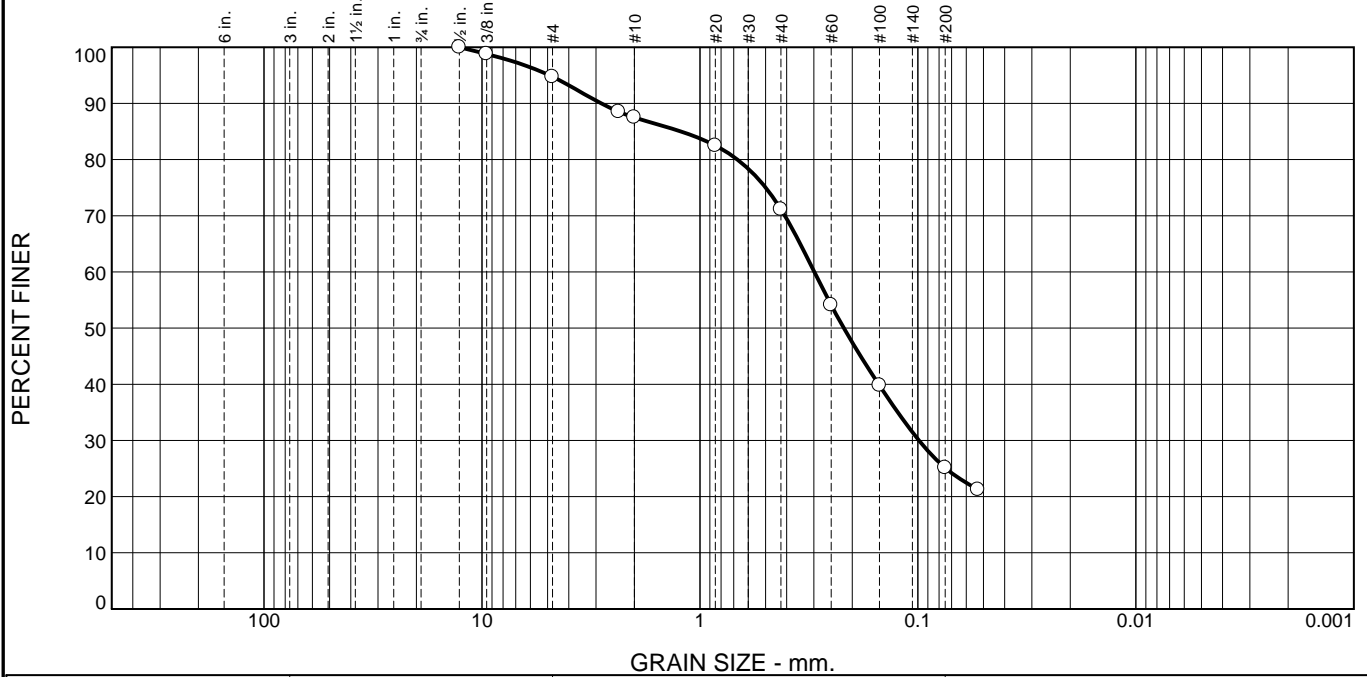


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.3 | 7.2 | 16.4 | 46.0 | 25.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 98.8 | | |
| #4 | 94.7 | | |
| #8 | 88.5 | | |
| #10 | 87.5 | | |
| #20 | 82.5 | | |
| #40 | 71.1 | | |
| #60 | 54.1 | | |
| #100 | 39.8 | | |
| #200 | 25.1 | | |
| #270 | 21.3 | | |

Material Description

silty SAND some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 2.8374 D₈₅= 1.2217 D₆₀= 0.2985
D₅₀= 0.2186 D₃₀= 0.0989 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8-30-2023 Date Tested: 10-27-2023

Tested By: FEW

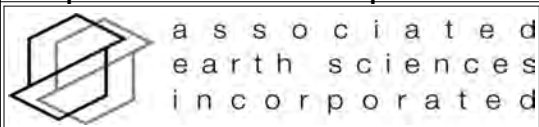
Checked By: SNFC/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Monroe Manry Residence
Sample Number: HA-3 Depth: 0.2-0.5'

Date Sampled: 8-29-2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 8/29/2023 | Project BHPS-Manry residence | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Monroe,WA | EB/EP No. MOMR-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2WP @ 0.3-0.8' | HA-3 @ 0.2-0.5' |
|--------------------|-------------------|-----------------|
| Wet Weight + Pan | 843.92 | 733.69 |
| Dry Weight + Pan | 771.48 | 669.63 |
| Weight of Pan | 247.11 | 247.52 |
| Weight of Moisture | 72.44 | 64.06 |
| Dry Weight of Soil | 524.37 | 422.11 |
| % Moisture | 13.81 | 15.18 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 771.48 | 669.63 |
| Dry Soil After Burn + Pan | 731.93 | 621.97 |
| Weight of Pan | 247.11 | 247.52 |
| Wt. Loss Due to Ignition | 39.55 | 47.66 |
| Actual Wt. Of Soil After Burn | 484.82 | 374.45 |
| % Organics | 7.54 | 11.29 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-----------------|--------------------------------|--|
| Project Name: | Manry Residence | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 8/30/2023 | Wetted Area (sq. feet): | 10:15: 456 ft^2 / 12:20: 317 ft^2 / 1320: 193 ft^2 |
| Weather: | Clear | Underdrain | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.43 |
| Performed By: | SNCF/SST | Receptor Soils: | Olympia Nonglacial Deposits |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Yard Drain (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|-----------------|---------------------|---|
| 7:25 | 21 | 0 | | | 0 | Water on |
| 7:30 | 29.9 | | | | 109 | |
| 7:45 | 29.9 | | 4.56 | | 557 | Ponded water reaches base of wellpoint |
| 8:05 | 29.9 | | 4.55 | | 1,177 | |
| 8:09 | | | | | | Flow rate up to 45gpm |
| 8:12 | 45.9 | 0.04 | | | | Wetted area reaches staff gauge |
| 8:15 | 45.86 | 0.1 | 4.51 | | 1,596 | |
| 8:30 | 45.9 | 0.3 | 4.36 | | 2,283 | |
| 8:45 | 45.8 | 0.38 | 4.27 | | 2,942 | |
| 9:00 | 45.88 | 0.47 | 4.19 | | 3,621 | Water leaking into yard drain from side. |
| 9:05 | 9.99 | 0.47 | | 2.12 | | Flow rate down to 10 gpm |
| 9:15 | 9.98 | 0.47 | 4.23 | 2.12 | 3,868 | |
| 9:31 | 9.97 | 0.4 | 4.26 | 2.12 | 4,029 | Placed datalogger in yard drain. Flow up to 20 gpm. |
| 9:45 | 19.87 | 0.41 | 4.26 | 2.12 | 4,303 | |
| 10:00 | 19.8 | 0.43 | 4.25 | 2.12 | 4,588 | |
| 10:15 | 19.83 | 0.43 | 4.23 | 2.12 | 4,894 | |
| 10:30 | 20.22 | 0.44 | 4.23 | | 5,190 | Flow down to 15 gpm |
| 10:45 | 16.03 | 0.43 | 4.24 | | 5,429 | |
| 11:00 | 17.25 | 0.43 | 4.24 | 2.12 | 5,686 | |
| 11:10 | | | | | | Water leaking on cell wall exterior. Flow down. |
| 11:15 | 4.85 | 0.42 | 4.26 | | 5,897 | |
| 11:34 | | 0.36 | | | 5,961 | Water off |
| 11:35 | | 0.36 | | | | |
| 11:42 | | 0.33 | | | | |
| 11:45 | | 0.32 | | | | |
| 11:50 | | 0.3 | | | | |
| 12:00 | | 0.27 | | | | |
| 12:10 | 0 | 0.24 | 4.45 | | | Water still leaking out of cell, but has stopped overflowing into the street. |
| 12:15 | | 0.2 | | | | |
| 12:44 | 2.97 | 0.13 | 4.55 | | 5,961 | Water on |
| 13:00 | 2.96 | 0.1 | | | 6,007 | |
| 13:15 | 3 | 0.09 | 4.57 | 2.12 | 6,052 | |
| 13:20 | 2.98 | 0.09 | 4.58 | | 6,066 | |
| 13:30 | 2.98 | 0.08 | 4.59 | | 6,098 | |
| 13:40 | 2.98 | 0.08 | 4.58 | | 6,126 | |
| 13:50 | 2.97 | 0.08 | 4.59 | | 6,156 | Water still leaking out of cell, but not pooling |
| 14:01 | 2.98 | 0.06 | 4.59 | 2.12 | 6,190 | |
| 14:10 | 2.92 | 0.06 | 4.59 | | 6,218 | |
| 14:20 | 2.9 | 0.06 | 4.59 | | 6,245 | |
| 14:30 | 0 | 0.06 | 4.59 | | 6,275 | Water off |
| 14:40 | | 0.06 | 4.61 | | | |

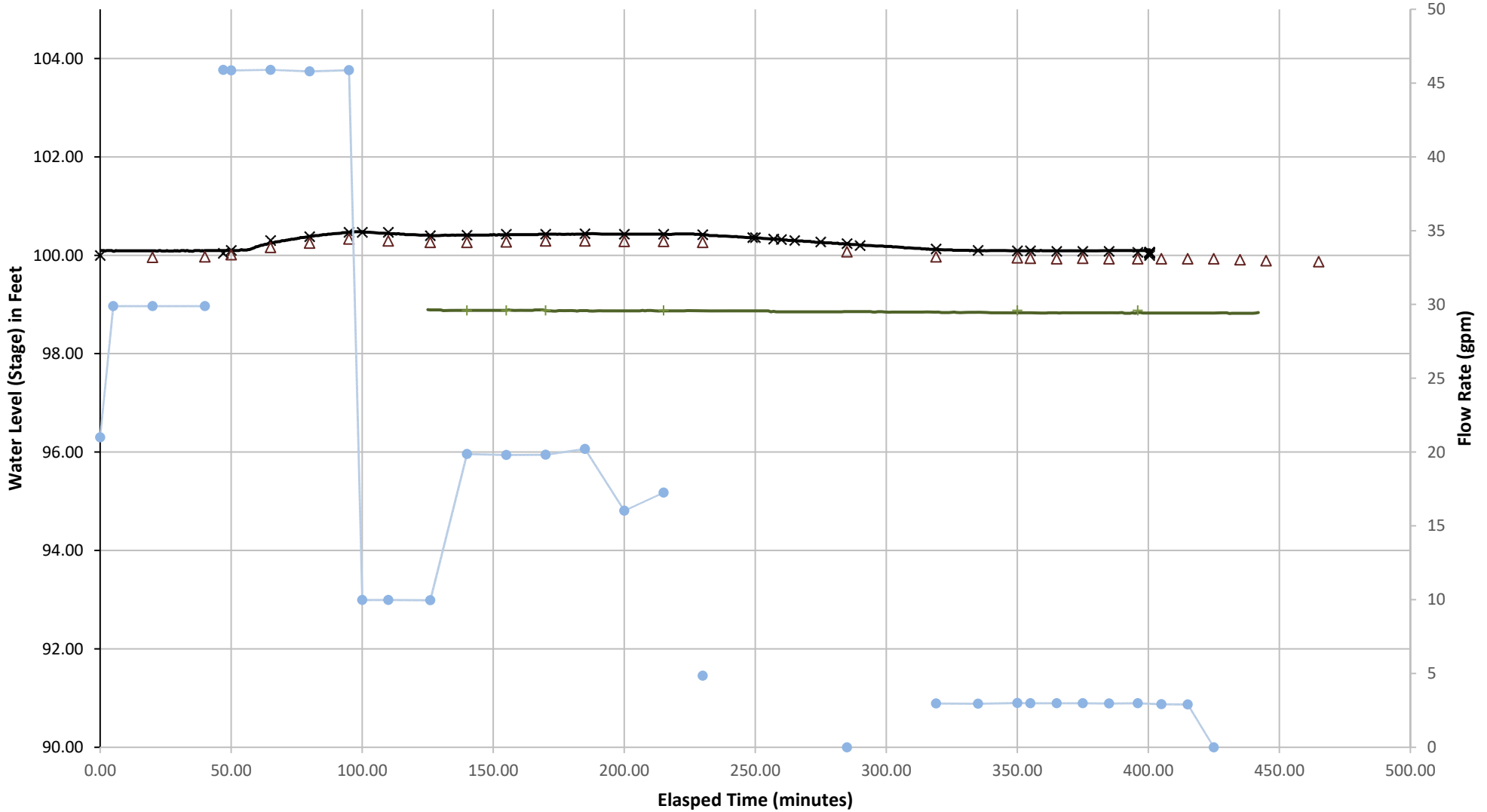
| | | | | | | |
|-------|--|------|------|--|--|----------|
| 14:50 | | 0.05 | 4.63 | | | |
| 15:00 | | 0.04 | | | | |
| 15:10 | | 0.03 | 4.65 | | | |
| 15:20 | | 0 | | | | Pond dry |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | - |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 0.5 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | - |
| WP Average Infiltration Rate (in/hr) during falling head: | 1.1 |

Manry Residence Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as relative reference. Elevation 100 represents ground surface. Wellpoint logger data faulty and not included in chart.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
Cell: 1800 Continental Pl.

Assessed On:
May 23, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2009 and collects roof runoff from the adjacent Skagit County Administrative building. The cell is constructed with 3" of mulch above 1'-9" of bioretention soil set above native soil. There are two overflow structures and catch basins on either end of the cell which are connected to one another by a non-perforated pipe. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 1.3-1.7'

The apparent thickness of the bioretention soil ranged from 1.3-1.7' below ground surface with an average of 1.4. The thickness decreased towards the southern end of the cell.

Composition: The plans call for a soil mix of 65-70% gravely sand (ASTM D422) to 30-35% compost. In comparison to the planned sand gradation, silt content, the tested material fell below the specification. The organic matter content fell within the specified range. In comparison to the 2019 specifications, the sand gradation fell below the standard while the fines content fell within the standard. The organic matter content was below the specified 5-8%.

Organic Matter Content (% by weight): 3.6

Percent passing #200 sieve: 3.9

Coefficient of Uniformity (Cu): 6.6

Coefficient of Curvature (Cc): 1.4

SUBGRADE CONDITIONS:

Geologic Unit: Alluvium-Skagit River Floodplain Deposits

Soil Description: Loose, moist, brownish gray, very silty, fine to medium SAND, trace gravel; scattered mica; occasional oxidation in horizontal layers (SM).

BUILT PER PLAN:

Water was observed entering the northern catch basin through leaky joints in the cement concrete structure. The flow rate was turned down to limit the water lost to leaks. Otherwise, the observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

Groundwater was encountered at 4.1' below ground surface in HA-1-WP. The temporary wellpoint was screened from 8.9-6.3' below ground surface. The wellpoint responded to testing and the groundwater levels increased by 1'.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): N/A

Subgrade Soil Rate (in/hr): 8.3

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying alluvial deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
 Cell: 1800 Continental Pl.

Assessed On:
 May 23, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:
 The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------------------|------------------|
| Weather | Cloudy, 60s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.1" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | Half Day: Catherine Ikeda | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: 20230523_214707548_iOS.jpg



Site Photo: 20230523_214738404_iOS.jpg



Site Photo: 20230523_214744765_iOS.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
 Cell: 1800 Continental Pl.


Assessed On:
 May 23, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Cell is an infiltrating bioretention cell which collects roof runoff from the adjacent building. The cell is designed to be divided into three sections by two check dams that step the ponding water before overflowing to lower elevations, from the southern, higher end, to the northern, lower end. Water is designed to infiltrate through the bioretention soil before reaching the underlying native subgrade. Two catch basins with overflow beehive grates are located at opposite ends of the cell and are connected to one another via a non-perforated pipe which would convey water to the storm drain network during overflow conditions. The cell is graded such that the southern 2/3rds of the cell would rarely, if ever, pond water. | |

Inlets


| | |
|--|---|
| IN-1 <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: | |
| Pipe: Material <input type="checkbox"/> PVC <input checked="" type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.55' | |
| Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: Functioning Concrete Apron: n/a | |
|  | |
| 20230523-194957.jpg | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Roof runoff enters the cell via a pipe. Water first lands on metal splash block ramp, then hits a ~2' wide flat boulder before landing on stream cobbles. | |

BIORETENTION CELL FIELD ASSESSMENT


Site: David Brookings Rain Garden (MVDB)
 Cell: 1800 Continental Pl.

Assessed On:
 May 23, 2023



| | |
|---|---|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: |  <p>20230523-195052.jpg</p> |
| Pipe: Material <input type="checkbox"/> PVC <input checked="" type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 0.55' | |
| Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: Functioning Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Flow into inlet collects in a rectangular box filled with gravel drain rock, it then enters a horizontal rectangular ramp, hits a splash pad, and then hits stream cobble on the bioretention cell's surface. | |

Design Overflow/Outlet

| | |
|---|---|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round Dimensions: <input checked="" type="checkbox"/> Rectangular Length: 1.76' <input type="checkbox"/> Other Width: 1.44' |  <p>20230523-213315.jpg</p> |
| Additional Details: Stickup (ft) From Ground: 1.1 Relative from staff gauge: 1.22 | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Small cracks in the catch basin allow ponded surface and subsurface water to enter the catch basin. The catch basin does not properly function as an "overflow" feature, instead it is a conduit for lateral flow. | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
Cell: 1800 Continental Pl.

Assessed On:
May 23, 2023



Cell Surface and Geotech Probe Observations

| | | | | | |
|--|---|---|-----------------------------------|-----------------------------------|---|
| Mulch: <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.3 | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Entire cell covered with mulch, the SE 2/3rd of the cell is more heavily vegetated and has a mix of landscape mulch and a natural mulch layer of leafy debris. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Additional Details: | | | | | |
| Vegetation Description | | | | | |
| The SE 2/3rds of the cell where water is less likely to pond is more heavily vegetated and thus mulch is a mix of leafy plant debris and shredded mulch. Vegetation covers approximately 60% of the cell and is denser in zones 2, 3, B, and C where water would not pond. | | | | | |
| Additional Details | | | | | |
| Geotechnical Observations: No zones of compaction were observed. | | | | | |

Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.7 |
| to Import/Underdrain: | |
| Total Depth: | 9.5 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium-coarse SAND, some fine sand, trace fine gravel, trace silt. Abundant organics, rootlets (SW) | |
| Native Soil Texture: Skagit River Alluvium: Loose, moist, brownish grey, very silty, fine-medium SAND, trace fine gravel. Scattered micas, occasional oxidation in horizontal layers (SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Depth to water from TOC (ft): 4.5 | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 2.54 | |
| Additional Details | |
| Water level measurements are adjusted to be from below ground surface. | |




20230522_222446305_iOS.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
 Cell: 1800 Continental Pl.

Assessed On:
 May 23, 2023



| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | 1.6 |
| to Import/Underdrain: | |
| Total Depth: | 2.2 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium-coarse SAND, trace fine gravel, trace silt. Abundant organics, rootlets (SW) Native Soil Texture: Loose, moist, brownish grey, very silty, fine-medium SAND, trace gravel. Scattered micas, occasional oxidation in horizontal layers (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| Additional Details Water measured at 1.8' below ground surface in HA-2 at 10:37am, just under 3 hours into the test. No water was encountered during excavation. | |

20230523_183729283_iOS.jpg

| | |
|--|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.7 |
| to Import/Underdrain: | |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium-coarse SAND, some fine sand, trace fine gravel, trace silt. Abundant organics, rootlets (SW) Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Encountered gravel at 1.7' below ground surface in HA-3. Moved over laterally 3 feet and did not encounter gravel. Assumption is that gravel is only laid immediately surrounding the pipe that connects the two catch basins. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
Cell: 1800 Continental Pl.

Assessed On:
May 23, 2023



HA-3

No photo was captured.

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-3 (3-50)

Wetted Pond Area (sq. ft) 144

Ponded Depth (ft) 0.3

Total Gallons 8,329

Steady State Flow Rate (GPM) 12.5

Additional Details:

Flow was reduced during the test to reduce the amount of water ponded around the catch basin to limit water entering the structure through lateral flow. Flow moves NW towards northern catch basin. Additional test details can be found in the executive summary.



20230523_214707548_iOS.jpg



20230523_214744765_iOS.jpg



20230523_214738404_iOS.jpg

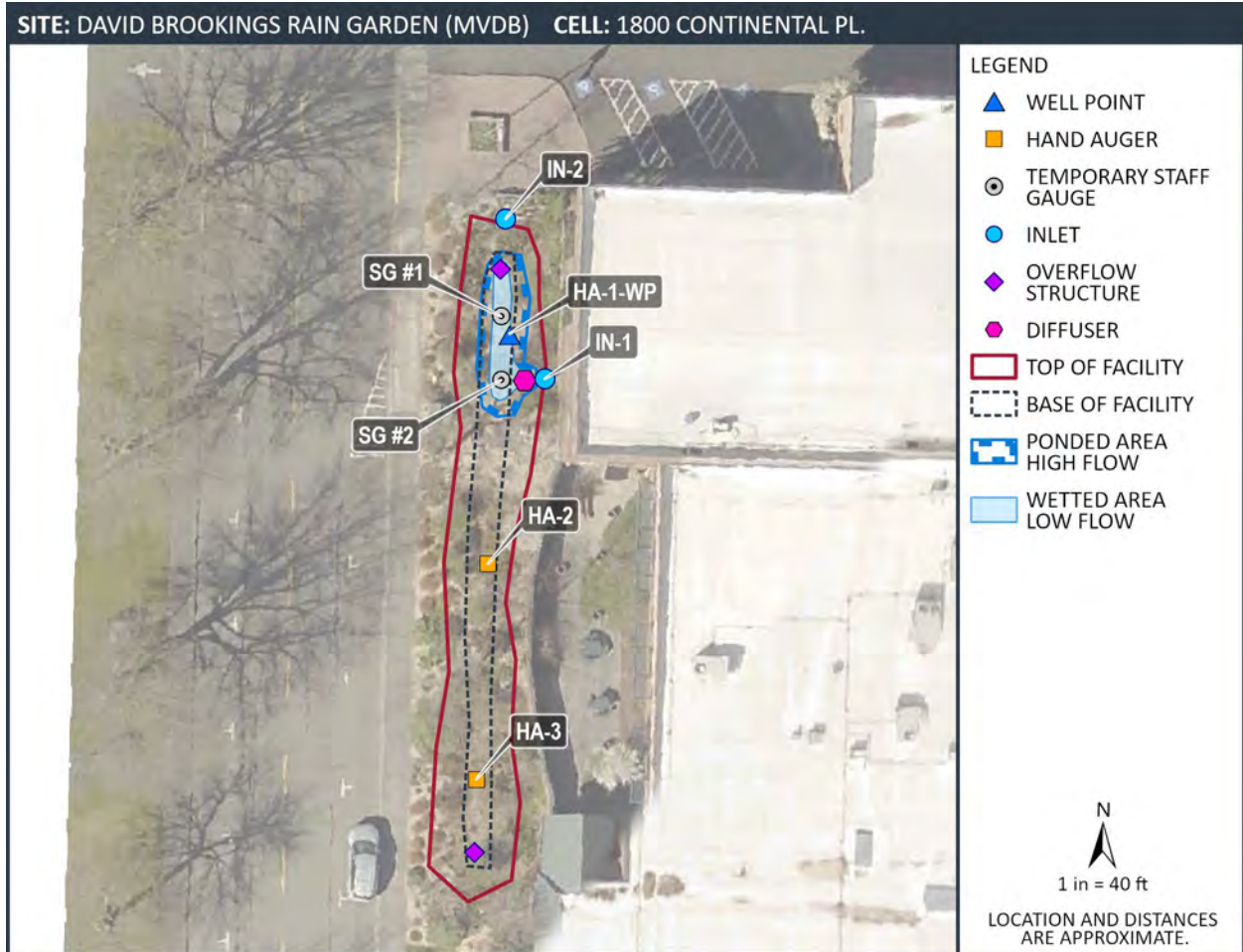
BIORETENTION CELL FIELD ASSESSMENT

Site: David Brookings Rain Garden (MVDB)
Cell: 1800 Continental Pl.

Assessed On:
May 23, 2023



Additional Comments





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Well Point

MVDB-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 2

Multiple Locations

Start Date: 5/22/23

Logged By: APJ

20150387H008

Ending Date: 5/22/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 9.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 9.5

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 102.1

Water Level Elevation (ft): 95.9

Datum: Project Datum

▼ Groundwater Depth ATD (ft): 4.1

∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Fibrous, stringy woody debris. | | | | | | | Stick up -2.1 to 0 feet Existing bioretention soils 0 to 5.1 feet |
| 1 | | 1 | | Bioretention Soil Mix Loose, moist, dark brown, medium to coarse SAND, trace fine gravel, trace silt; abundant organics; rootlets (SW). | | | | | | | |
| 2 | | 2 | | Holocene Alluvium - Skagit River Floodplain Deposits Loose, moist, brownish gray, very silty, fine to medium SAND, trace gravel; scattered mica; occasional oxidation in horizontal layers (SM). | | | | | | | 1.25-inch I.D. threaded galvanized steel casing -2.1 to 6.3 feet |
| 3 | | 3 | | | | | | | | | |
| 4 | | 4 | | | | | | | | | |
| 5 | | 5 | | | | | | | | | |
| 6 | | 6 | | As above; distinct oxidation horizon (1 inch thick). | | | | | | | |
| 7 | | 7 | | As above, becomes wet; groundwater encountered. | | | | | | | |
| 8 | | 8 | | | | | | | | | 3/8-inch bentonite chips 5.1 to 5.5 feet |
| | | | | | | | | | | | Medium grained silica sand 5.5 to 9.5 feet |
| | | | | | | | | | | | 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 6.3 to 8.9 feet |

1/24/2024

20150387H008



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Well Point

MVDB-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 2 of 2

Multiple Locations

Start Date: 5/22/23

Logged By: APJ

20150387H008

Ending Date: 5/22/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 9.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 9.5

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 102.1

Water Level Elevation (ft): 95.9

Datum: Project Datum

∇ Groundwater Depth ATD (ft): 4.1

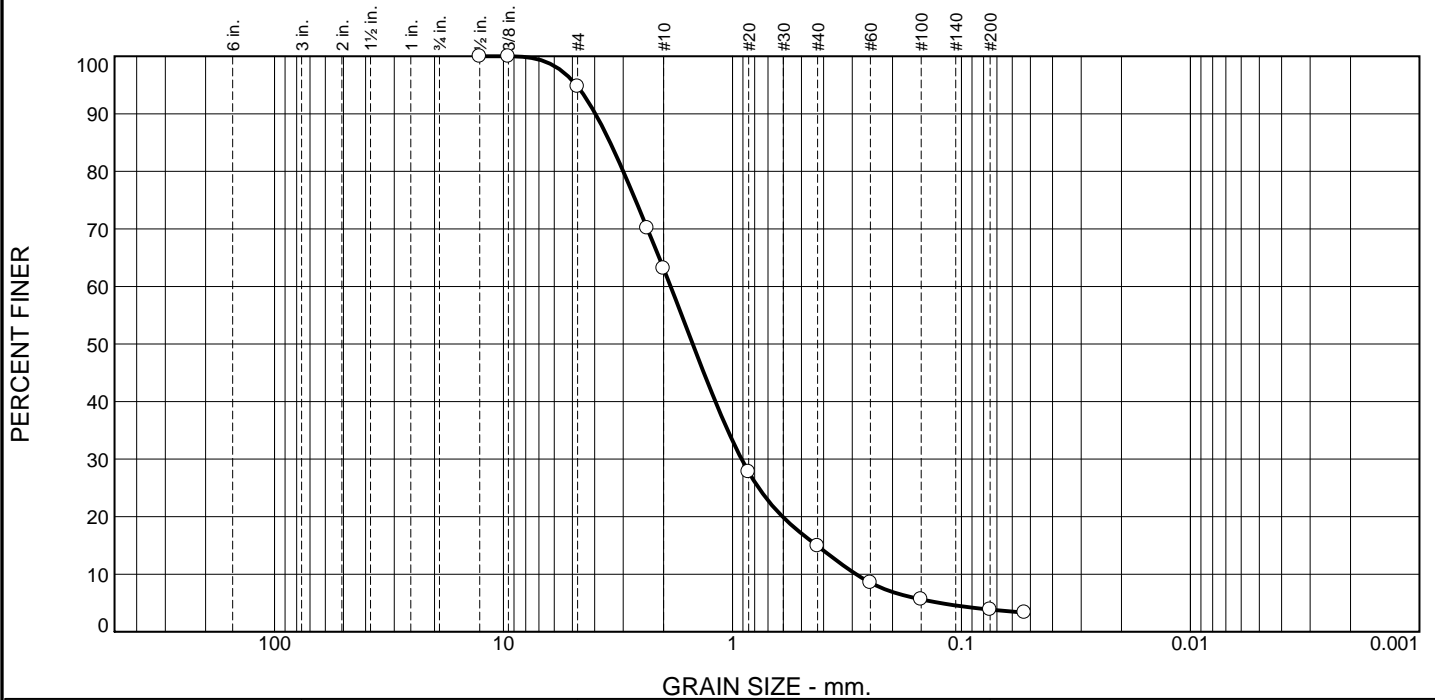
∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 8.0 | Hand | 9 | [Symbol] | Hole caving. | | | | | | | <p>Cast iron drive cap 8.9 to 9.2 feet Cast iron drive point 9.2 to 9.5 feet</p> |
| 9.0 | Hand | 10 | [Symbol] | | | | | | | | |
| 9.5 | Hand | 11 | [Symbol] | | | | | | | | |
| 10.0 | | | | Groundwater encountered at 4.1 feet ATD. Caving at 8.5 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 11.0 | | | | | | | | | | | |
| 12.0 | | | | | | | | | | | |
| 13.0 | | | | | | | | | | | |
| 14.0 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.2 | 31.7 | 48.2 | 11.0 | 3.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 100.0 | | |
| #4 | 94.8 | | |
| #8 | 70.1 | | |
| #10 | 63.1 | | |
| #20 | 27.8 | | |
| #40 | 14.9 | | |
| #60 | 8.5 | | |
| #100 | 5.6 | | |
| #200 | 3.9 | | |
| #270 | 3.3 | | |

* (no specification provided)

Material Description

BSM
SAND, some gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.9669 | D ₈₅ = 3.4198 | D ₆₀ = 1.8615 |
| D ₅₀ = 1.4911 | D ₃₀ = 0.9124 | D ₁₅ = 0.4278 |
| D ₁₀ = 0.2887 | C _u = 6.45 | C _c = 1.55 |

Remarks

Date Received: 5/23/2023 Date Tested: 7/18/2023

Tested By: CI/EW

Checked By: APJ/JHS

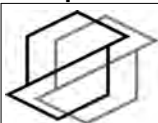
Title: _____

Location: Onsite - DBRG

Sample Number: HA-1

Depth: 0.5-1'

Date Sampled: 5/23/2023



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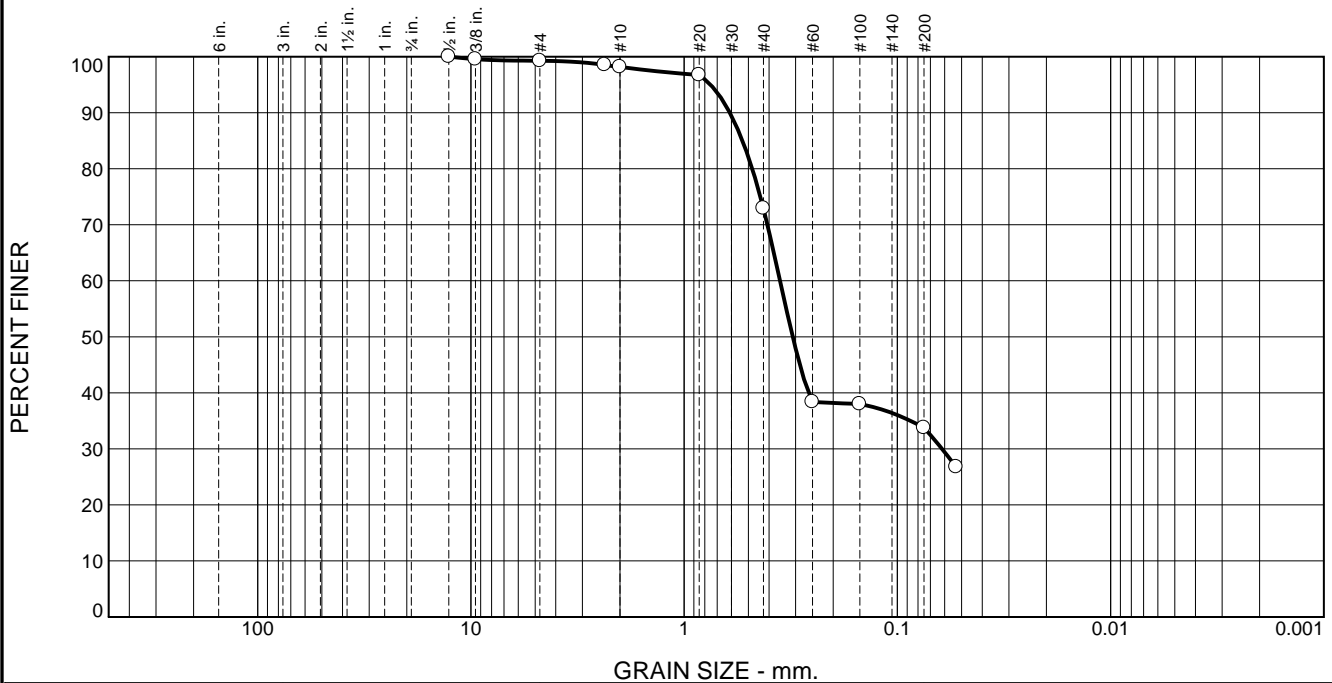
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.7 | 1.1 | 25.3 | 39.1 | 33.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.5 | | |
| #4 | 99.3 | | |
| #8 | 98.5 | | |
| #10 | 98.2 | | |
| #20 | 96.7 | | |
| #40 | 72.9 | | |
| #60 | 38.4 | | |
| #100 | 38.0 | | |
| #200 | 33.8 | | |
| #270 | 26.8 | | |

Material Description

Native
very silty SAND, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 0.6105 D₈₅= 0.5327 D₆₀= 0.3552
D₅₀= 0.3098 D₃₀= 0.0618 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 5/23/2023 Date Tested: 6/23/2023

Tested By: CI/EW

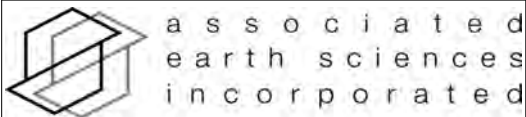
Checked By: APJ/JS

Title: _____

* (no specification provided)

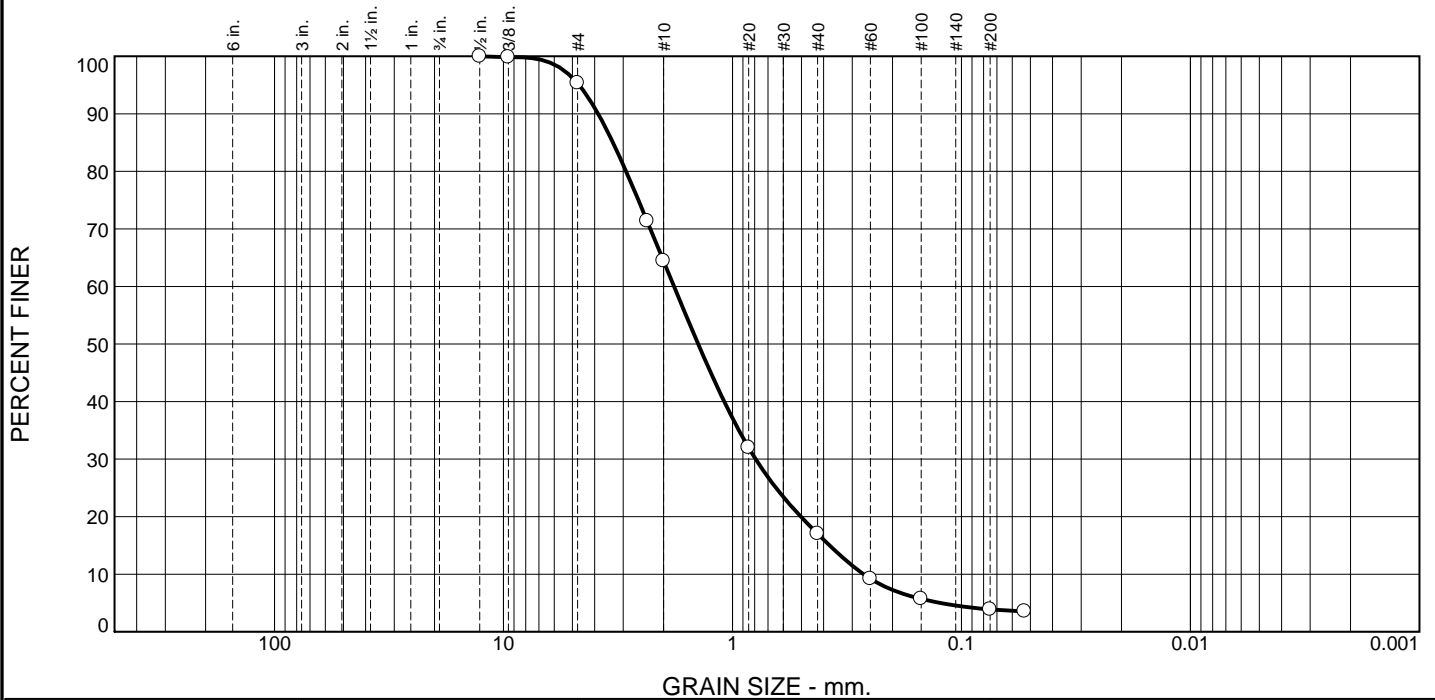
Location: Onsite
Sample Number: HA-1 Depth: 2.35'

Date Sampled: 5/23/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 4.7 | 30.9 | 47.4 | 13.1 | 3.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.9 | | |
| #4 | 95.3 | | |
| #8 | 71.4 | | |
| #10 | 64.4 | | |
| #20 | 32.0 | | |
| #40 | 17.0 | | |
| #60 | 9.2 | | |
| #100 | 5.7 | | |
| #200 | 3.9 | | |
| #270 | 3.6 | | |

* (no specification provided)

Material Description

SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.8599 D₈₅= 3.3258 D₆₀= 1.7993
D₅₀= 1.4118 D₃₀= 0.7920 D₁₅= 0.3766
D₁₀= 0.2676 C_u= 6.72 C_c= 1.30

Remarks

Date Received: 5/23/2023 Date Tested: 7/18/2023

Tested By: CI/EW

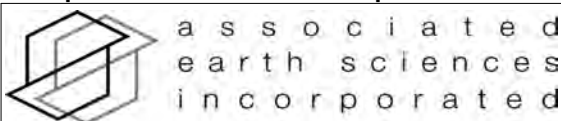
Checked By: APJ/JHS

Title: _____

Location: Onsite - DBRG
Sample Number: HA-3

Depth: 0.5'

Date Sampled: 5/23/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|-------------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 5/23/2023 | Project BHPS - MVDB | Project No. 20150387 H008 | | Soil Description Bioretention Soil Mix |
| Tested By CI | Location Mount Vernon, WA | EB/EP No. MVDB-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.5-1' | HA-3 @ 0.5' |
|--------------------|---------------|-------------|
| Wet Weight + Pan | 1387.50 | 1324.20 |
| Dry Weight + Pan | 1268.45 | 1246.20 |
| Weight of Pan | 391.90 | 357.97 |
| Weight of Moisture | 119.05 | 78.00 |
| Dry Weight of Soil | 876.55 | 888.23 |
| % Moisture | 13.58 | 8.78 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------|---------|
| Dry Soil Before Burn + Pan | 1268.45 | 1246.20 |
| Dry Soil After Burn + Pan | 1237.80 | 1214.50 |
| Weight of Pan | 391.90 | 357.97 |
| Wt. Loss Due to Ignition | 30.65 | 31.70 |
| Actual Wt. Of Soil After Burn | 845.90 | 856.53 |
| % Organics | 3.50 | 3.57 |

ASSOCIATED EARTH SCIENCES

| | | | |
|------------------------|-----------------------------|--------------------------------|-----------------------|
| Project Name: | David Brookings Rain Garden | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-3 3-50 |
| Date: | 5/23/2023 | Wetted Area (sq. feet): | 144 ft^2 |
| Weather: | Cloudy, 60s | Underdrain | No |
| Test No.: | IT-1 | Test Depth (feet): | Surface, 0.15 |
| Performed By: | APJ/CSI | Receptor Soils: | Skagit River Alluvium |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (feet) | Staff Gauge #2 (feet) | Wellpoint (feet btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|-----------------------|-----------------------|-----------------------|---------------------|--|
| 7:51 | 42.15 | | | 5.66 | 0 | Water on |
| 7:52 | 11.64 | | 0.15 | | 55 | |
| 7:53 | 40.47 | | | | 81 | |
| 7:54 | 43.25 | | | | 106 | |
| 7:55 | 35.67 | | 0.15 | | 136 | |
| 7:56 | 35.32 | | | | 179 | |
| 7:57 | 35.34 | | 0.16 | | 213 | |
| 7:58 | 35.34 | | | | 258 | |
| 7:59 | 31.44 | | | | 301 | |
| 8:00 | 0 | | | | 353 | Water off - leaky hose |
| 8:02 | 19.4 | | | | 354 | Water back on |
| 8:03 | 27.1 | | | | 373 | |
| 8:04 | 28.16 | | 0.2 | | 385 | |
| 8:05 | 44.55 | 0.14 | | | 427 | Flow moving N toward inlet |
| 8:06 | 44.43 | | | 5.55 | 496 | |
| 8:08 | 44.66 | 0.14 | 0.2 | | 592 | Mulch floating on surface |
| 8:11 | 44.45 | | | | 714 | Flow approaching beehive |
| 8:13 | 44.3 | | | | 801 | |
| 8:14 | 44.42 | | | | 832 | |
| 8:15 | 36.35 | | 0.2 | | 880 | Decrease flow to 35 gpm |
| 8:20 | 35.96 | 0.15 | 0.21 | 5.39 | 1,046 | Water percolating into CB via cement sides |
| 8:30 | 35.78 | 0.15 | 0.2 | 5.29 | 1,386 | Water audibly trickling into CB |
| 8:45 | 35.7 | 0.19 | 0.2 | 5.13 | 1,936 | Decrease flow to 25 gpm |
| 9:00 | 26.95 | 0.19 | 0.2 | 5.03 | 2,320 | Water approaching metal grate of CB |
| 9:15 | 26.88 | 0.22 | 0.2 | 4.98 | 2,715 | |
| 9:30 | 26.75 | 0.25 | 0.2 | 4.93 | 3,143 | |
| 9:45 | 26.66 | 0.26 | 0.2 | 4.89 | 3,521 | |
| 10:00 | 26.82 | 0.28 | 0.2 | 4.85 | 3,920 | |
| 10:15 | 26.66 | 0.3 | 0.2 | 4.83 | 4,347 | |
| 10:30 | 26.82 | 0.31 | 0.2 | 4.79 | 4,748 | |
| 10:45 | 26.7 | 0.32 | 0.2 | 4.76 | 5,128 | Appox seepage into CB ~4 gpm |
| 10:53 | 12.46 | 0.32 | 0.18 | 4.75 | 5,374 | Decrease flow to 12 gpm due to seepage into CB |
| 11:00 | 12.43 | 0.26 | 0.15 | 4.75 | 5,455 | |
| 11:15 | 12.38 | 0.18 | 0.15 | 4.74 | 5,640 | |
| 11:30 | 12.48 | 0.14 | 0.14 | 4.75 | 5,807 | |
| 11:45 | 12.45 | 0.12 | 0.14 | 4.73 | 5,999 | Seepage into CB <1 gpm |
| 12:00 | 12.43 | 0.12 | 0.14 | 4.73 | 6,203 | |
| 12:15 | 12.46 | 0.12 | 0.15 | 4.71 | 6,396 | |
| 12:30 | 12.34 | 0.12 | 0.16 | 4.71 | 6,575 | |
| 12:45 | 12.4 | 0.11 | 0.16 | 4.7 | 6,761 | |
| 13:00 | 12.42 | 0.11 | 0.16 | 4.68 | 6,945 | |

| | | | | | | |
|----------|-------|------|------|------|-------|---------------------------------------|
| 13:15 | 12.42 | 0.11 | 0.16 | 4.68 | 7,139 | |
| 13:30 | 12.38 | 0.11 | 0.16 | 4.68 | 7,314 | |
| 13:45 | 12.36 | 0.12 | 0.16 | 4.67 | 7,501 | |
| 14:00 | 12.38 | 0.12 | 0.16 | 4.66 | 7,685 | |
| 14:15 | 12.42 | 0.12 | 0.16 | 4.66 | 7,869 | |
| 14:30 | 12.34 | 0.12 | 0.16 | 4.64 | 8,062 | |
| 14:45 | 12.31 | 0.12 | 0.16 | 4.64 | 8,249 | |
| 14:52 | 12.31 | 0.12 | 0.14 | 4.64 | 8,329 | Water off |
| 14:52:30 | | 0.12 | 0.12 | | | |
| 14:53 | | 0.12 | 0.1 | | | |
| 14:53:30 | | 0.10 | 0.09 | | | |
| 14:54 | | 0.10 | 0.06 | | | |
| 14:54 | | 0.08 | 0.04 | | | |
| 14:55 | | 0.07 | 0.03 | | | |
| 14:56 | | 0.05 | 0 | | | Staff gauge #2 sunk 0.04' during test |
| 14:56 | | 0.04 | | | | |
| 14:57 | | 0.01 | | | | |
| 14:58 | | 0 | | 4.65 | | |
| 15:00 | | | | 4.66 | | |
| 15:13 | | | | | | |
| 15:15 | | | | 4.71 | | |
| 15:20 | | | | 4.77 | | |
| 15:26 | | | | 4.77 | | |
| 15:30 | | | | 4.8 | | |
| 15:35 | | | | 4.81 | | |
| 15:40 | | | | 4.83 | | |
| 15:50 | | | | 4.84 | | |

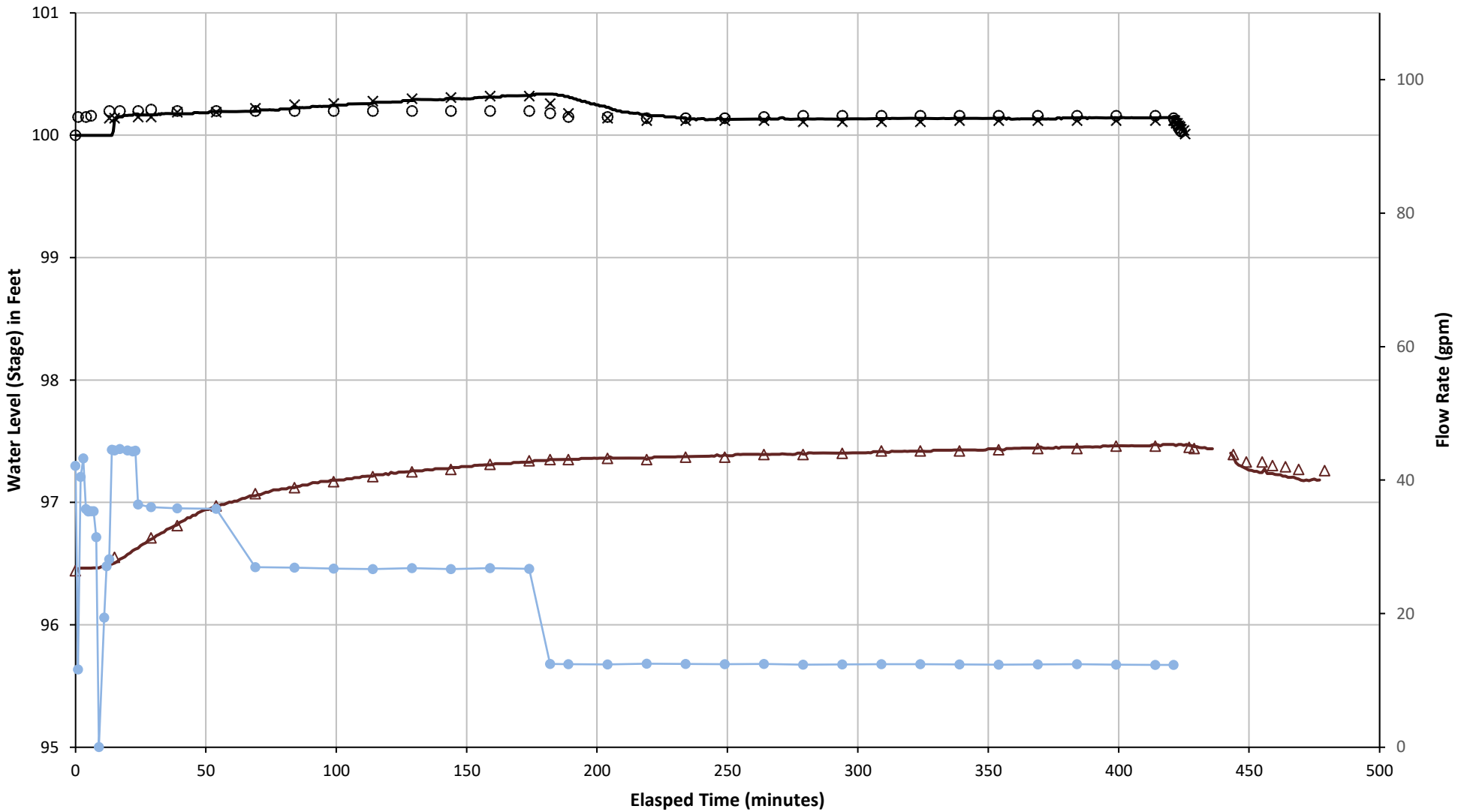
| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 8.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 12.8 |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 8.5 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 28.8 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 8.6 |
| WP Average Infiltration Rate (in/hr) during falling head: | 3.1 |

David Brookings Rain Garden Field Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- x Staff Gauge #1 Hand Data
- Δ Well Point Hand Data
- Staff Gauge #1 Logger
- Well Point Logger
- o Staff Gauge #2 Hand Data
- Flow Rate (gpm)

EXECUTIVE SUMMARY**PLAN REVIEW:**

This tested bioretention cell was constructed in 2013 and designed to collect water from McPhee road and the adjacent sidewalk. Water enters the cell through multiple curb cuts long the roadway and a small amount through the adjacent porous concrete sidewalk. The cell design calls for 1.5 ft of engineered soil above the native subgrade in the base of the cell and along the side slopes. Water is designed to infiltrate into the ground, though there is an overflow catch basin that conveys water to the 420 McPhee bioretention cell on the south side of the driveway.

BIORETENTION SOIL:

Thickness: 0.3-2.0 ft

The apparent thickness of loose bioretention soil based on probe data and hand augers ranged from 0.3-2.0 ft, with soil depth tapering out towards the edges of the cell. Average soil depth in the base of the cell was 1.2 ft, and side slopes had an average soil depth of 0.7 ft.

Composition:

Design plans call for engineered soil, the provided plans give instructions for compost amended soil for the landscape areas, but do not provide specifications on the referenced engineered soil. In comparison to the 2019 Ecology specifications, the tested soil did not meet the recommended guidelines for grain size distribution with an excess of fine gravels, as well as a higher percentage of fines passing the #200 sieve. The tested soil samples also had a higher percentage of organic matter and did not meet the 2019 Ecology specifications.

Organic Matter Content (% by weight): 11.5

Percent passing #200 sieve: 16.6

Coefficient of Uniformity (Cu): 43.5

Coefficient of Curvature (Cc): 0.5

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Loose, moist, grayish brown, very gravelly, medium SAND, trace silt, massive (SP-SM)

BUILT PER PLAN:

The compost amended soil was significantly thinner than called for in the design plans. The gravel placed under the porous sidewalk adjacent to the cell sloughs into the cell and the sidewalk is undercut by a few inches, as there is no soil there to hold the gravel in place, likely related to the soil depth being roughly 0.8 ft below what is specified in the design. Cracks in the concrete base of the catch basin allowed infiltration test water to seep in during the test. Water was observed ponding at the outfall, in what is the 436 McPhee bioretention cell, towards the end of the test. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

The temporary wellpoint we installed, screened 1.8-2.1 ft below ground surface, did not encounter groundwater. The wellpoint responded to infiltration testing with the shallowest depth to water during the test occurring above the ground surface.

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 9.3
Subgrade Soil Rate (in/hr): >9.3

The measured infiltration rate is interpreted to represent the bioretention soil due to the coarse texture of the underlying Vashon Recessional Outwash deposits.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Consider addressing:

- 1) Sloughing gravel and undercut sidewalk.
- 2) Cracks in the overflow catch basin.

Field Conditions

| | | | |
|-----------------|-------------------------|-------------------------|------------------|
| Weather | Partly Cloudy, 60's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Aaron Turnley | Half Day: Sarah Faubion | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 16 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



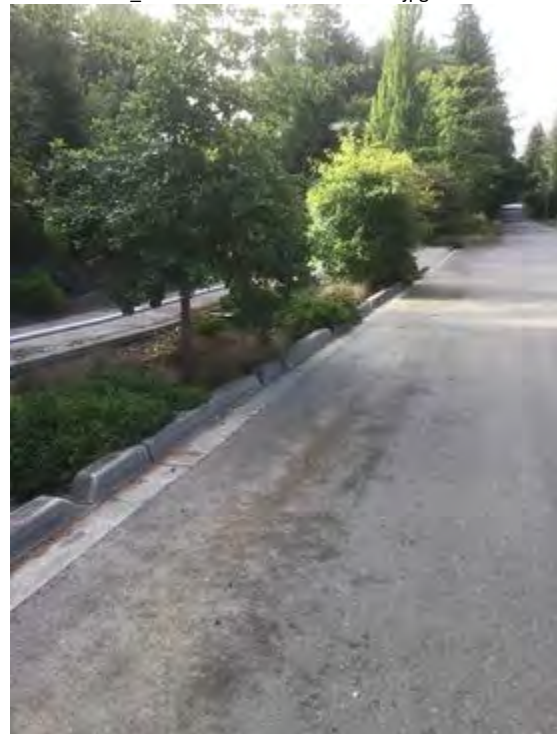
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Site Photo: FA_SitePhotos-20230920-164105.jpg



Site Photo: FA_SitePhotos-20230920-164056.jpg



Site Photo: FA_SitePhotos-20230920-164136.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
 Cell: Bioretention 1

Assessed On:
 September 20, 2023



Site Photo: FA_SitePhotos-20230920-164146.jpg



Site Photo: OutfallPonding.JPG

Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Cut off exposed flex tubing was observed, it is assumed that irrigation was present at some point, but is not operational at this time. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from the adjacent street by several curb cuts, with some small volumes via sheet flow from the adjacent porous concrete sidewalk. Water is designed to infiltrate through the bioretention soil before infiltrating into the existing native subgrade. There is a designed overflow catch basin that plans show leading to 12" concrete pipe that leads under driveway into what was labeled as a ditch at the time, but is now the bioretention cell at 436 McPhee. The catch basin concrete is cracked and ponded water seeps through before it reaches the designed overflow height. The culvert is now metal, changes were possibly made to the structure in the construction of the McPhee 436 bioretention facility. The sidewalk consists of porous pavement over clean crushed gravel, the plans state bioretention soil filled up to edge of sidewalk, at 1.5' thick. The sidewalk is currently undercut by a few inches and crushed gravel is exposed and spills into the cell. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-164531.jpg

Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023

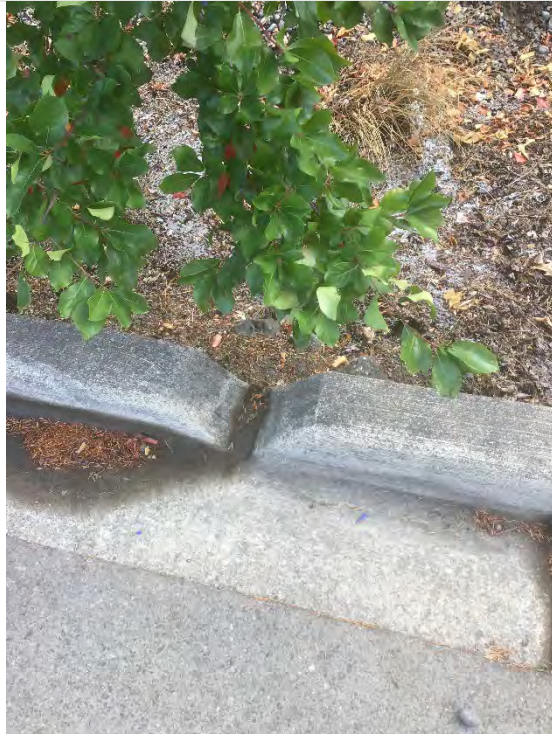


IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



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Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



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Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:

September 20, 2023



IN-4

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



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BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A thick deposition of pine needles partially block the inlet.



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Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023




| | |
|---|--|
| <p>IN-5</p> <p><input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 0.2'</p> <p>Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230920-164900.jpg</p> |
| <p>Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 5% blocked</p> <p>Types: <input type="checkbox"/> Sediment <input checked="" type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input type="checkbox"/> Vegetation</p> <p>Additional Details: A thin deposition of pine needles partially block the inlet.</p> |
| <p>Additional Details:</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



| | |
|---|---|
| <p>IN-6</p> <p><input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 0.2'</p> <p>Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230920-164943.jpg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked</p> <p>Types: <input type="checkbox"/> Sediment <input checked="" type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input type="checkbox"/> Vegetation</p> <p>Additional Details: A thin deposition of pine needles partially block the inlet.</p> |
| <p>Additional Details:</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-7

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165013.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:
 Sediment Organic Rock
 Trash Vegetation

Additional Details: A thin deposition of pine needles partially block the inlet.


Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



| | |
|---|---|
| <p>IN-8</p> |  |
| <p><input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 0.2'</p> <p>Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> | <p>FA_INphoto-20230920-165101.jpg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked</p> <p>Types: <input type="checkbox"/> Sediment <input checked="" type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input type="checkbox"/> Vegetation</p> <p>Additional Details: A thin deposition of pine needles partially block the inlet.</p> |
| <p>Additional Details:</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-9

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



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BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A dandelion and a thin deposition of pine needles partially block the inlet.



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Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-10

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165212.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

- Types:
- Sediment Organic Rock
 - Trash Vegetation

Additional Details: A thin deposition of pine needles partially block the inlet.

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-11

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165246.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A thin deposition of pine needles partially block the inlet.

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-12

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165312.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:
 Sediment Organic Rock
 Trash Vegetation

Additional Details: A thin deposition of pine needles partially block the inlet.

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-13

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



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BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A thick deposition of pine needles partially block the inlet.



FA_INBLPhoto-20230920-165347.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-14

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165424.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A thin deposition of pine needles partially block the inlet.

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-15

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Width: 0.2'

Energy Dissipation
Angular Rock: Buried
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165508.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: A thick deposition of pine needles, dried leaves and vegetation block the inlet.



FA_INBLPhoto-20230920-165503.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



IN-16

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 150'

Energy Dissipation
Angular Rock: Eroded
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230920-165629.jpg

Erosion Present? Yes No
Severity: Major
Sidewalk basecourse is severely undermined.
Additional Details:

Blockage Present? Yes No


BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2' Width: 2' |
| Additional Details: | |
| Stickup (ft) From Ground: Relative from staff gauge: | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Cracks in concrete allow test water to seep in during the test. Water was observed ponding at the outfall, in what is the 436 McPhee bioretention cell, towards the end of the test. | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| FA_DOPhoto-20230920-165712.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|---|--|--|-----------------------------------|--|------------------------------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Natural mulch of leaf litter covers much of cell with an average of 0.1' depth. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Additional Details: | | | | | |
| Vegetation Description The cell is moderately vegetated, covering about 60% of the cell. Vegetation on the south end limits access and visibility for the overflow features. | | | | | |
| Additional Details Geotech Probe Observations: At the cell base, probe measurements found 0.3-2.0' of bioretention soil, with an average of 1.2', before encountering the underlying subgrade. This is less than the 1.5' specified by the plans. On the cell edges, probe measurements found 0.2-1.3' of bioretention soil, with an average depth of 0.7', less than the 1.5't of soil specified in the plans. Although, each curb cut inlet has corresponding angular rock energy dispersion features that extend to the base of the cell and this greatly reduces the average probe measurements. | | | | | |

BIORETENTION CELL FIELD ASSESSMENT


Site: 420 McPhee (OL420)
 Cell: Bioretention 1

Assessed On:
 September 20, 2023



Side slopes were designed for a shallow slope from the top of the sidewalk, and road surface, to the base of the cell. Existing conditions consisted of a steep side slope and an undercut sidewalk with the underlying clean crushed rock exposed and eroding into the cell.

Hand Auger

| | | |
|---|---|--|
| HA-1 | |  <p>IMG_0626.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.1 | |
| to Native Soil: | 1.8 | |
| to Import/Underdrain: | | |
| Total Depth: | 2.1 | |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics (SM) Native Soil Texture: Vashon Recessional Outwash: Loose, moist, greyish brown, very gravelly, fine to medium SAND, some coarse sand, trace silt, massive. (SP) | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |

| | | |
|---|---|--|
| HA-3 | |  <p>IMG_0622.jpg</p> |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.5 | |
| to Native Soil: | 1.5 | |
| to Import/Underdrain: | | |
| Total Depth: | 1.8 | |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics (SM) Native Soil Texture: Vashon Recessional Outwash: Loose, moist, greyish brown, very gravelly, fine to medium SAND, some coarse sand, trace silt, massive. (SP) | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details | | |

| | |
|--|--|
| HA-2WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)
Cell: Bioretention 1

Assessed On:
September 20, 2023



| | |
|---|---|
| HA-2WP | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | |
| Total Depth: | 2.5 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics (SM) | |
| Native Soil Texture: Vashon Recessional Outwash: Loose, moist, greyish brown, very gravelly, fine to medium SAND, some coarse sand, trace silt, massive. (SP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
|  | |
| FA_FPhoto-20230920-170534.jpg | |
| Additional Details | |
| Shallowest depth to water during the test was above the ground surface. | |

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# 6 | |
| Wetted Pond Area (sq. ft) | 547 |
| Ponded Depth (ft) | 0.34 |
| Total Gallons | 27,735 |
| Steady State Flow Rate (GPM) | 53 |

BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Additional Details:

Turned flow down 4 hours into test as water was leaking into catch basin through cracks in the concrete wall. Water was observed in the outfall, on the south side of the driveway (436 McPhee) at 15:45. Additional test details provided in the executive summary



IT_Photo-20230920-170621.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

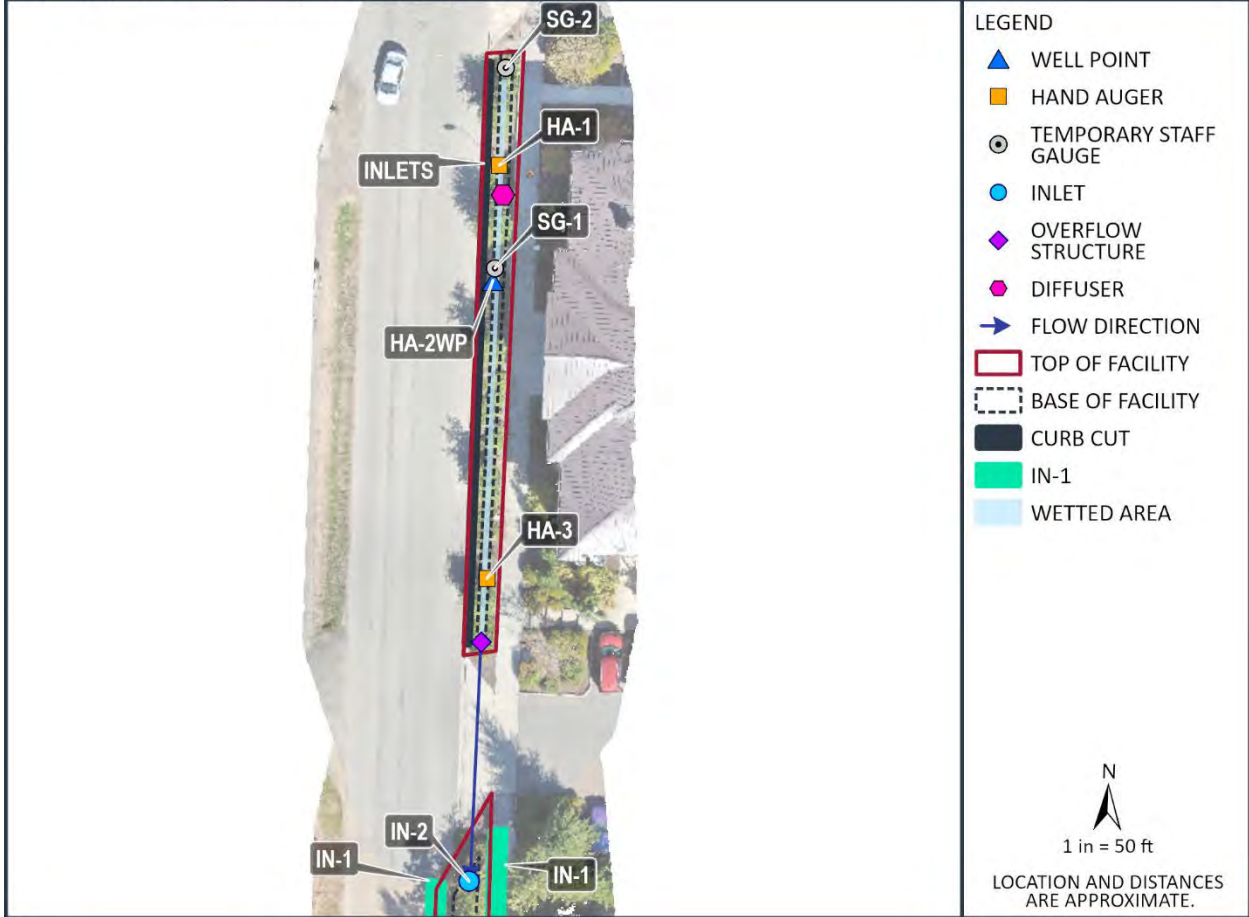
Site: 420 McPhee (OL420)

Cell: Bioretention 1

Assessed On:
September 20, 2023



SITE: 420 MCPHEE (OL420) CELL: BIORETENTION 1





associated
earth sciences
incorporated

Well Point

OL420-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/20/23

Logged By: ART

20150387H008

Ending Date: 9/20/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.7

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.0

Water Level Elevation (ft): N/A

Datum: Project Datum

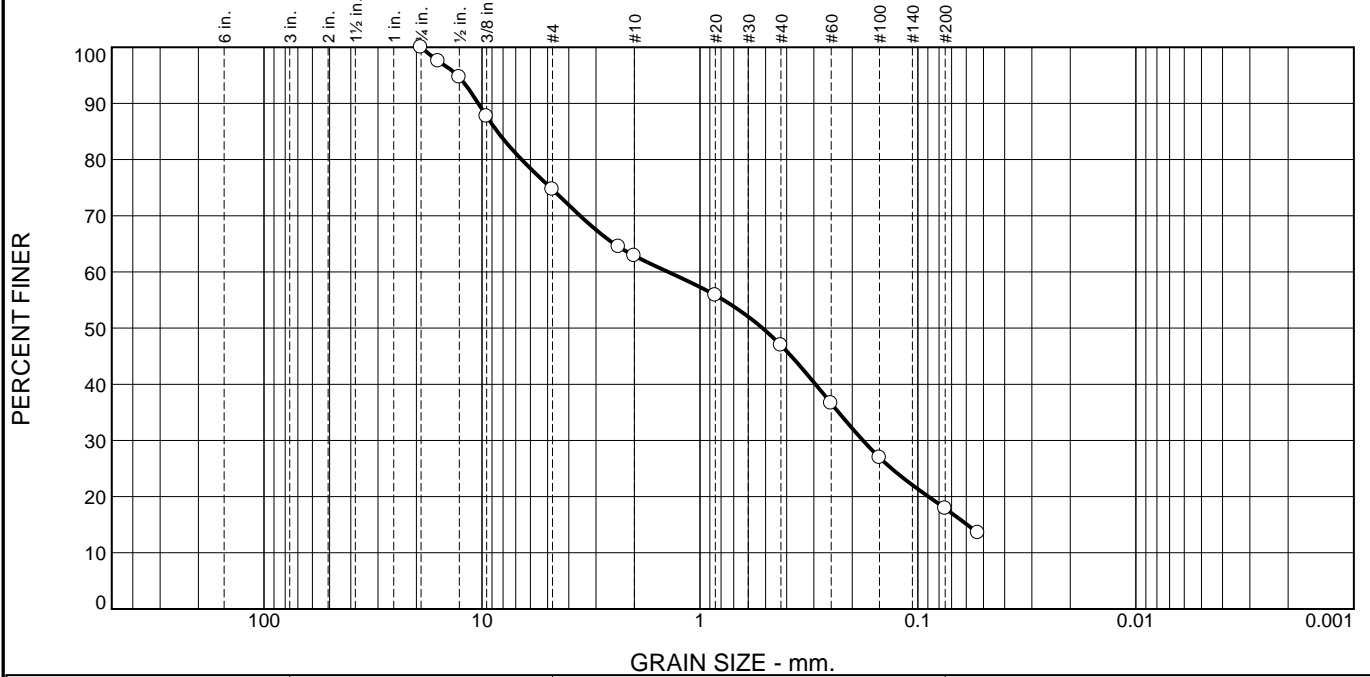
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | Mulch Leaf litter and heavily vegetated. | | | | | | | Stickup -5.0 to 0 feet Bioretention soil mix 0 to 1.3 feet 1.25-inch I.D. threaded galvanized steel casing -5.0 to -0.3 feet; duct tape covers screen -0.3 to 1.8 feet 3/8-inch bentonite chips 1.3 to 1.5 feet Medium grain silica sand 1.5 to 2.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.8 to 2.1 feet Cast iron endcap 2.1 to 2.4 feet Cast iron drivepoint 2.4 to 2.7 feet |
| 1 | | | | Bioretention Soil Mix Loose, moist, brown, gravelly, silty, fine to medium SAND, trace gravel; abundant organics (rootlets) (SP-SM). | | | | | | | |
| 2 | Hand | 2 | | Vashon Recessional Outwash Loose, moist, grayish brown, very gravelly, medium SAND, trace silt, massive (SP-SM). | | | | | | | |
| 3 | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 25.3 | 11.8 | 16.0 | 29.0 | 17.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 97.5 | | |
| 1/2" | 94.7 | | |
| 3/8" | 87.7 | | |
| #4 | 74.7 | | |
| #8 | 64.5 | | |
| #10 | 62.9 | | |
| #20 | 55.9 | | |
| #40 | 46.9 | | |
| #60 | 36.6 | | |
| #100 | 27.0 | | |
| #200 | 17.9 | | |
| #270 | 13.5 | | |

* (no specification provided)

Material Description

gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 10.4043 D₈₅= 8.5028 D₆₀= 1.4009
D₅₀= 0.5162 D₃₀= 0.1788 D₁₅= 0.0595
D₁₀= C_u= C_c=

Remarks

Date Received: 9-21-2023 Date Tested: 11-7-2023

Tested By: FEW

Checked By: ART/SNCF/JS

Title: _____

Location: Onsite - BHPS-OL420
Sample Number: OL420-HA-1

Depth: 0.1-0.8'

Date Sampled: 9-20-2023



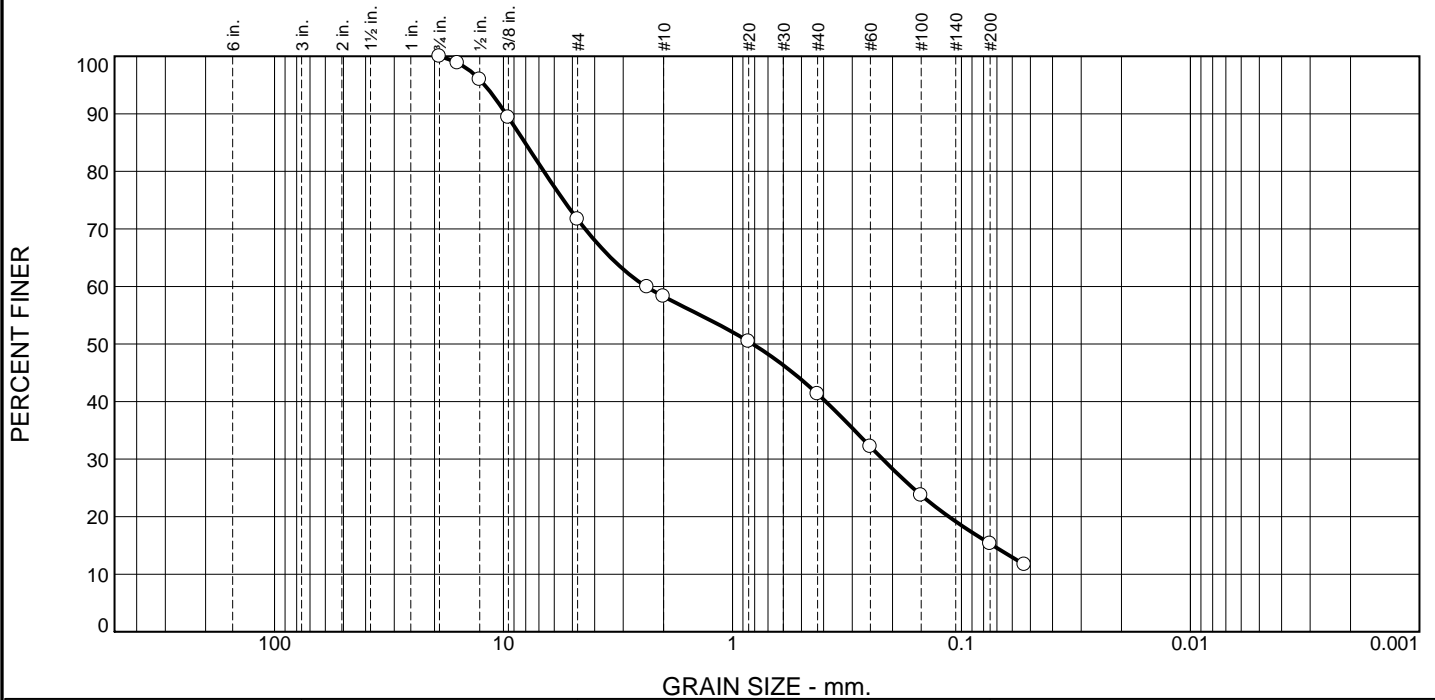
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 28.3 | 13.4 | 17.0 | 26.0 | 15.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 98.8 | | |
| 1/2" | 96.0 | | |
| 3/8" | 89.4 | | |
| #4 | 71.7 | | |
| #8 | 59.9 | | |
| #10 | 58.3 | | |
| #20 | 50.4 | | |
| #40 | 41.3 | | |
| #60 | 32.2 | | |
| #100 | 23.7 | | |
| #200 | 15.3 | | |
| #270 | 11.6 | | |

* (no specification provided)

Material Description

gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 9.7584 D₈₅= 8.0605 D₆₀= 2.3862
D₅₀= 0.8159 D₃₀= 0.2210 D₁₅= 0.0729
D₁₀= C_u= C_c=

Remarks

Date Received: 9-21-2023 Date Tested: 11-6-2023

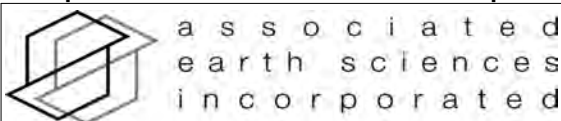
Tested By: FEW

Checked By: ART/SNCF/JS

Title: _____

Location: Onsite - BHPS-420 Mcphee Olympia
Sample Number: OL420-HA-2WP **Depth:** 0.1-1.0'

Date Sampled: 9-20-2023

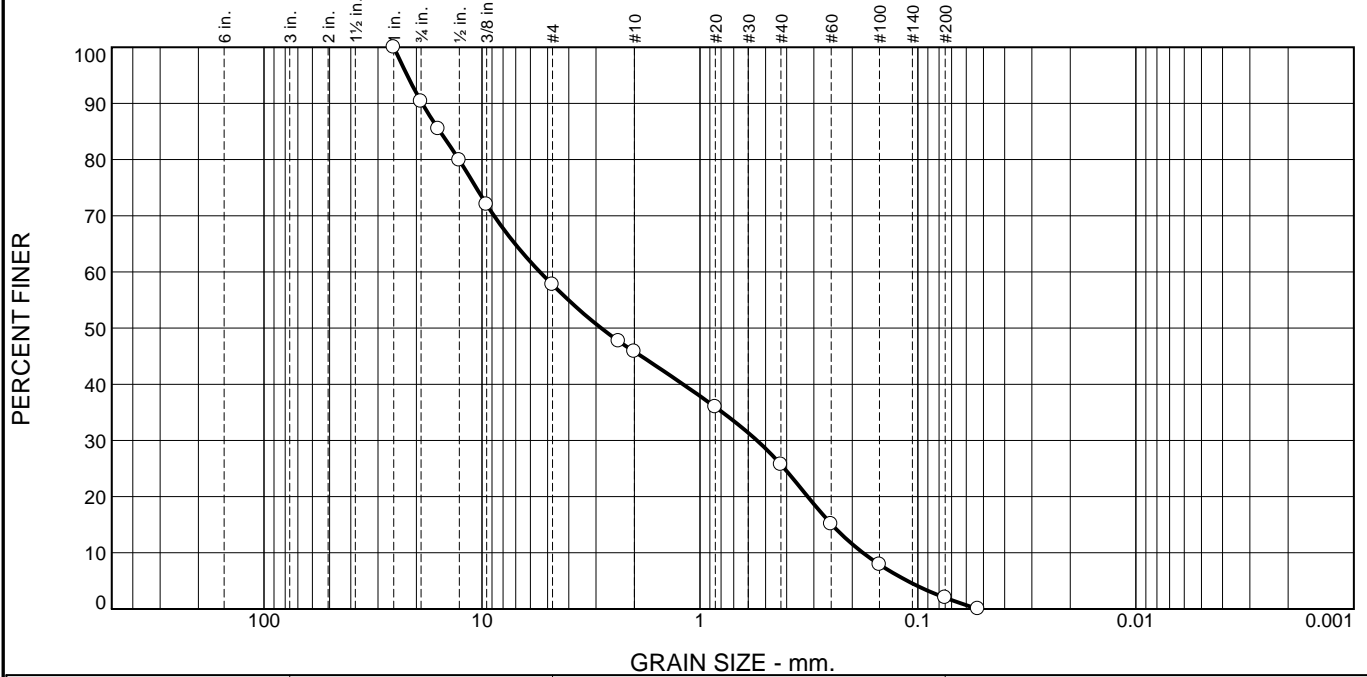


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 9.7 | 32.6 | 11.9 | 20.1 | 23.7 | 2.0 | 0.0 |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 90.3 | | |
| 5/8" | 85.5 | | |
| 1/2" | 79.9 | | |
| 3/8" | 72.0 | | |
| #4 | 57.7 | | |
| #8 | 47.7 | | |
| #10 | 45.8 | | |
| #20 | 35.9 | | |
| #40 | 25.7 | | |
| #60 | 15.1 | | |
| #100 | 7.9 | | |
| #200 | 2.0 | | |
| #270 | 0.0 | | |

Material Description
very gravelly SAND trace silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SP AASHTO (M 145)= A-1-a

Coefficients
 D₉₀= 18.8246 D₈₅= 15.5744 D₆₀= 5.4258
 D₅₀= 2.8396 D₃₀= 0.5476 D₁₅= 0.2482
 D₁₀= 0.1787 C_u= 30.37 C_c= 0.31

Remarks

Date Received: 9-21-2023 Date Tested: 10-26-2023

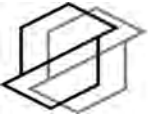
Tested By: FEW

Checked By: ART/SNCF/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-McPhee420 Date Sampled: 9-20-2023
 Sample Number: HA-2WP Depth: 1.5-2.0'

| | | |
|---|---|--------|
|  | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 | Figure |
|---|---|--------|



| | | | | |
|----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/20/2023 | Project BHPS-OL420 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Olympia, Wa. | EB/EP No. OL420-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.1-0.8' | HA-2WP @ 0.1-1' |
|--------------------|-----------------|-----------------|
| Wet Weight + Pan | 509.4 | 840.0 |
| Dry Weight + Pan | 486.2 | 773.3 |
| Weight of Pan | 258.2 | 247.6 |
| Weight of Moisture | 23.2 | 66.7 |
| Dry Weight of Soil | 227.9 | 525.7 |
| % Moisture | 10.2 | 12.7 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 486.2 | 773.3 |
| Dry Soil After Burn + Pan | 460.1 | 712.8 |
| Weight of Pan | 258.2 | 247.6 |
| Wt. Loss Due to Ignition | 26.0 | 60.5 |
| Actual Wt. Of Soil After Burn | 201.9 | 465.2 |
| % Organics | 11.4 | 11.5 |

ASSOCIATED EARTH SCIENCES, INC

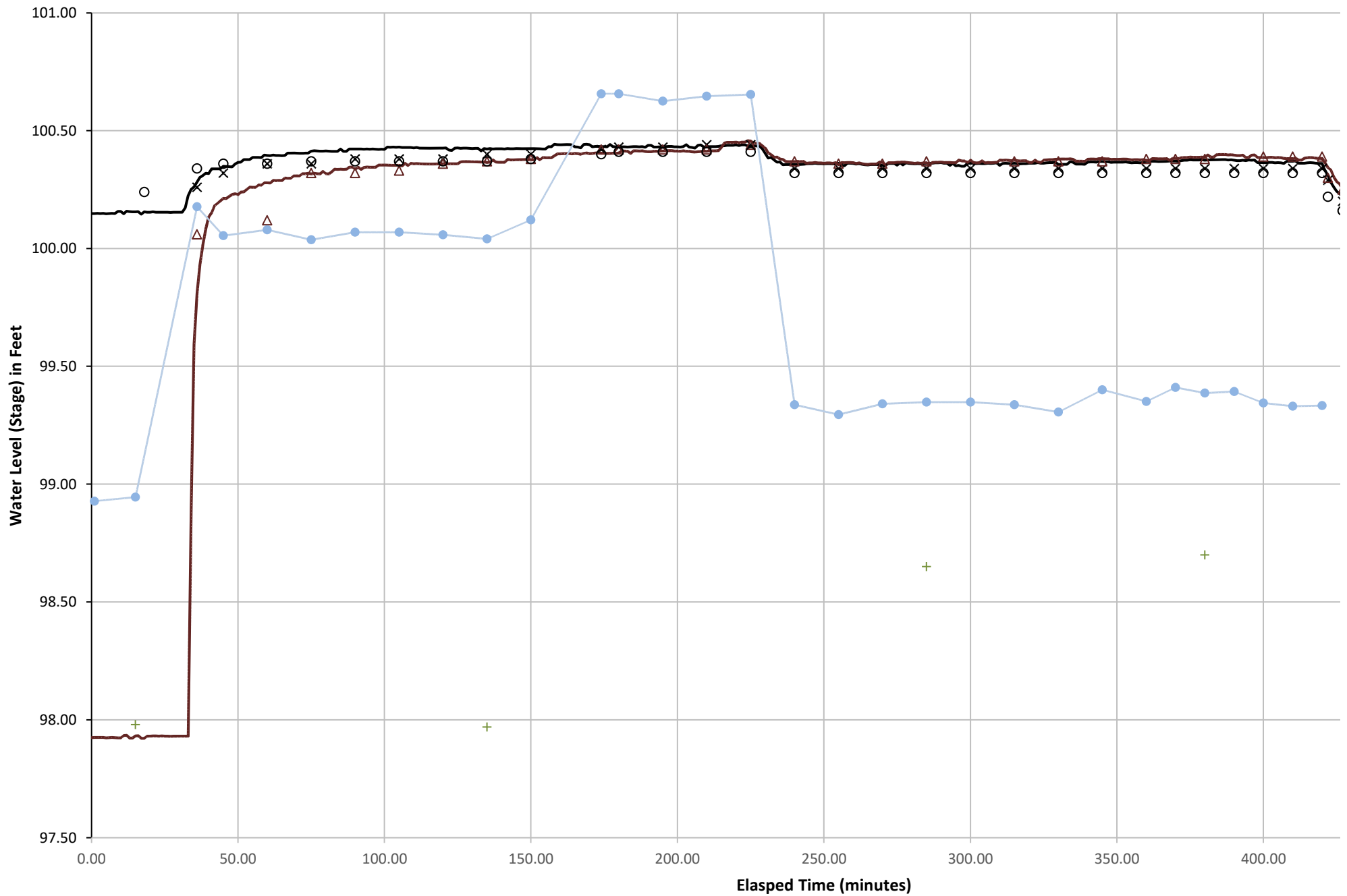
911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--------------|--------------------------------|--|
| Project Name: | 420 McPhee | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 9/20/2023 | Wetted Area (sq. feet): | 10:30 315 ft^2 / 13:30 490 ft^2 / 15:55 547 ft^2 |
| Weather: | Clear | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.44 |
| Performed By: | ART/SNCF | Receptor Soils: | Qvr |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | CB-1 | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|------|----------------------|---------------------|---|
| 9:15 | | | | | | | Water on |
| 9:16 | 40.8 | | | | | | |
| 9:30 | 41.29 | | | 2.02 | | 609 | Increase flow to 76 gpm |
| 9:33 | | | 0.14 | | | | |
| 9:51 | 76.5 | 0.26 | 0.24 | | 5.14 | 2,272 | |
| 10:00 | 73 | 0.32 | 0.26 | | | 2,890 | |
| 10:15 | 73.7 | 0.36 | 0.26 | | 5.08 | 3,996 | |
| 10:30 | 72.5 | 0.36 | 0.27 | | 4.88 | 5,103 | Ponded area = 315 sqft |
| 10:45 | 73.4 | 0.38 | 0.27 | | 4.88 | 6,205 | |
| 11:00 | 73.4 | 0.38 | 0.27 | | 4.87 | 7,311 | |
| 11:15 | 73.1 | 0.38 | 0.27 | | 4.84 | 8,475 | |
| 11:30 | 72.6 | 0.4 | 0.27 | 2.03 | 4.83 | 9,517 | |
| 11:45 | 74.9 | 0.4 | 0.28 | | 4.82 | 10,608 | |
| 11:50 | | | | | | | Increase flow to 90 gpm |
| 12:09 | 90.2 | 0.42 | 0.3 | | 4.78 | 12,685 | |
| 12:15 | 90.2 | 0.43 | 0.31 | | 4.78 | 13,232 | |
| 12:30 | 89.3 | 0.43 | 0.31 | | 4.78 | 14,543 | |
| 12:45 | 89.9 | 0.44 | 0.31 | | 4.78 | 15,902 | Ponded area = 490 sqft |
| 13:00 | 90.1 | 0.44 | 0.31 | | 4.76 | 17,256 | Decrease flow |
| 13:15 | 52.5 | 0.34 | 0.22 | | 4.83 | 18,157 | |
| 13:30 | 51.3 | 0.34 | 0.22 | | 4.84 | 18,929 | |
| 13:45 | 52.6 | 0.34 | 0.22 | | 4.84 | 19,768 | |
| 14:00 | 52.8 | 0.34 | 0.22 | 1.35 | 4.83 | 20,557 | Staff change likely resulted in change of CB monitoring location. |
| 14:15 | 52.8 | 0.34 | 0.22 | | | 21,350 | |
| 14:30 | 52.5 | 0.34 | 0.22 | | 4.83 | 22,103 | |
| 14:45 | 51.6 | 0.34 | 0.22 | | 4.83 | 22,919 | |
| 15:00 | 54.3 | 0.34 | 0.22 | | 4.83 | 23,779 | |
| 15:15 | 52.9 | 0.34 | 0.22 | | 4.82 | 24,550 | |
| 15:25 | 54.6 | 0.34 | 0.22 | | 4.82 | 25,083 | |
| 15:35 | 53.9 | 0.34 | 0.22 | 1.3 | 4.82 | 25,597 | |
| 15:45 | 54.1 | 0.34 | 0.22 | | | 26,193 | |
| 15:55 | 52.7 | 0.34 | 0.22 | | 4.81 | 26,735 | Ponded area = 547.5 sqft |
| 16:05 | 52.3 | 0.34 | 0.22 | | 4.81 | 27,217 | |
| 16:15 | 52.4 | 0.34 | 0.22 | | 4.81 | 27,735 | Water Off |
| 16:17 | | 0.29 | 0.12 | | 4.9 | | |
| 16:22 | | 0.2 | 0.06 | | 4.95 | | |
| 16:26 | | 0.17 | 0 | | 5 | | |
| 16:31 | | 0.14 | | | 5.02 | | |
| 16:37 | | 0.13 | | | 5.02 | | |
| 16:41 | | 0.11 | | | 5.04 | | |
| 16:47 | | 0.08 | | | 5.05 | | |
| 16:55 | | 0.06 | | | 5.05 | | |
| 17:03 | | 0 | | | 5.08 | | End of test |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 9.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 5.0 |
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 9.3 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 16.5 |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 9.5 |
| WP Average Infiltration Rate (in/hr) during falling head: | 4.1 |

420 McPhee Infiltration Test
Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)
Cell: Bioretention 1

Assessed On:
September 21, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This tested bioretention cell was constructed in 2005 and designed to collect water from McPhee road and the adjacent sidewalk. Water enters the cell through sheet flow and through an inlet pipe that conveys overflow water from an upgradient bioretention cell to the north. Additionally, the cell features a 1 ft diameter culvert beneath the southern driveway with equalizing ponds on either side. The cell designs state a minimum of 2 ft compost amended soil above native soils. All water is designed to infiltrate into the ground and there is no emergency overflow bypass.

BIORETENTION SOIL:

Thickness: 0.2-1.3 ft

The apparent thickness of amended soil based on probe data and hand augers ranged from 0.2-1.3 ft below the ground surface. The whole cell appears to have been compacted based on probe depths. Compost amended soil instructions on the design plans instruct to amend native soils in place through tilling in new material and then lightly compacting the soil.

Composition:

Design plans provide methods for amending native soil with compost, siting the compost is to meet the specifications of the Department of Ecology Interim Guidelines for Compost Quality, #94-38. Designs instruct adding compost to the tilled soil at a 2:1 ratio (loose soil to loose compost). Then to harrow or rake, and lightly compact the amended soil to 2" below finished grade. In comparison to the 2019 Ecology specifications, the tested soil did not meet the recommended guidelines for grain size distribution with an excess of fine and coarse gravels, as well as a higher percentage of fines passing the #200 sieve. The tested soil samples also had a higher percentage of organic matter and did not meet the 2019 Ecology specifications.

Organic Matter Content (% by weight): 10.2

Percent passing #200 sieve: 13.0

Coefficient of Uniformity (Cu): 91.3

Coefficient of Curvature (Cc): 0.4

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Medium dense, slightly moist, light tan, gravelly, silty, fine to medium, SAND (SM)

With a layer (~1 in thick) of orange oxidation.

BUILT PER PLAN:

The compost amended soil was significantly thinner than called for in the design plans, and compacted. The gravel placed under the porous sidewalk adjacent to the cell sloughs into the cell and the sidewalk is undercut by a few inches, as there is no amended soil there to hold the gravel in place, likely related to the soil depth being roughly 1 ft below specified in the design. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

The temporary wellpoint we installed, screened 2.8-3.3 ft below ground surface, did not encounter

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)
Cell: Bioretention 1

Assessed On:
September 21, 2023



groundwater. The wellpoint responded to infiltration testing with the minimum measured water level below the ground surface as 1.57 ft.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 9.6
Subgrade Soil Rate (in/hr): >9.6

A vertical gradient during the final hour of testing was observed between the water levels ponded on the surface and the subsurface water level in the wellpoint implying that the control on infiltration was the bioretention soil.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Consider addressing:

- 1) Sloughing gravel and undercut sidewalk.
- 2) The compaction of the amended soil in the cell.

Field Conditions

| | | | |
|-----------------|-------------------------|-------------------------|------------------|
| Weather | Clear, 60's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Aaron Turnley | Half Day: Sarah Faubion | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 4 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

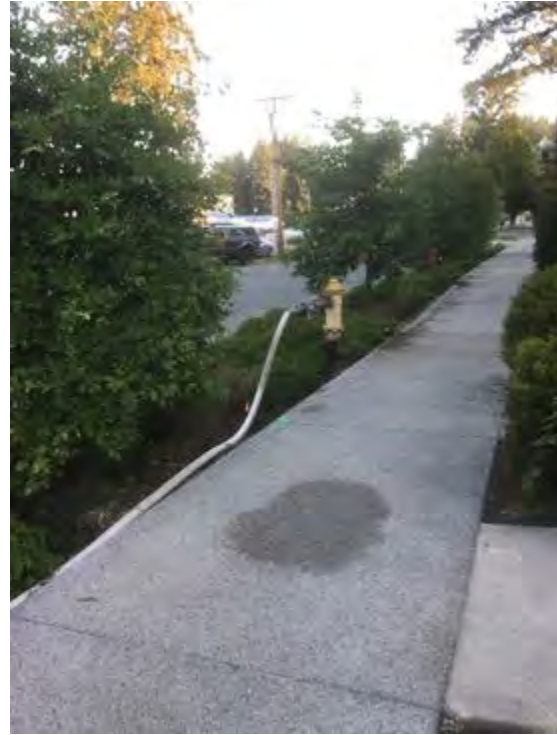
Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023



Site Photo: FA_SitePhotos-20230921-143426.jpg



Site Photo: FA_SitePhotos-20230921-143443.jpg



Site Photo: FA_SitePhotos-20230921-143520.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023



Site Photo: FA_SitePhotos-20230921-143533.jpg



Site Photo: FA_SitePhotos-20230921-143601.jpg



Site Photo: FA_SitePhotos-20230921-143548.jpg



Site Photo: FA_SitePhotos-20230921-143622.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)
Cell: Bioretention 1

Assessed On:
September 21, 2023



Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation sprinklers were observed east of the sidewalk along building, outside of the cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from the adjacent sidewalk to the east and roadway to the west via sheet flow, water also enters the cell through the outfall pipe from the 420 McPhee bioretention cell's overflow catch basin. A 12" culvert connects two ends of the cell under the driveway, either end of the culvert has equalizing ponds. Water is designed to infiltrate through the bioretention soil before infiltrating into the underlying substrate. Soil for cell is "compost amended soil" and has a higher gravel content than typically observed in bioretention soil mix. The porous pavement of the sidewalk potentially encouraged erosion of the adjacent bioretention soil as water will infiltrate through the porous pavement, through the washed gravels, meet the compacted subgrade, then laterally flow towards the bioretention cell, eroding the soil. With no soil to contain the washed gravels, they slough off into the bioretention cell and undercut the sidewalk. | |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023

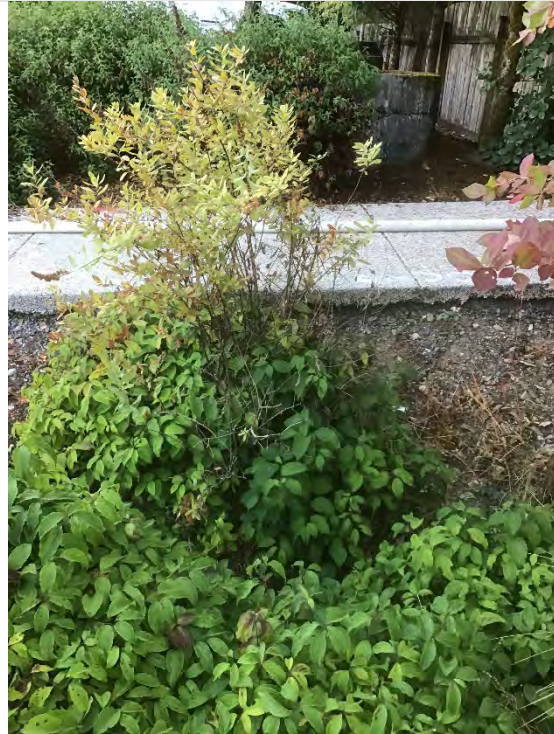


IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 218'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230921-143917.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023



Erosion Present? Yes No

Severity: Major

The porous pavement sidewalk on the east side of the cell is undermined and the underlain gravel are eroding into the cell.

Blockage Present? Yes No

Approximately 75% blocked

Types:

Sediment Organic Rock

Trash Vegetation

Additional Details: Vegetation blockage on street side of cell.



FA_INBLPhoto-20230921-143929.jpg


Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)
 Cell: Bioretention 1

Assessed On:
 September 21, 2023



| | |
|--|--|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: |  <p>OutfallPonding.JPG</p> |
| Pipe: Material <input type="checkbox"/> PVC <input checked="" type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 1' | |
| Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: No energy dissipation feature was observed. Photograph of the outfall is from the test the day before on 420 McPhee. | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|--|---|--------------------------------|--|--|------------------------------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Natural mulch of leaf litter covers much of the cell where shrubs are not present. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Additional Details: | | | | | |
| Vegetation Description Vegetation is woody and dense, this limits ability to navigate the cell for digging and observing ponded area. | | | | | |
| Additional Details Geotech Probe Observations: At the cell base, probe measurements found 0.2-1.3' of compost amended soil, with an average of 0.6', before encountering the underlying substrate. This is less than the 2' minimum depth specified by the plans. On the cell edges, less than 0.5 feet of soil was encountered above native soils. This is inconsistent with the cell design which shows a 2:1 slope with a minimum of 2 feet of soil above the existing subgrade. The whole cell appears to have been compacted based on probe depths. Compost amended soil | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)


Cell: Bioretention 1

Assessed On:
September 21, 2023



instructions on plans state amending native soils in place through tilling and lightly compacting the soil. Some areas of the cell could not be probed due to thick, woody vegetation.

Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, sandy GRAVEL, trace silt, abundant organics (GP) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| IMG_0628.jpg | |
| Additional Details | |

| | |
|--|---|
| HA-2WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 3.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, very gravelly, silty, fine to medium SAND, some coarse sand, abundant organics (SM) | |
| Native Soil Texture: Medium dense, slightly moist, light tan, gravelly, silty, fine to medium SAND, some coarse sand (SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)
Cell: Bioretention 1

Assessed On:
September 21, 2023



HA-2WP

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft): 1.57



IMG_0631.jpg



IMG_0632.jpg

Additional Details

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)
Cell: Bioretention 1

Assessed On:
September 21, 2023



| | |
|--|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 1.2 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, very gravelly, silty, fine to medium SAND, some coarse sand, abundant organics (SM) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |



IMG_0634.jpg

| | |
|---|---|
| HA-4 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, wet, dark brown, very sandy GRAVEL, some silt, abundant organics (GP-GM) | |
| Native Soil Texture: Medium dense, slightly moist, light tan, gravelly, silty, fine to medium SAND, some coarse sand (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |
| Sample taken after the infiltration test from the southern section of cell, south of connecting culvert in the equalization pond. No picture taken. | |

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 | |
| Wetted Pond Area (sq. ft) | 245 |
| Ponded Depth (ft) | 0.6 |
| Total Gallons | 14,403 |

BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023



| | |
|---|----|
| Steady State Flow Rate (GPM) | 25 |
| Additional Details: Additional test details can be found in the executive summary. | |



IT_Photo-20230921-144229.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

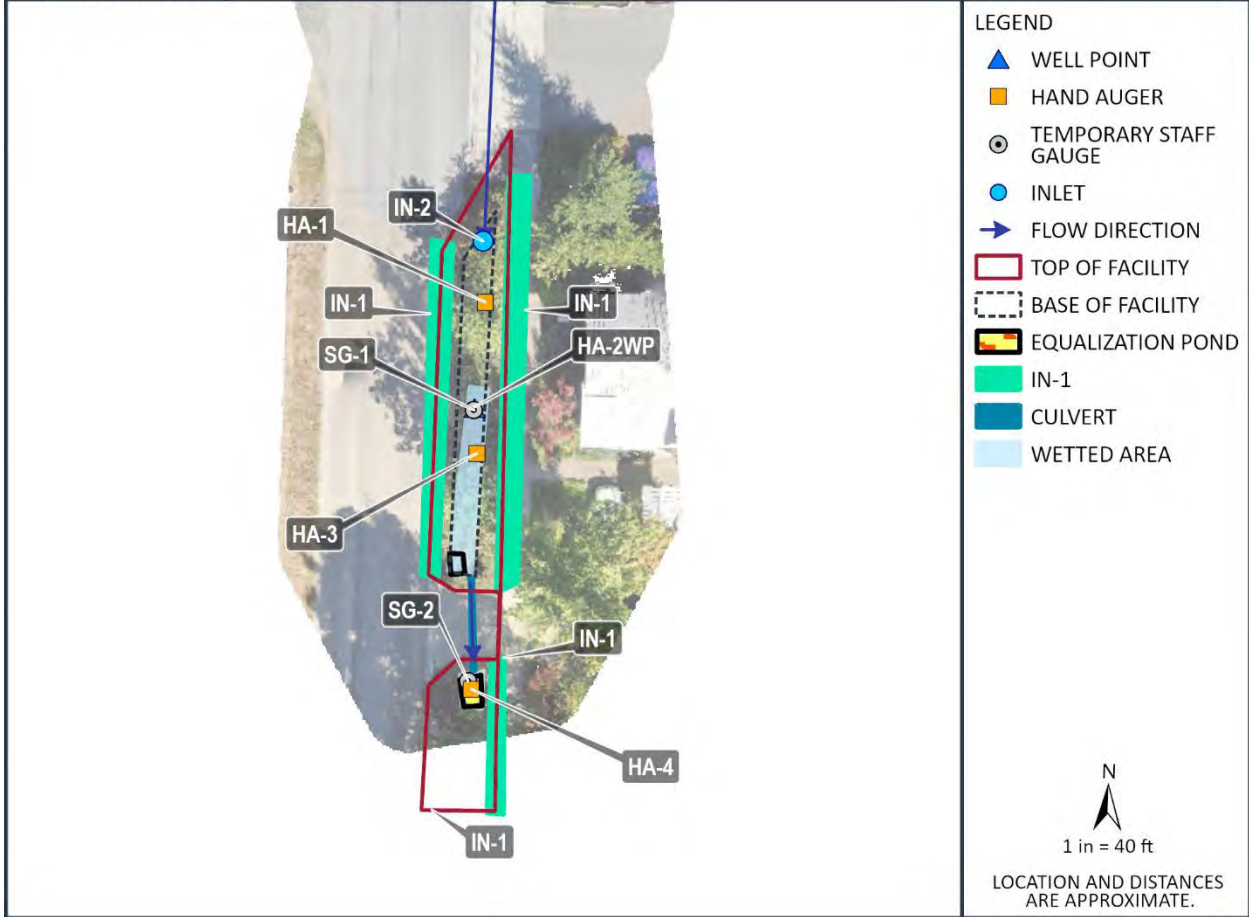
Site: 436 McPhee (OL436)

Cell: Bioretention 1

Assessed On:
September 21, 2023



SITE: 436 MCPHEE (OL436) CELL: BIORETENTION 1





associated
earth sciences
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Well Point

OL436-HA-2-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/20/23

Logged By: SNCF

20150387H008

Ending Date: 9/20/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 3.4

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.6

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 102.5

Water Level Elevation (ft): N/A

Datum: Project Datum

∇ Groundwater Depth ATD (ft): N/A

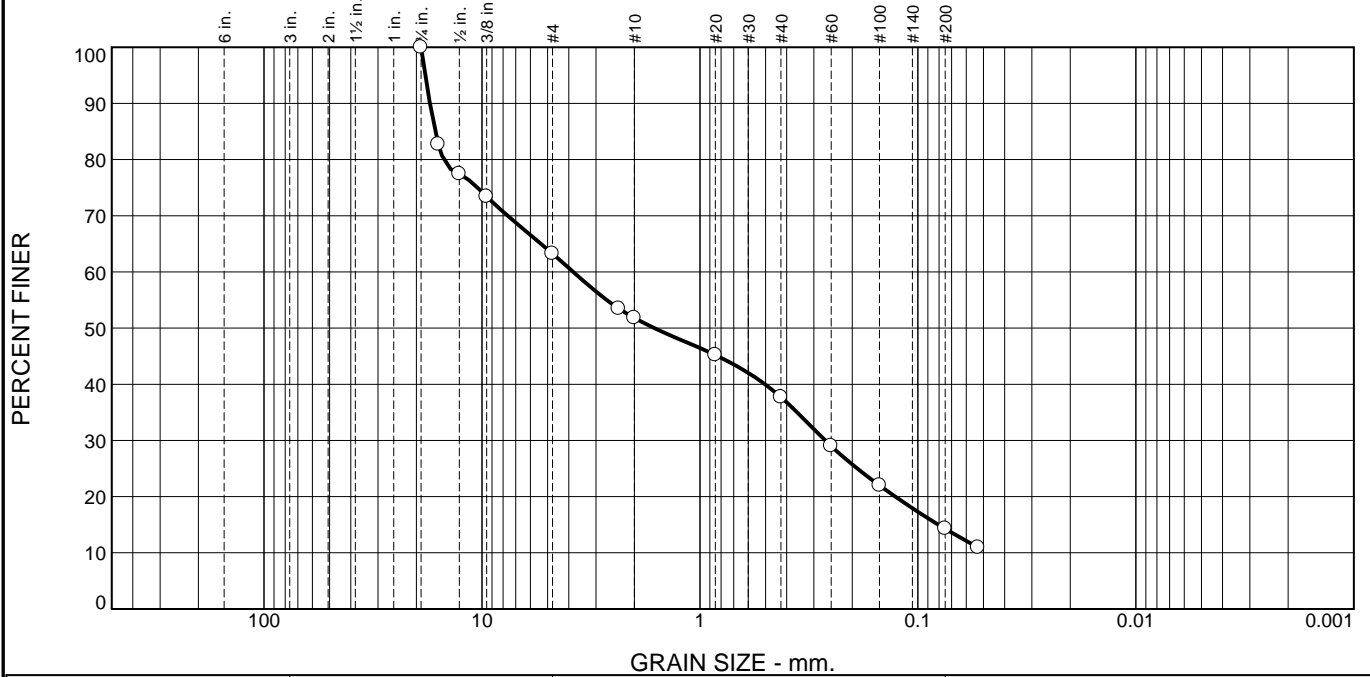
∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Natural Mulch Natural mulch (dry leaves and grasses). | | | | | | | Stickup -2.5 to 0 feet Existing bioretention soil 0 to 1.4 feet 1.25-inch I.D. threaded galvanized steel casing -2.5 to 0.8 feet; duct tape covers screen 0.8 to 2.8 feet 3/8-inch bentonite chips 1.4 to 1.7 feet Existing native soils 1.7 to 2.5 feet Medium grain silica sand 2.5 to 3.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel Cast iron endcap 3.3 to 3.6 feet Cast iron drivepoint 3.6 to 3.9 feet |
| | Hand | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, very gravelly, silty, fine to medium SAND; abundant organics (SM). | | | | | | | |
| | Hand | 2 | | | | | | | | | |
| 1 | Hand | 3 | | Becomes silty; trace organics. | | | | | | | |
| | Hand | 4 | | Vashon Recessional Outwash Medium dense, slightly moist, light tan, gravelly, silty, fine to medium SAND (SM). Layer (≈1 inch thick) of orange oxidation at 1.7 feet. | | | | | | | |
| 2 | Hand | 5 | | | | | | | | | |
| | Hand | 6 | | Becomes gray; very gravelly. | | | | | | | |
| 3 | Hand | 7 | | No seepage. Moderate caving 0 to 1.4 feet. Refusal at gravel. Located at base of cell. | | | | | | | |
| 4 | | | | Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/13/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 36.7 | 11.5 | 14.1 | 23.4 | 14.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 82.7 | | |
| 1/2" | 77.5 | | |
| 3/8" | 73.4 | | |
| #4 | 63.3 | | |
| #8 | 53.5 | | |
| #10 | 51.8 | | |
| #20 | 45.2 | | |
| #40 | 37.7 | | |
| #60 | 29.0 | | |
| #100 | 22.0 | | |
| #200 | 14.3 | | |
| #270 | 11.0 | | |

* (no specification provided)

Material Description

very gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 17.3484 D₈₅= 16.3978 D₆₀= 3.8143
D₅₀= 1.6193 D₃₀= 0.2660 D₁₅= 0.0805
D₁₀= C_u= C_c=

Remarks

Date Received: 9-21-2023 Date Tested: 11-8-2023

Tested By: FEW

Checked By: ART/NCF/JS

Title: _____

Location: Onsite - Olympia436
Sample Number: OL436-HA-2WP

Depth: 0.2-0.5'

Date Sampled: 9-20-2023



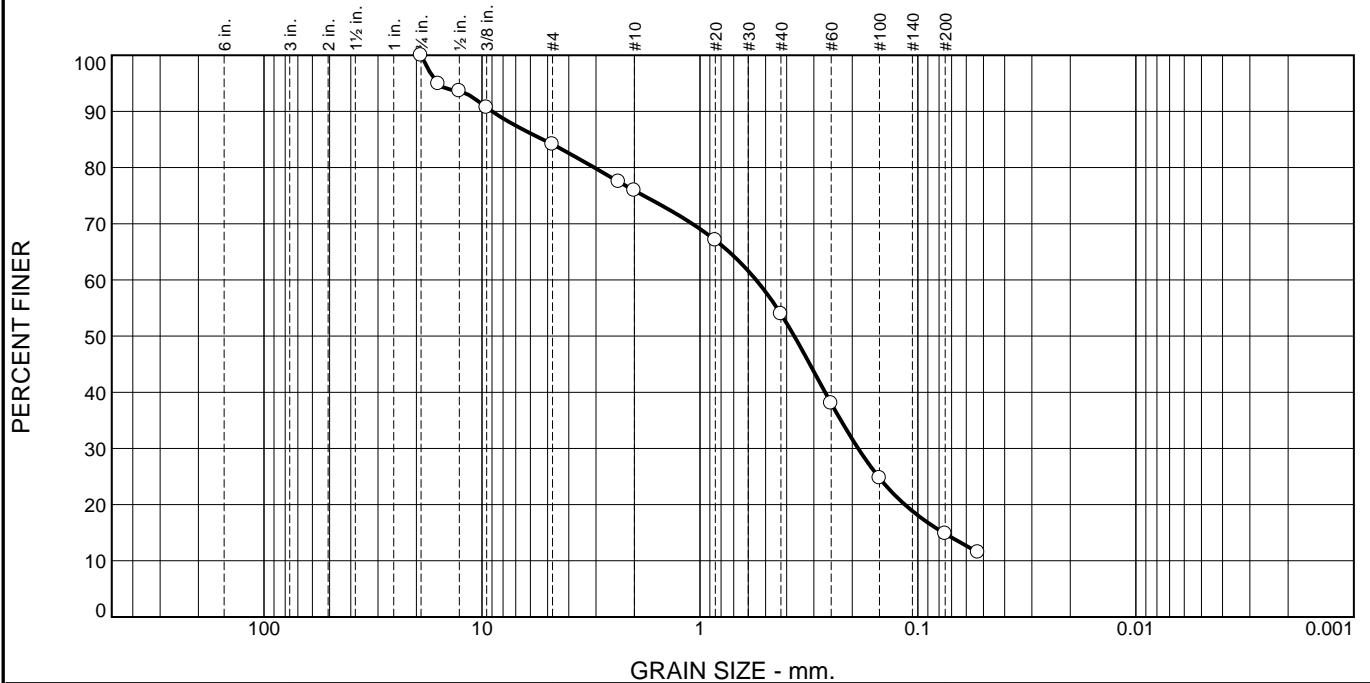
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 15.9 | 8.2 | 22.0 | 39.1 | 14.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 94.9 | | |
| 1/2" | 93.6 | | |
| 3/8" | 90.7 | | |
| #4 | 84.1 | | |
| #8 | 77.5 | | |
| #10 | 75.9 | | |
| #20 | 67.1 | | |
| #40 | 53.9 | | |
| #60 | 38.0 | | |
| #100 | 24.7 | | |
| #200 | 14.8 | | |
| #270 | 11.5 | | |

* (no specification provided)

Material Description

gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 8.9813 D₈₅= 5.2556 D₆₀= 0.5524
D₅₀= 0.3692 D₃₀= 0.1880 D₁₅= 0.0763
D₁₀= C_u= C_c=

Remarks

Date Received: 9-21-2023 Date Tested: 11-16-2023

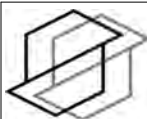
Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - Olympia 436 Mcphee
Sample Number: HA-2 **Depth:** 1.4-2.5'

Date Sampled: 9-20-2023



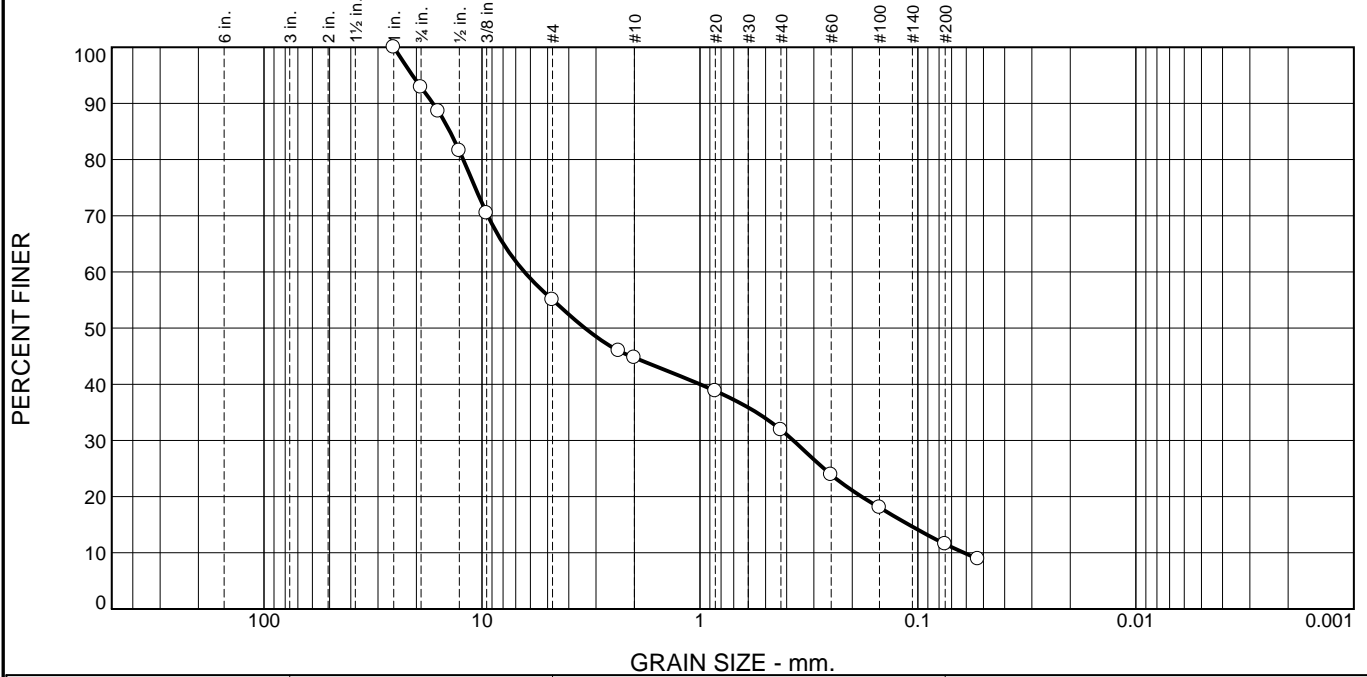
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 7.1 | 37.9 | 10.3 | 12.8 | 20.3 | 11.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 92.9 | | |
| 5/8" | 88.6 | | |
| 1/2" | 81.6 | | |
| 3/8" | 70.5 | | |
| #4 | 55.0 | | |
| #8 | 46.0 | | |
| #10 | 44.7 | | |
| #20 | 38.8 | | |
| #40 | 31.9 | | |
| #60 | 23.9 | | |
| #100 | 18.1 | | |
| #200 | 11.6 | | |
| #270 | 8.9 | | |

Material Description
very sandy GRAVEL some silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI= NP

Classification
 USCS (D 2487)= GP-GM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 16.7906 D₈₅= 14.0237 D₆₀= 6.3919
 D₅₀= 3.3697 D₃₀= 0.3731 D₁₅= 0.1100
 D₁₀= 0.0615 C_u= 103.98 C_c= 0.35

Remarks

Date Received: 9-21-2023 Date Tested: 11-6-2023

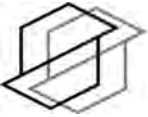
Tested By: FEW

Checked By: ART/SNCF

Title: _____

* (no specification provided)

Location: Onsite - BHPS-436 Mcphee Olympia Date Sampled: 9-21-2023
 Sample Number: OL436-HA-4 Depth: 0-0.5'

| | | |
|---|---|----------------------|
|  | <p>Client: City of Olympia</p> <p>Project: Bioretention Hydrologic Performance Monitoring Study</p> <p>Project No: 20150387 H008</p> | <p>Figure</p> |
|---|---|----------------------|



| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/20/2023 | Project BHPS-Olympia436 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Olympia, Wa. | EB/EP No. OL436-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2WP @ 0.2-0.5' | HA-4 @ 0-0.5' |
|--------------------|-------------------|---------------|
| Wet Weight + Pan | 525.8 | 1111.2 |
| Dry Weight + Pan | 496.7 | 819.6 |
| Weight of Pan | 255.3 | 247.1 |
| Weight of Moisture | 29.1 | 291.5 |
| Dry Weight of Soil | 241.4 | 572.5 |
| % Moisture | 12.1 | 50.9 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 496.7 | 819.6 |
| Dry Soil After Burn + Pan | 471.1 | 763.5 |
| Weight of Pan | 255.3 | 247.1 |
| Wt. Loss Due to Ignition | 25.6 | 56.1 |
| Actual Wt. Of Soil After Burn | 215.8 | 516.4 |
| % Organics | 10.6 | 9.8 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------|--------------------------------|-----------------------------------|
| Project Name: | 436 McPhee | Water Source: | Hydrant |
| Project Number: | 20150387 H008 | Meter: | FM-6 (10-100) |
| Date: | 9/21/2023 | Wetted Area (sq. feet): | 09:45: 245 ft^2 / 11:15: 245 ft^2 |
| Weather: | Clear | Underdrain | No |
| Test No.: | IT-2 | Test Depth (feet): | 0.6 |
| Performed By: | ART | Receptor Soils: | Vashon Recessional Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | CB-1 | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|------|----------------------|---------------------|-------------------------------------|
| 7:15 | 44.63 | | | 2.01 | | | Water on |
| 7:30 | 44.81 | 0.06 | 0 | | | 654 | |
| 7:45 | 40.74 | 0.08 | | | | 1,295 | |
| 8:00 | 41.23 | 0.13 | | | | 1,915 | Increase flow |
| 8:15 | 69.88 | 0.16 | | | | 2,960 | |
| 8:30 | 70.44 | 0.16 | | | 4.71 | 3,992 | |
| 8:36 | | | 0.7 | | | | SG-2 moved South |
| 8:38 | 70.84 | | | | | 4,609 | Decrease flow; moved diffuser North |
| 8:45 | 41.23 | 0.12 | 0.63 | | 4.43 | 4,897 | |
| 9:00 | 41.4 | 0.16 | 0.52 | | 4.29 | 5,505 | |
| 9:15 | 41.68 | 0.16 | 0.56 | | 4.19 | 6,110 | |
| 9:30 | 41.34 | 0.16 | 0.6 | | 4.14 | 6,733 | Decrease flow |
| 9:45 | 30.74 | 0.14 | 0.59 | | 4.09 | 7,225 | |
| 10:00 | 30.54 | 0.14 | 0.58 | | 4.02 | 7,685 | |
| 10:15 | 30.71 | 0.14 | 0.58 | | 3.99 | 8,146 | |
| 10:30 | 30.51 | 0.14 | 0.58 | | 3.95 | 8,611 | |
| 10:45 | 30.73 | 0.14 | 0.58 | | 3.92 | 9,061 | |
| 11:00 | 31.76 | 0.15 | 0.6 | | 3.9 | 9,534 | Decrease flow |
| 11:15 | 25.54 | 0.13 | 0.59 | | 3.9 | 9,958 | |
| 11:45 | 25.16 | 0.13 | 0.58 | | 3.9 | 10,683 | |
| 12:00 | 25.51 | 0.13 | 0.58 | | 3.9 | 11,079 | |
| 12:15 | 25.32 | 0.13 | 0.58 | | 3.9 | 11,462 | |
| 12:30 | 25.14 | 0.14 | 0.57 | | 3.89 | 11,826 | |
| 12:45 | 25.04 | 0.13 | 0.57 | | 3.89 | 12,187 | |
| 13:00 | 25.34 | 0.13 | 0.57 | | 3.89 | 12,557 | |
| 13:15 | 25.42 | 0.13 | 0.57 | 2.01 | 3.9 | 12,939 | |
| 13:25 | 25.1 | 0.13 | 0.57 | | 3.89 | 13,164 | |
| 13:35 | 24.18 | 0.13 | 0.57 | | 3.89 | 13,409 | |
| 13:45 | 25.32 | 0.13 | 0.57 | | 3.88 | 13,650 | |
| 13:55 | 24.92 | 0.13 | 0.57 | | 3.88 | 13,900 | |
| 14:05 | 24.32 | 0.13 | 0.57 | | 3.87 | 14,144 | |
| 14:15 | 25.11 | 0.13 | 0.57 | | 3.87 | 14,403 | Flow off, falling head |
| 14:17 | | 0.08 | 0.57 | | 3.87 | | |
| 14:22 | | 0 | 0.57 | | 3.9 | | |
| 14:26 | | | 0.56 | | 3.95 | | |
| 14:30 | | | 0.53 | | 4.08 | | |
| 14:36 | | | 0.47 | | 4.11 | | |
| 14:42 | | | 0.44 | | 4.2 | | |

| | | | | | | | |
|-------|--|--|------|--|------|--|--|
| 14:50 | | | 0.39 | | 4.24 | | |
| 15:00 | | | 0.31 | | 4.31 | | |
| 15:15 | | | 0.24 | | 4.55 | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 9.6 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 18.0 |

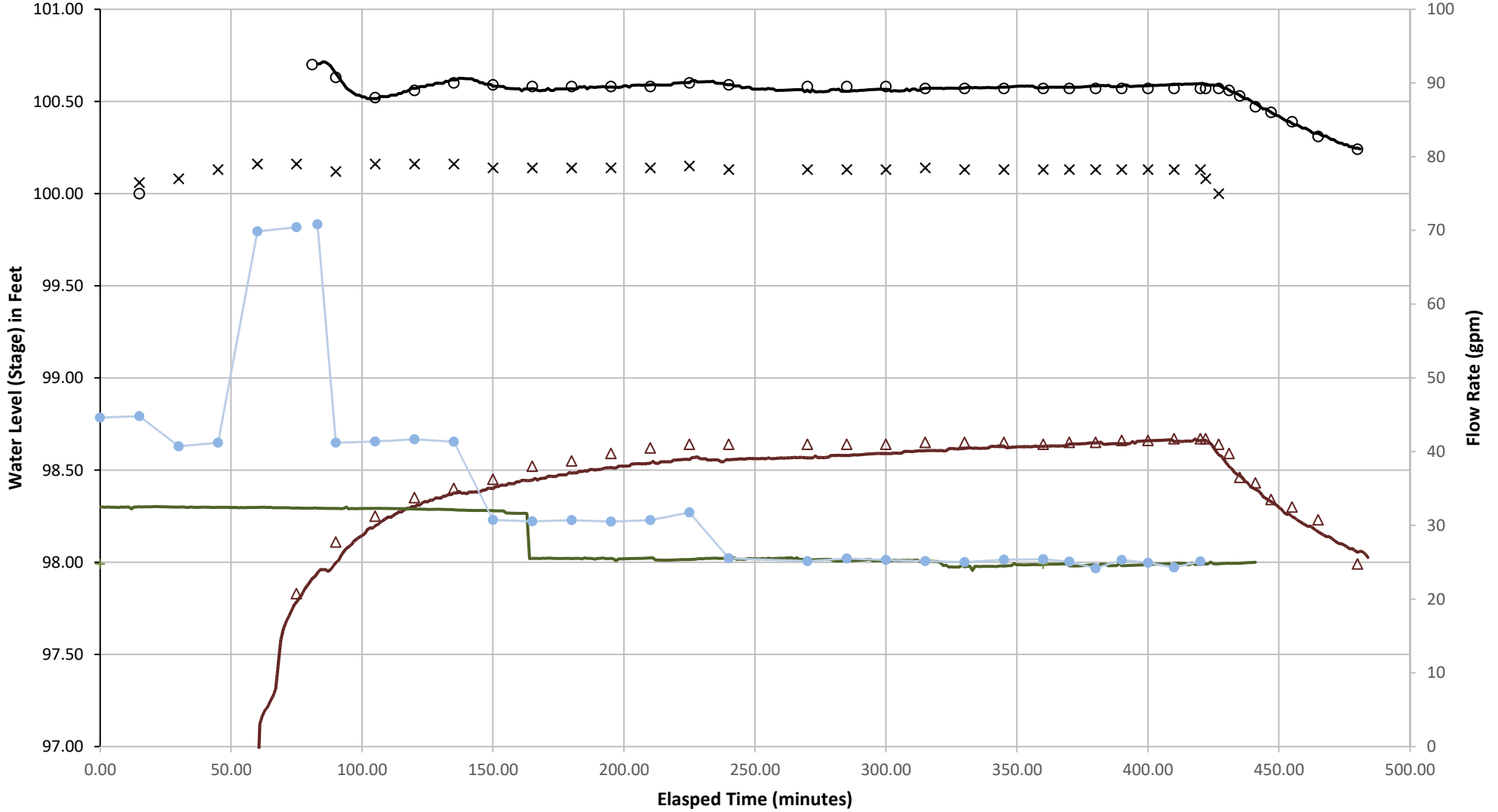
| | |
|--|-----|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 9.6 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 4.0 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 9.9 |
| WP Average Infiltration Rate (in/hr) during falling head: | 7.4 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during falling head (Logger): | 7.4 |
|--|-----|

436 McPhee Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- | | | |
|----------------------------|-------------------------|----------------------|
| × Staff Gauge #1 Hand Data | — Staff Gauge #2 Logger | △ Wellpoint Hand |
| — Wellpoint Logger | + Catch Basin Hand | — Catch Basin Logger |
| ○ Staff Gauge #2 Hand Data | ● Flow Rate (gpm) | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2008 and treats stormwater runoff from the adjacent street. The cell is constructed with 1.5' of bioretention soil mix above a 2' wide, 1' deep underdrain trench with gravel drain rock and a perforated pipe. The perforated pipe does not connect to the northern catch basin.

BIORETENTION SOIL:

Thickness: 0.4-0.8'

The apparent thickness of the bioretention soil ranged from 0.4-0.8' with an average of 0.6' based on probe data and hand auger explorations. This is far less than the 1.5' specified by the plans.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications, the sand gradation fell below the standard for the gravel and coarse sand content while the medium to fine sand and silt content exceeded the standard. The organic content fell within the specified range.

Organic Matter Content (% by weight): 7.4

Percent passing #200 sieve: 18.3

Coefficient of Uniformity (Cu): N/A

Coefficient of Curvature (Cc): N/A

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Hand auger explorations within the cell did not penetrate the underdrain gravels.

BUILT PER PLAN:

The cell was observed to have 1' less bioretention soil than the plans specified. Otherwise, the cell was built to plan. The cell has a unique design where water conveyed from the street directly enters the underdrain, despite its stated function as a "rain garden."

GROUNDWATER CONDITIONS:

No groundwater was observed in hand auger explorations and the wellpoint, screened in the underdrain gravels from 1.2-1.7' below ground surface did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 65

Subgrade Soil Rate (in/hr): N/A

The subgrade soil infiltration rate cannot be determined due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be maintained nearly identically to the adjacent park. Mowed grasses filled much of the base of the cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | Clear, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230605-175145.jpg



Site Photo: FA_SitePhotos-20230605-193349.jpg



Site Photo: FA_SitePhotos-20230605-193313.jpg



Site Photo: FA_SitePhotos-20230605-193438.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



Cell Construction

| | |
|-----------------------------|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation sprinklers were observed along roadside curb running north-south. Grasses appear healthy and well irrigated. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.66' Full Width Width 3' An 8" diameter underdrain pipe runs north from the southern catch basin along the center of the cell, stopping just short of the northern catch basin. The gravel drain rock trench is wrapped in geotextile fabric burrito and extends the full width of zone 1 of the cell (varies 2.5-3'). |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | Water is conveyed to the cell from rainfall on the adjacent pervious concrete roadway. Water infiltrates through the roadway to the roadway underdrain, and then any excess rain water that does not infiltrate into the native soil there is conveyed to the southern catch basin where water then is dispersed through the rain garden's perforated pipe. Any surface run off from the hillside also collects in the cell. Water is designed to pond in the rain garden and infiltrate through the drain rock to the native soil. Water will overflow into the northern catch basin which connects to the storm drain network. |

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other
- Diameter: 0.66'

Energy Dissipation

- Angular Rock: n/a
- Stream Cobble: n/a
- Water Wheel: n/a
- Splash Block: n/a
- Concrete Apron: n/a



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Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: There is a mossy mat growing on the bottom of the inflow pipe. Abundant leafy materials were observed in the catch basin bottom and small fish are living in the standing water.

Additional Details: The inlet is not typical. The inlet drains the permeable pavement on Decatur St. from 11th-10th. Water into southern catch basin which connects to the underdrain pipe. Base of inflow pipe is 2.44' below low rim of catch basin. Base of underdrain pipe is 2.46' below rim of catch basin.

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



Design Overflow/Outlet

| | | |
|---|-----------------------------|---|
| DO - 1 | |  |
| Shape: | Dimensions: | |
| <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Length: 1.7' Width: 1.5' | |
| Additional Details: | | |
| Stickup (ft) | | |
| From Ground: 0 | | |
| Relative from staff gauge: | | |
| Damage Indicators: | | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: | | |
| <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 15% blocked Additional Details: The trash rack is overgrown with grasses. | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

FA_DOPhoto-20230605-202550.jpg

| | | |
|---|-------------------------------|--|
| DO - 2 | |  |
| Shape: | Dimensions: | |
| <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Length: 1.75' Width: 1.48' | |
| Additional Details: | | |
| Stickup (ft) | | |
| From Ground: 0.8 | | |
| Relative from staff gauge: | | |
| Damage Indicators: | | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: | | |
| <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked Additional Details: Overgrown grasses and debris on the southern side of the catch basin. | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

FA_DOPhoto-20230605-202926.jpg

Cell Surface and Geotech Probe Observations

| | |
|---|-------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth (ft): |
| Cell Coverage | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



Mulch None < 25% 25 - 50% 50 - 75% 75 - 100%
 Bare Ground None < 25% 25 - 50% 50 - 75% 75 - 100%
 Other None < 25% 25 - 50% 50 - 75% 75 - 100%

The entire cell is covered in overgrown grass. If there was mulch, it is natural mulch underneath live grass. The grass in the cell is the same grass as the adjacent park.

Pest Evidence

Animal Burrows Yes No
 Animal Plant Damage Yes No
 Large Deposition of Feces Yes No

Additional Details: Small fish were observed in the southern catch basin.

Vegetation Description

Fibrous vegetation covers the length of the cell and impedes field staff ability to observe the ponding and surface water. Parks maintenance workers were out mowing lawn of adjacent park today.

Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 0.35-0.8' of bioretention soil, with an average of 0.6', before encountering the underdrain gravels. This is less than the 1.5' specified by the plans. The cell edges are made up of a rock wall that runs the length of the east side of the cell and wraps around the north and south ends of the cell for 14 feet and 25 feet respectively. The remainder of the west side of the cell edge is a 3:1 slope designed as compost amended native soil with wood chip mulch, which is now vigorously covered in grass. Cannot probe or excavate west of the cell to observe native soils because of the PSE gas line (4" main). No zones of compaction were observed.

Hand Auger

HA-1-WP

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.2

to Native Soil:

to Import/Underdrain: 0.5

Total Depth: 1.5

Rain/Garden Mix Soil Texture: Loose, dark brown, slightly moist, very gravelly, silty, fine to medium SAND, some coarse sand, abundant organics and rootlets (SM).

Native Soil Texture: N/A

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Plans call for geotextile wrap of gravel underdrain trench. Did not encounter/reach the bottom layer of the filter fabric.

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):



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BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



| | |
|---|--|
| HA-1-WP | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): | |
| Additional Details | |
| WellPoint was screened in the underdrain gravels. No native soils were encountered. WellPoint did not respond to testing. | |

| | |
|--|--|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | 0.6 |
| Total Depth: | 0.6 |
| Rain/Garden Mix Soil Texture: Loose, dark brown, slightly moist, very gravelly, silty, fine to medium SAND, some coarse sand, abundant organics and rootlets (SM). Native Soil Texture: N/A | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Geotextile fabric wrapped around underdrain trench. |
| Additional Details | |
| Stopped excavation at filter fabric. | |



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| | |
|---|--|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | |
| to Import/Underdrain: | 0.8 |
| Total Depth: | 0.8 |
| Rain/Garden Mix Soil Texture: Loose, dark brown, slightly moist, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics and rootlets (SM). Native Soil Texture: N/A | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Geotextile fabric wrapped around underdrain trench. |

BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
 Cell: Rain Garden

Assessed On:
 June 5, 2023



HA-3



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Additional Details
 Stopped excavation at filter fabric.

Infiltration Test

IT-1

| | |
|--|-------|
| Water Supply | |
| <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-3 3-50 | |
| Wetted Pond Area (sq. ft) | 13.5 |
| Ponded Depth (ft) | 0.12 |
| Total Gallons | 3,300 |
| Steady State Flow Rate (GPM) | 9.3 |

Additional Details:
 For infiltration test #1 the diffuser was set 5 feet north of the southern catch basin. At 10:00am the flow was observed to be backflowing into the southern catch basin and out to street. For infiltration test #2 the diffuser was set 50 feet north of the southern catch basin. Very little ponding was observed. Additional test details can be found in the executive summary.



BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)

Cell: Rain Garden

Assessed On:

June 5, 2023



IT_Photo-20230605-205108.jpg



IT_Photo-20230605-205149.jpg



IT_Photo-20230605-205213.jpg

Additional Comments

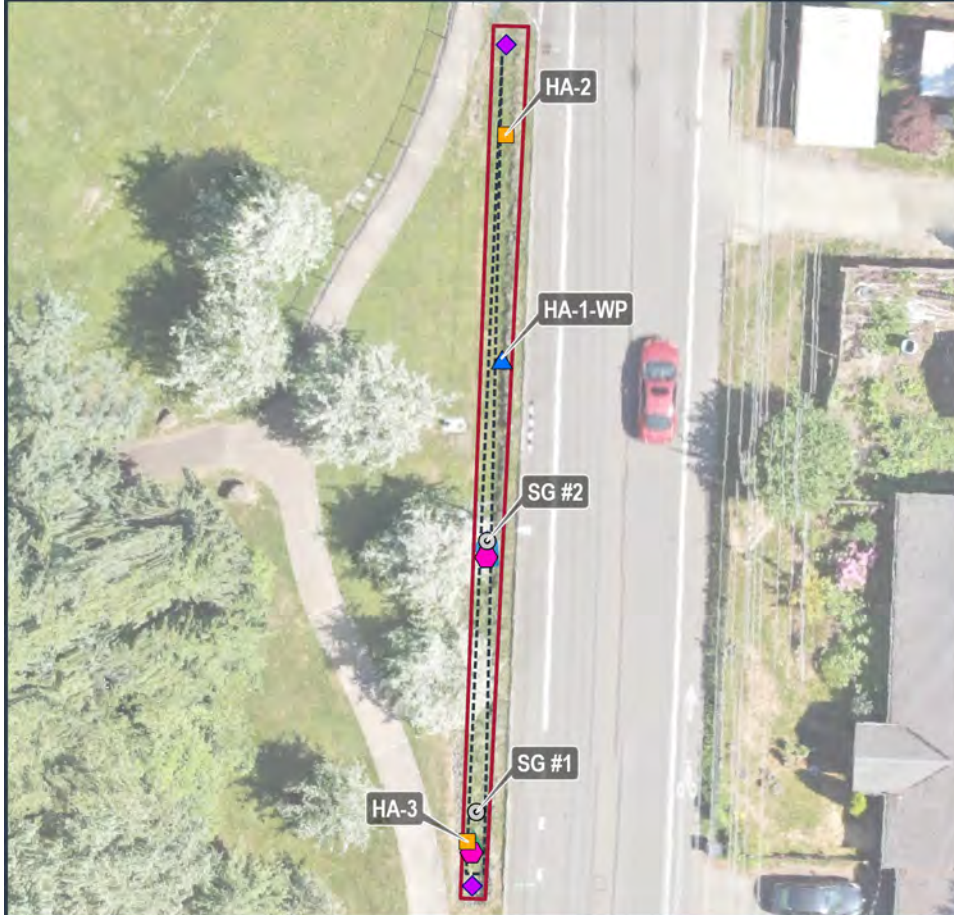
BIORETENTION CELL FIELD ASSESSMENT

Site: Decatur (OLDE)
Cell: Rain Garden

Assessed On:
June 5, 2023



SITE: DECATUR (OLDE) CELL: RAIN GARDEN



- LEGEND**
- WELL POINT
 - HAND AUGER
 - TEMPORARY STAFF GAUGE
 - OVERFLOW STRUCTURE
 - DIFFUSER
 - TOP OF FACILITY
 - BASE OF FACILITY
 - WETTED AREA #2
 - WETTED AREA (DIFFUSER LOCATION #1)

N
1 in = 30 ft
LOCATION AND DISTANCES ARE APPROXIMATE.



associated
earth sciences
incorporated

Well Point

OLDE-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/1/23

Logged By: APJ

20150387H008

Ending Date: 6/1/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.3

Water Level Elevation (ft): N/A

Datum: Project Datum

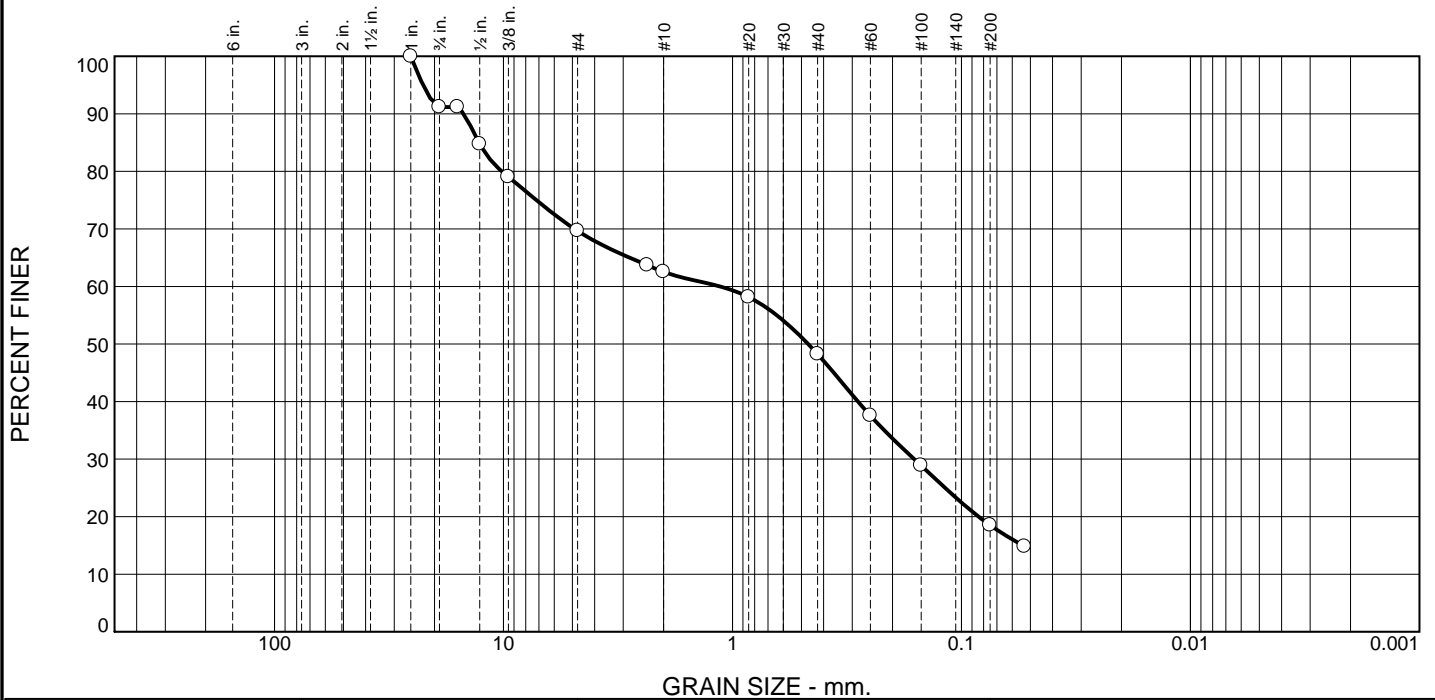
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Surface Cover Matted fibrous grasses and roots. | | | | | | | Stick up -5.3 to 0 feet Existing bioretention soils 0 to 0.5 feet 1.25-inch I.D. threaded galvanized steel casing -5.3 to 1 foot; duct tape covers screen -1.0 to 1.2 feet Bentonite chips 0.5 to 0.8 feet Medium grain silica sand 0.8 to 1 foot Existing gravel 1 to 2.3 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.2 to 1.7 feet Cast iron endcap 1.7 to 2 feet Cast iron drivepoint 2 to 2.3 |
| 1 | Hand | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, very gravelly, silty, SAND; abundant organics and rootlets (SM). Black geotextile fabric encountered at 0.5 feet. | | | | | | | |
| 1 | | | | Underdrain Gravel Loose, slightly moist, gray, GRAVEL; rounded; average diameter 1 inch (GP). | | | | | | | |
| 2 | Hand | 2 | | No seepage. Caving from 0.5 to 1.5 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. Hole terminated due to time constraints and caving within gravel. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/13/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 8.8 | 21.5 | 7.1 | 14.4 | 29.7 | 18.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 91.2 | | |
| 5/8" | 91.2 | | |
| 1/2" | 84.7 | | |
| 3/8" | 79.1 | | |
| #4 | 69.7 | | |
| #8 | 63.7 | | |
| #10 | 62.6 | | |
| #20 | 58.2 | | |
| #40 | 48.2 | | |
| #60 | 37.6 | | |
| #100 | 28.9 | | |
| #200 | 18.5 | | |
| #270 | 14.8 | | |

* (no specification provided)

Material Description

BSM
very gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 14.9214 D₈₅= 12.8074 D₆₀= 1.1333
D₅₀= 0.4671 D₃₀= 0.1608 D₁₅= 0.0540
D₁₀= C_u= C_c=

Remarks

Date Received: 6/06/2023 Date Tested: 8/21/2023

Tested By: FEW

Checked By: APJ/JHS

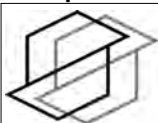
Title: _____

Location: Onsite - Decatur

Sample Number: HA-1

Depth: 0.15-0.5'

Date Sampled: 6/05/2023



associated
earth sciences
incorporated

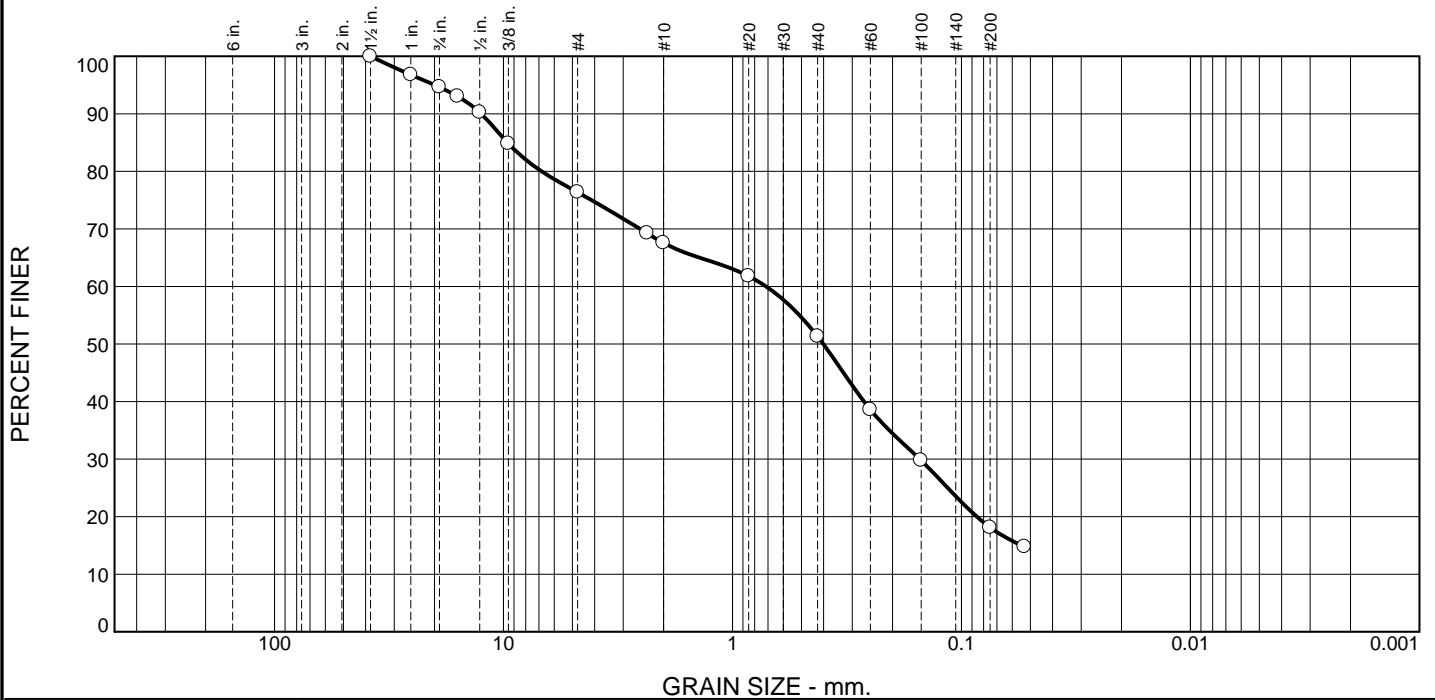
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.4 | 18.2 | 8.8 | 16.3 | 33.2 | 18.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 96.8 | | |
| 3/4" | 94.6 | | |
| 5/8" | 93.0 | | |
| 1/2" | 90.2 | | |
| 3/8" | 84.8 | | |
| #4 | 76.4 | | |
| #8 | 69.3 | | |
| #10 | 67.6 | | |
| #20 | 61.8 | | |
| #40 | 51.3 | | |
| #60 | 38.6 | | |
| #100 | 29.8 | | |
| #200 | 18.1 | | |
| #270 | 14.7 | | |

* (no specification provided)

Material Description

BSM
gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 12.5107 D₈₅= 9.6092 D₆₀= 0.7129
D₅₀= 0.4011 D₃₀= 0.1521 D₁₅= 0.0546
D₁₀= C_u= C_c=

Remarks

Date Received: 6/06/2023 Date Tested: 9/18/2023

Tested By: FEW

Checked By: APJ/JHS

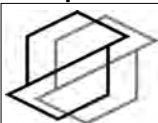
Title: _____

Location: Onsite - Decatur

Sample Number: HA-3

Depth: 0-0.8'

Date Sampled: 6/05/2023



associated
earth sciences
incorporated

Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|---------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 6/5/2023 | Project BHPS - Decatur | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Olympia, WA | EB/EP No. OLDE-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.15-0.5 | HA-3 @ 0-0.8' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 889.5 | 1322.8 |
| Dry Weight + Pan | 823.7 | 1228.7 |
| Weight of Pan | 247.1 | 358.0 |
| Weight of Moisture | 65.8 | 94.1 |
| Dry Weight of Soil | 576.7 | 870.7 |
| % Moisture | 11.4 | 10.8 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|--------|
| Dry Soil Before Burn + Pan | 823.7 | 1228.7 |
| Dry Soil After Burn + Pan | 785.2 | 1158.4 |
| Weight of Pan | 247.1 | 358.0 |
| Wt. Loss Due to Ignition | 38.6 | 70.3 |
| Actual Wt. Of Soil After Burn | 538.1 | 800.4 |
| % Organics | 6.7 | 8.1 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

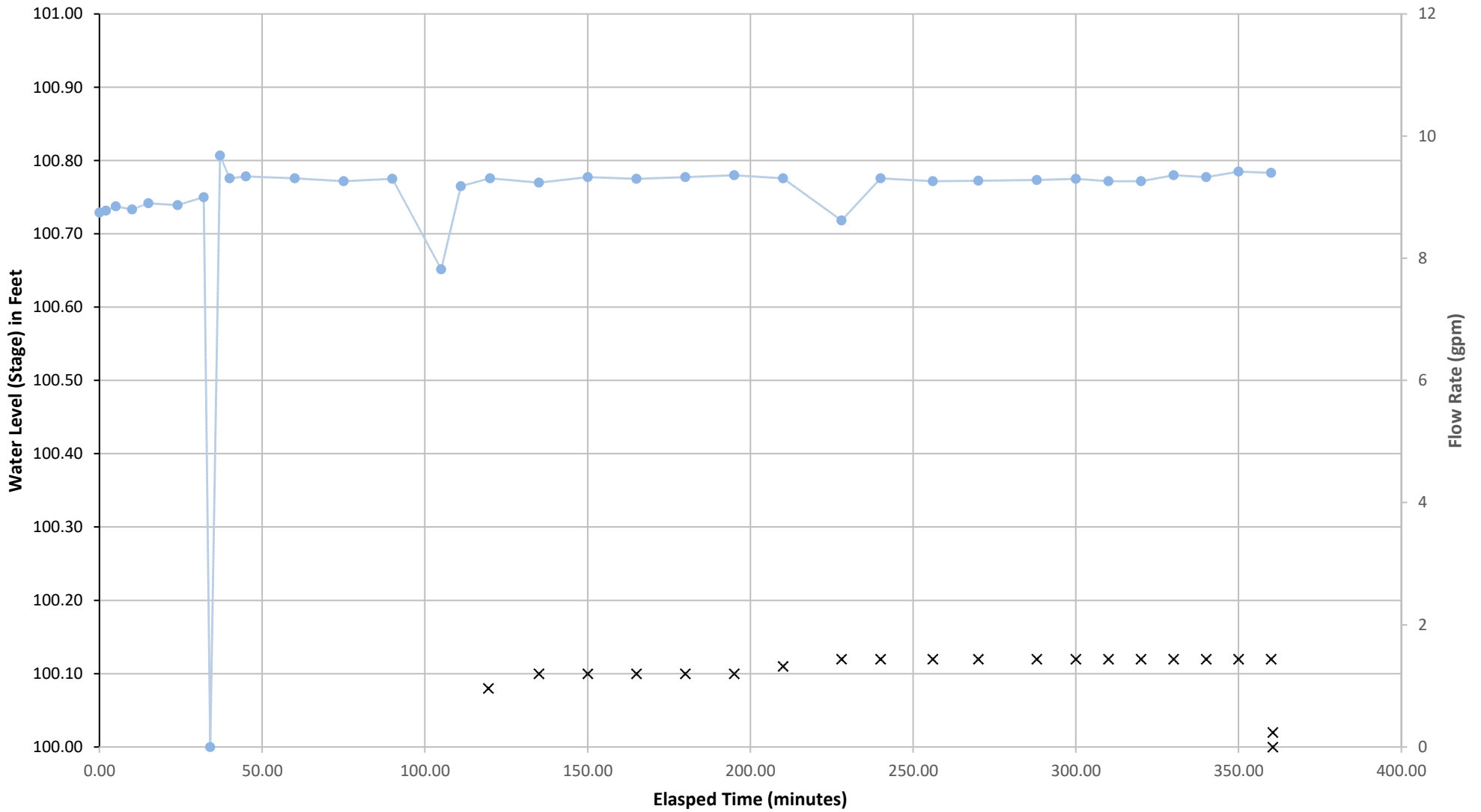
| | | | |
|------------------------|---------------------|--------------------------------|------------------------|
| Project Name: | Decatur Rain Garden | Water Source: | Hose Bib |
| Project Number: | 20150387H008 | Meter: | FM#3 3-50 |
| Date: | 6/5/2023 | Wetted Area (sq. feet): | Static Pond= 13.5 ft^2 |
| Weather: | Clear, 70s | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | Surface, 0.12 |
| Performed By: | APJ / CSI | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #2 (feet) | Totalizer (gallons) | Comments |
|--------------|-----------------|-----------------------|---------------------|--|
| 9:45 | 8.75 | | 0 | Water on |
| 9:47 | 8.78 | | 16 | |
| 9:50 | 8.85 | | 43 | |
| 9:55 | 8.8 | | 85 | |
| 10:00 | 8.9 | | 130 | Flow entering southern catch basin, flowing out to street. |
| 10:09 | 8.87 | | 208 | |
| 10:17 | 9 | | 283 | |
| 10:19 | 0 | | 297 | Water off. Moving diffuser 50' north away from southern catch basin. |
| 10:22 | 9.68 | | | |
| 10:25 | 9.31 | | 328 | Water back on, totalizer cleared. |
| 10:30 | 9.34 | | 375 | |
| 10:45 | 9.31 | | 512 | |
| 11:00 | 9.26 | | 652 | |
| 11:15 | 9.3 | | 792 | |
| 11:30 | 7.82 | | 931 | |
| 11:36 | 9.18 | | | |
| 11:45 | 9.31 | 0.08 | 1,070 | Adjusted staff gauge 1' north to be closer to diffuser. |
| 12:00 | 9.24 | 0.1 | 1,212 | |
| 12:15 | 9.33 | 0.1 | 1,350 | |
| 12:30 | 9.3 | 0.1 | 1,489 | |
| 12:45 | 9.33 | 0.1 | 1,628 | |
| 13:00 | 9.36 | 0.1 | 1,770 | |
| 13:15 | 9.31 | 0.11 | 1,910 | |
| 13:33 | 8.62 | 0.12 | 2,085 | |
| 13:45 | 9.31 | 0.12 | 2,185 | |
| 14:01 | 9.26 | 0.12 | 2,339 | |
| 14:15 | 9.27 | 0.12 | 2,461 | |
| 14:33 | 9.28 | 0.12 | 2,632 | |
| 14:45 | 9.3 | 0.12 | 2,753 | |
| 14:55 | 9.26 | 0.12 | 2,843 | |
| 15:05 | 9.26 | 0.12 | 2,927 | |
| 15:15 | 9.36 | 0.12 | 3,020 | |
| 15:25 | 9.33 | 0.12 | 3,117 | |
| 15:35 | 9.42 | 0.12 | 3,209 | |
| 15:45:00 | 9.4 | 0.12 | 3,300 | Water off. |
| 15:45:30 | | 0.02 | | |
| 15:45 | | 0 | | Staff Gauge dry |

| | |
|--|-------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 65.0 |
| SG- 2 Average Infiltration Rate (in/hr) during falling head: | 129.6 |

Decatur Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

x Staff Gauge #1 Hand Data

—●— Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
Cell: Cell 1

Assessed On:
June 1, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2009 and collects stormwater runoff from the adjacent parking lot as well as runoff from overflow events in the neighboring stormwater pond. Water is conveyed to the cell through 4 curb cut inlets. The cell is constructed with 18" of bioretention soil above the native subgrade which was to be ripped and tilled prior to soil placement. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 1.2-1.5'

The apparent thickness of the bioretention soil ranged from 1.2-1.5' with an average of 1.3'. This is less than the 1.5' specified by the plans.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications, the sand gradation fell below the standard for the gravel and coarse sand content while the medium to fine sand and silt content exceeded the standard. The organic content fell within the specified range.

Organic Matter Content (% by weight): 5.0

Percent passing #200 sieve: 16.3

Coefficient of Uniformity (Cu): 36.4

Coefficient of Curvature (Cc): 1.3

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Medium dense, slightly moist, dark brown, very sandy GRAVEL, trace silt; gravels rounded (GP)

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell. The temporary wellpoint was screened from 0.9-1.4' below ground surface and responded to testing after approximately 1 hour and rose to close to the surface water level after approximately 200 minutes where it remained for the duration of the test.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >2.7

Subgrade Soil Rate (in/hr): 2.7

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
 Cell: Cell 1

Assessed On:
 June 1, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

A veneer of silty, organic material was found above the bioretention soil which may slow the infiltration rate of the bioretention soil. This material was likely deposited during flood events of the adjacent stormwater pond which was observed in the initial site visit during the site selection phase of this project.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | PC, 60s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 4 | Predominate Landuse | Parkland |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: 20230601_200840276_iOS.jpg



Site Photo: 20230601_200849182_iOS.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
Cell: Cell 1

Assessed On:
June 1, 2023



Site Photo: 20230601_200902001_iOS.jpg



Site Photo: 20230601_200910070_iOS.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Cell is an infiltrating bioretention cell with bioretention soil above tilled recessional outwash. Water enters the cell from the adjacent pervious pavement parking lot through four curb cut inlets. The bioretention soil is coated in a thin silty/organic veneer, presumably deposited during flooding of the adjacent stormwater pond. There is no designed overflow feature. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)

Cell: Cell 1

Assessed On:

June 1, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 4'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



20230601-191105.jpg

Erosion Present? Yes No

Severity: Minor

Blockage Present? Yes No

Additional Details: Water falls approximately 6 inches to the cluster of stream cobbles around the inlet, but there are also scattered cobbles up to 6 feet from the inlet. Unclear if they were transported through natural processes or kids moving rocks.

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
Cell: Cell 1

Assessed On:
June 1, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 4'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



20230601-191253.jpg

Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No

Additional Details: Water falls approximately 6 inches to the cluster of stream cobbles around the inlet, but there are also scattered cobbles up to 6 feet from the inlet. Unclear if they were transported through natural processes or kids moving rocks.

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
Cell: Cell 1

Assessed On:
June 1, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 4'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



20230601-191718.jpg

Erosion Present? Yes No
Severity: Minor

Blockage Present? Yes No


Additional Details: Stream cobbles were observed near the beginning of the inlet, the concrete base of the light post is located 2.2 feet from the curb cut with stream cobbles wrapping around to the west of the light post.

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
Cell: Cell 1

Assessed On:
June 1, 2023



| | |
|--|---|
| IN-4 | |
| <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 4' Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>20230601-193318.jpg</p> |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Rounded cobbles at the base of inlet, shrubs on either side. | |

Cell Surface and Geotech Probe Observations

| | |
|--|--|
| Mulch: <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.2 | |
| Cell Coverage | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Natural mulch of dead leaves and plant scraps cover remaining area of cell. Thin (<0.2') veneer of gray silt & dead leaves covering portions of pond bottom. Likely residue from flooded storm water pond. Portions of grass outside parking lot appear similar. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Some ducks and geese located in the area, no large deposition of feces present, but some distribution throughout parking lot and around cell. Public works staff notes that beavers cut down tree in bioretention pond. | |
| Vegetation Description | |
| Larger vegetation covers approximately 30% of the cell. Smaller grass/plant clusters covering the remaining portion of the cell. The grasses leave behind a natural mulch each cutting. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
 Cell: Cell 1

Assessed On:
 June 1, 2023



Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 1.2-1.45' of bioretention soil, with an average of 1.3', before encountering the native soils. This is less than the 1.5' specified by the plans. the probe depths on the cell edges were not discernibly different than those in the center of the cell. No zones of compaction were observed.

Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics and rootlets (SM). Native Soil Texture: Vashon Recessional Outwash: Medium dense, slightly moist, brown, very sandy GRAVEL, trace silt. Gravels rounded, average diameter 1". (GP). | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |



20230601-184942.jpg



HA_1.jpg

Additional Details

Shallowest depth to water during the test was above the ground surface.

| | |
|--|--|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
 Cell: Cell 1

Assessed On:
 June 1, 2023



HA-2

Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | 0 |
| Total Depth: | 1.4 |

Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics and rootlets (SM).

Native Soil Texture: Vashon Recessional Outwash: Medium dense, slightly moist, brown, very sandy GRAVEL, trace silt, scattered organics. Gravels rounded, average diameter 1". (GP).

Liner Present:
 Yes No

Filter Fabric Present:
 Yes No



20230601-185235.jpg



HA-2.jpg

Additional Details

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)
Cell: Cell 1

Assessed On:
June 1, 2023



| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | 0 |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, gravelly, silty, fine to medium SAND, some coarse sand, abundant organics and rootlets (SM). Native Soil Texture: Vashon Recessional Outwash: Medium dense, slightly moist, brown, very sandy GRAVEL, trace silt, scattered organics. Gravels rounded, average diameter 1". (GP). | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |



20230601-185459.jpg

Infiltration Test

| | |
|--|-------|
| IT-1 | |
| Water Supply <input type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input checked="" type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-3 3-50gpm | |
| Wetted Pond Area (sq. ft) | 275 |
| Ponded Depth (ft) | 0.42 |
| Total Gallons | 2,935 |
| Steady State Flow Rate (GPM) | 8.3 |
| Additional Details: Additional test details can be found in the executive summary. | |



BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)

Cell: Cell 1

Assessed On:

June 1, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Yauger Park (OLYA)

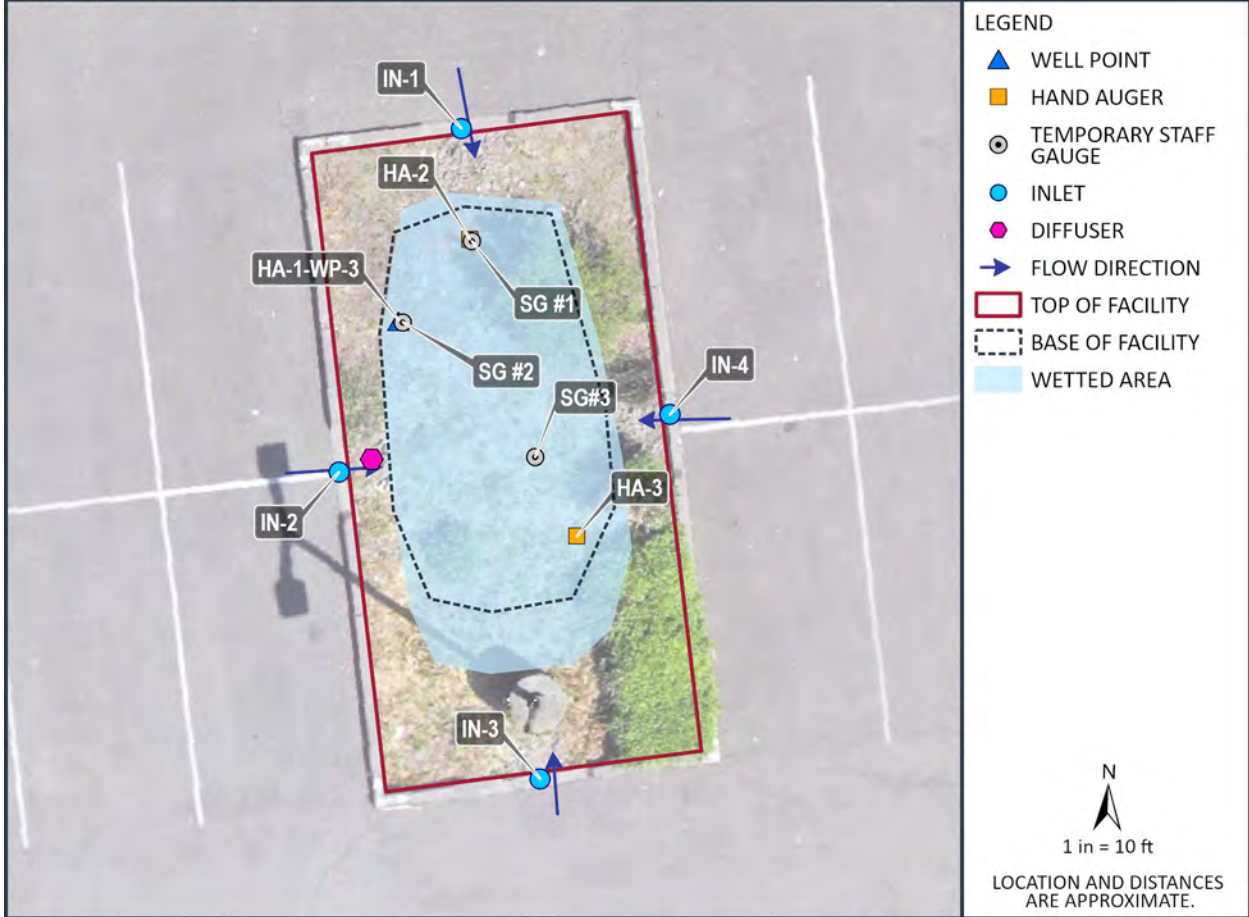
Cell: Cell 1

Assessed On:

June 1, 2023



SITE: YAUGER PARK (OLYA) CELL: CELL 1





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Well Point

OLYA-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 06/01/2023

Logged By: APJ

20150387H008

Ending Date: 06/01/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.9

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2

Hole Diameter (in): 4

Well Tag No.: N/A

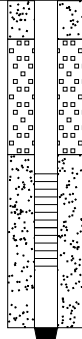
Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.5

Water Level Elevation (ft): N/A

Datum: Project Datum

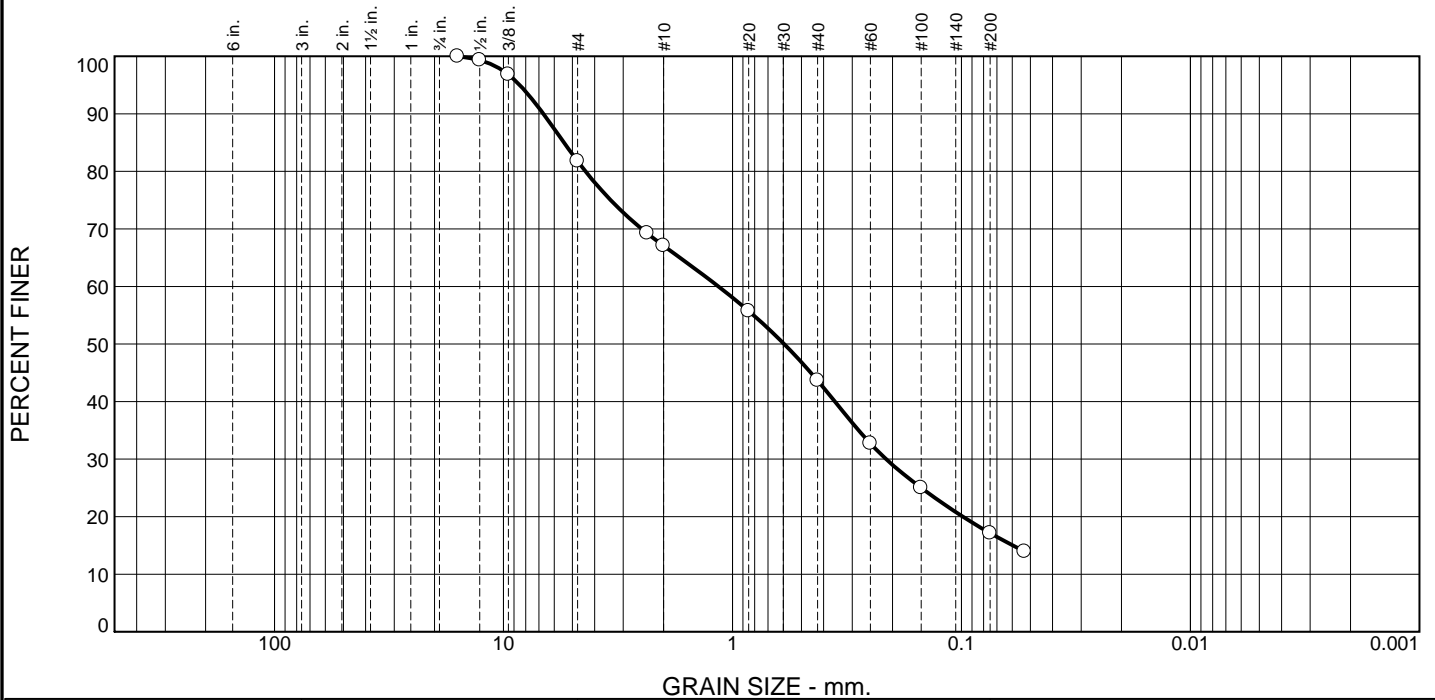
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----------|----------|----------|----------|--|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Surface Cover - 2 inches Dead plant litter; organic debris coated in gray, silty, veneer from flooding events. | | | | | | |  <p>Stick up -5.5 feet to 0.2 feet Existing bioretention soil 0 to 0.2 feet 3/8-inch bentonite chips 0.2 to 0.8 feet 1.25-inch I.D. threaded galvanized steel casing -5.5 to 1.2 feet; duct tape covers screen -1.2 to 0.9 feet Medium grain silica sand 0.8 to 2.0 feet 1.25-inch I.D. stainless steel slotted screen with 0.01-inch slot with and #60 stainless steel gauge 0.9 to 1.4 feet Cast iron endcap 1.4 to 1.7 feet Cast iron drivepoint 1.7 to 2 feet</p> |
| 1 | | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, gravelly, silty, fine to medium SAND; abundant organics and rootlets (SM). | | | | | | | |
| | | 2 | | As above; becomes very gravelly. | | | | | | | |
| | | 3 | | Vashon Recessional Outwash Medium dense, slightly moist, dark brown, very sandy, GRAVEL, trace silt; gravel rounded (GP). | | | | | | | |
| 2 | | 4 | | No seepage. No caving. Exploration terminated due to difficulty excavating gravel. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 18.2 | 14.7 | 23.4 | 26.6 | 17.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 99.3 | | |
| 3/8" | 96.8 | | |
| #4 | 81.8 | | |
| #8 | 69.2 | | |
| #10 | 67.1 | | |
| #20 | 55.7 | | |
| #40 | 43.7 | | |
| #60 | 32.7 | | |
| #100 | 25.0 | | |
| #200 | 17.1 | | |
| #270 | 13.9 | | |

* (no specification provided)

Material Description

gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 6.6993 D₈₅= 5.4437 D₆₀= 1.1512
D₅₀= 0.5947 D₃₀= 0.2133 D₁₅= 0.0596
D₁₀= C_u= C_c=

Remarks

Date Received: 6/01/2023 Date Tested: 9/05/2023

Tested By: FEW

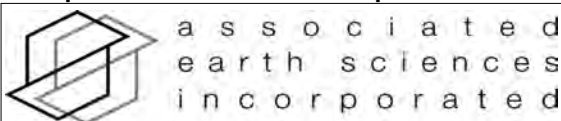
Checked By: APJ/JHS

Title: _____

Location: Onsite - Yaeger Park
Sample Number: HA-1

Depth: 0.5'

Date Sampled: 6/01/2023

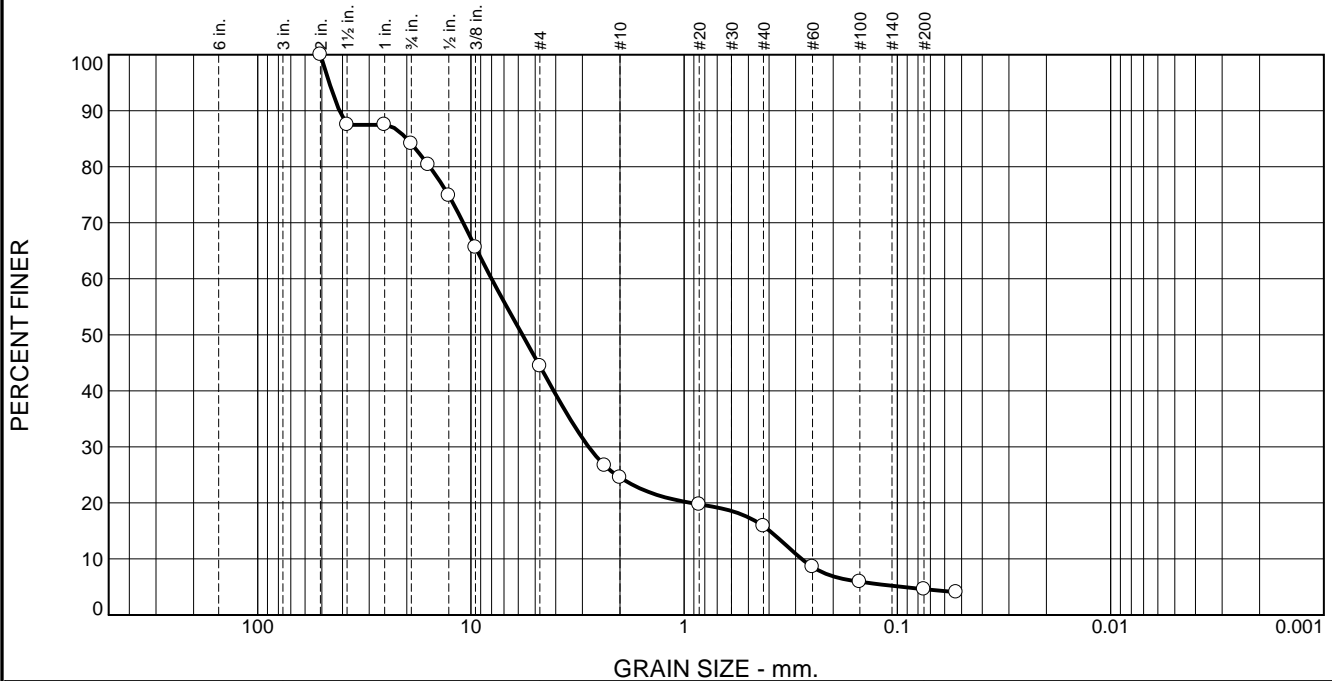


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 15.9 | 39.7 | 19.9 | 8.6 | 11.3 | 4.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 2" | 100.0 | | |
| 1.5" | 87.5 | | |
| 1" | 87.5 | | |
| 3/4" | 84.1 | | |
| 5/8" | 80.4 | | |
| 1/2" | 74.9 | | |
| 3/8" | 65.6 | | |
| #4 | 44.4 | | |
| #8 | 26.7 | | |
| #10 | 24.5 | | |
| #20 | 19.7 | | |
| #40 | 15.9 | | |
| #60 | 8.6 | | |
| #100 | 5.9 | | |
| #200 | 4.6 | | |
| #270 | 4.1 | | |

Material Description

Native
very sandy GRAVEL, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 41.3707 D₈₅= 20.0026 D₆₀= 7.9988
D₅₀= 5.7390 D₃₀= 2.8063 D₁₅= 0.3971
D₁₀= 0.2812 C_u= 28.45 C_c= 3.50

Remarks

Date Received: 6/01/2023 Date Tested: 6/27/2023

Tested By: CI/EW

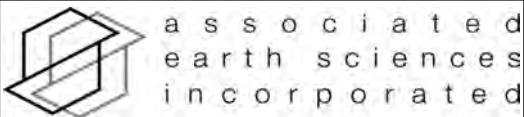
Checked By: APJ/JHS

Title: _____

* (no specification provided)

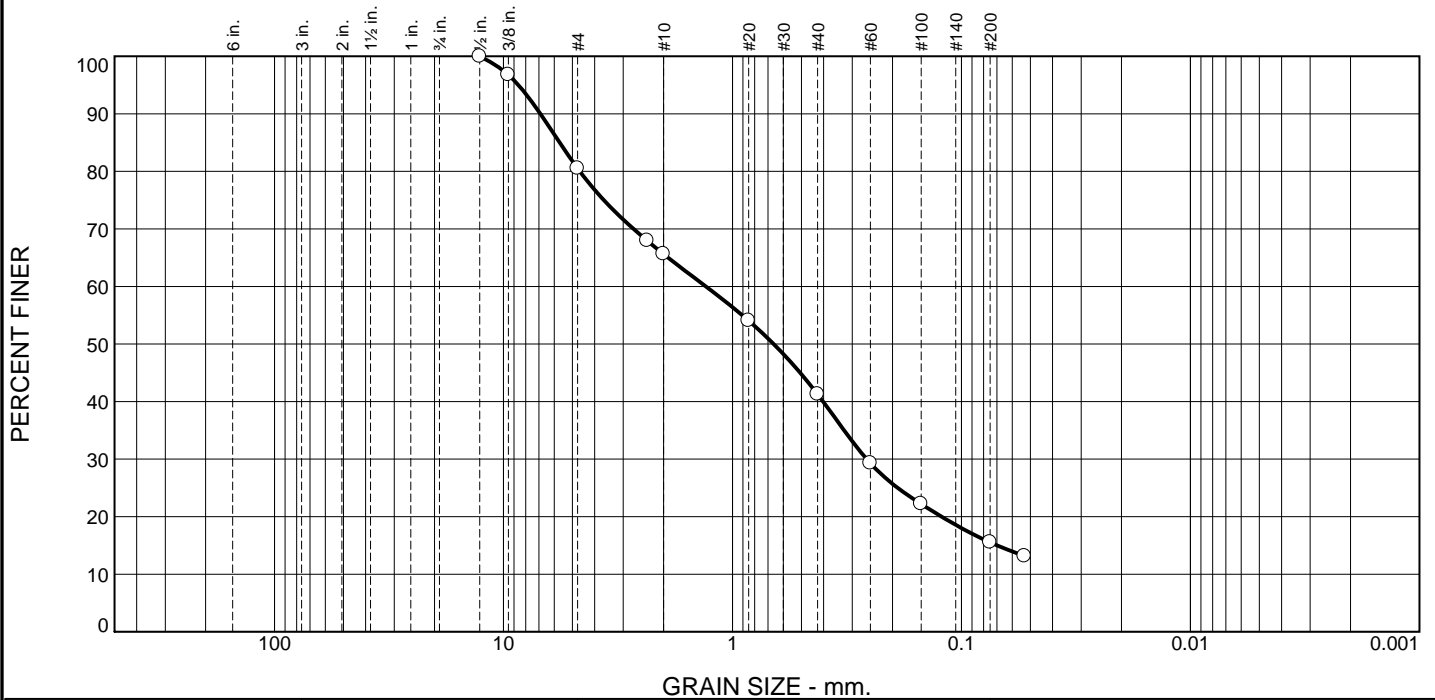
Location: Onsite - Yauger Park
Sample Number: HA-1 Depth: 1.8

Date Sampled: 6/01/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 19.5 | 14.9 | 24.3 | 25.8 | 15.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 96.8 | | |
| #4 | 80.5 | | |
| #8 | 68.0 | | |
| #10 | 65.6 | | |
| #20 | 54.1 | | |
| #40 | 41.3 | | |
| #60 | 29.3 | | |
| #100 | 22.2 | | |
| #200 | 15.5 | | |
| #270 | 13.1 | | |

* (no specification provided)

Material Description

gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 6.9020 D₈₅= 5.6828 D₆₀= 1.3065
D₅₀= 0.6608 D₃₀= 0.2593 D₁₅= 0.0698
D₁₀= C_u= C_c=

Remarks

Date Received: 6/1/2023 Date Tested: 7/27/2023

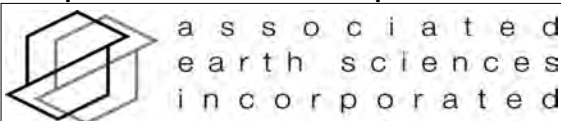
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Yauger Park
Sample Number: HA-3 Depth: 3-6"

Date Sampled: 6/1/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|---------------------------------|--------------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 6/1/2023 | Project BHPS - Yauger Park | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Olympia, WA | EB/EP No. OLYA-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.5' | HA-3 @ 0.25-0.5' |
|--------------------|-------------|------------------|
| Wet Weight + Pan | 875.5 | 896.8 |
| Dry Weight + Pan | 780.6 | 798.3 |
| Weight of Pan | 247.5 | 247.5 |
| Weight of Moisture | 94.9 | 98.5 |
| Dry Weight of Soil | 533.1 | 550.8 |
| % Moisture | 17.8 | 17.9 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 780.6 | 798.3 |
| Dry Soil After Burn + Pan | 755.1 | 769.8 |
| Weight of Pan | 247.5 | 247.5 |
| Wt. Loss Due to Ignition | 25.5 | 28.5 |
| Actual Wt. Of Soil After Burn | 507.6 | 522.3 |
| % Organics | 4.8 | 5.2 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--------------|--------------------------------|----------------------------------|
| Project Name: | Yauger Park | Water Source: | Irrigation Tap, hose bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 6/1/2023 | Wetted Area (sq. feet): | 14:30: 275 ft^2 / 16:00 275 ft^2 |
| Weather: | Clear, 70's | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | Surface, 0.4 |
| Performed By: | APJ / CSI | Receptor Soils: | Qvr |

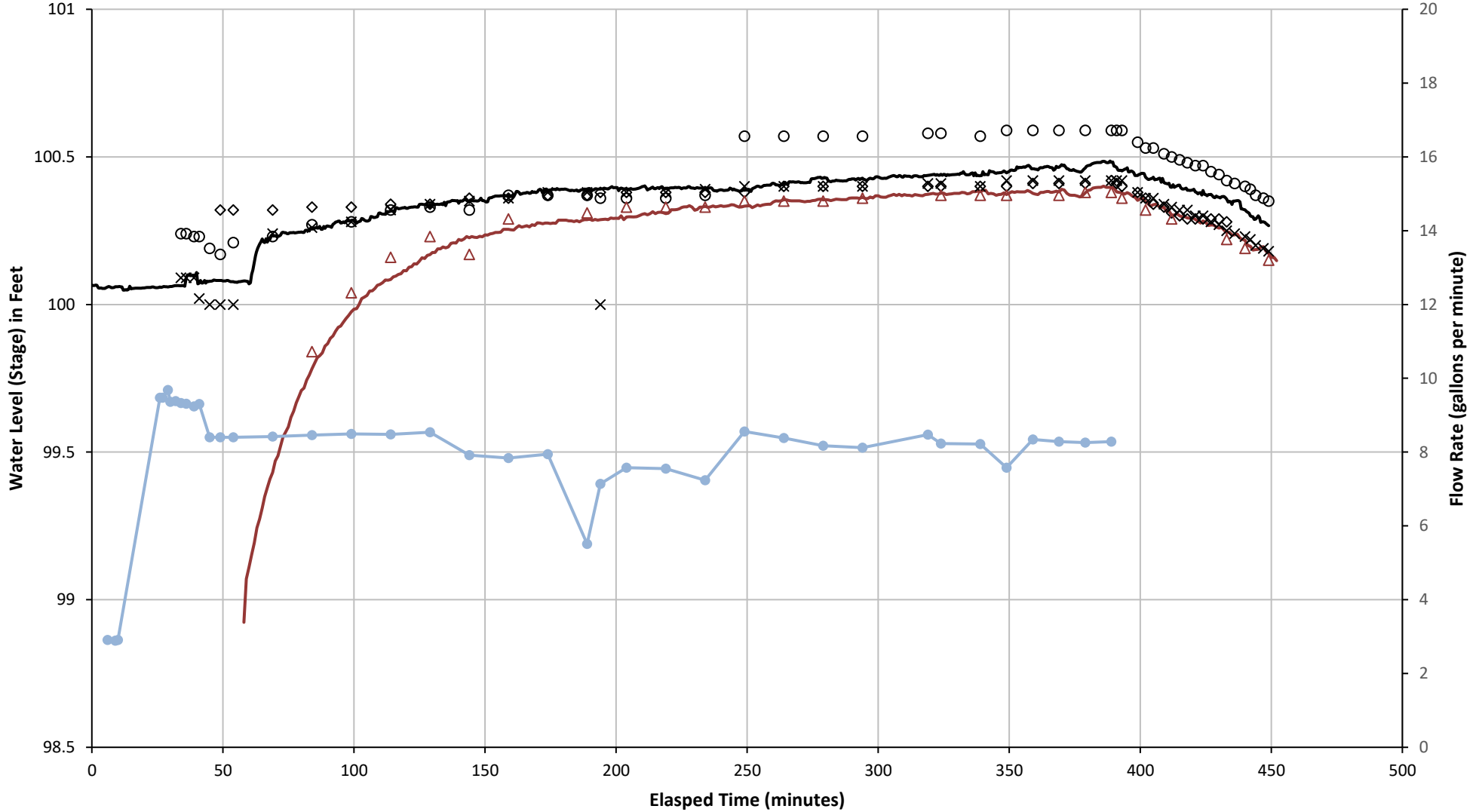
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (feet) | Staff Gauge #2 (feet) | Staff Gauge #3 (feet) | Wellpoint (feet, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|-----------------------|-----------------------|-----------------------|------------------------|---------------------|---|
| 10:21 | | | | | | | Water on (3-50 flow meter) |
| 10:21 | | | | | | | Water off. Flow meter not recording flow. |
| 10:25 | | | | | | | Water on low flow meter (.3-3) |
| 10:27 | 2.91 | | | | | 4 | |
| 10:30 | 2.89 | | | | | 13 | |
| 10:31 | 2.91 | | | | | 16 | Water off. Attempt to rehab FM-3 3-50 flowmeter |
| 10:47 | 9.47 | | | | | | Water on with FM-3 3-50. FM rehabilitated & passed bucket test. |
| 10:48 | 9.47 | | | | | 25 | |
| 10:50 | 9.68 | | | | | | Water on |
| 10:51 | 9.36 | | | | | 35 | |
| 10:53 | 9.38 | | 0.06 | | | 53 | |
| 10:55 | 9.33 | 0.09 | 0.07 | | | 71 | |
| 10:57 | 9.31 | 0.09 | 0.06 | | | 90 | |
| 11:00 | 9.24 | 0.09 | 0.06 | | | | |
| 11:02 | 9.3 | 0.02 | 0.06 | | | | Water infilling quickly at SG 1 |
| 11:06 | 8.4 | 0 | 0.02 | | | 171 | Added SG#3 |
| 11:10 | 8.4 | 0 | 0.04 | 0.04 | | 205 | |
| 11:15 | 8.4 | 0 | 0.04 | 0.04 | | 251 | |
| 11:30 | 8.42 | 0.24 | 0.06 | 0.04 | 6.15 | 379 | |
| 11:45 | 8.46 | 0.26 | 0.1 | 0.05 | 5.83 | 497 | |
| 12:00 | 8.49 | 0.28 | 0.11 | 0.05 | 5.63 | 627 | |
| 12:15 | 8.48 | 0.32 | 0.15 | 0.06 | 5.51 | 760 | |
| 12:30 | 8.54 | 0.34 | 0.16 | 0.06 | 5.44 | 880 | Parks and Rec staff working on irrigation |
| 12:45 | 7.92 | 0.35 | 0.15 | 0.08 | 5.4 | 1,007 | |
| 13:00 | 7.84 | 0.36 | 0.2 | 0.08 | 5.38 | 1,122 | |
| 13:15 | 7.94 | 0.38 | 0.2 | 0.09 | | 1,243 | |
| 13:30 | 5.51 | 0.38 | 0.2 | 0.09 | 5.36 | 1,354 | Park suffered water main blowout, flow rate dropped |
| 13:35 | 7.14 | | | | | 1,385 | |
| 13:45 | 7.58 | 0.38 | 0.19 | 0.1 | 5.34 | 1,463 | Pond stable |
| 14:00 | 7.55 | 0.38 | 0.19 | 0.1 | 5.34 | 1,570 | |
| 14:15 | 7.24 | 0.39 | 0.2 | 0.1 | 5.34 | 1,686 | |
| 14:30 | 8.56 | 0.4 | 0.22 | 0.1 | 5.32 | 1,810 | |
| 14:45 | 8.38 | 0.4 | 0.23 | 0.12 | 5.32 | 1,938 | |
| 15:00 | 8.17 | 0.4 | 0.23 | 0.12 | 5.32 | 2,066 | |
| 15:15 | 8.12 | 0.4 | 0.23 | 0.12 | 5.31 | 2,193 | |
| 15:40 | 8.47 | 0.41 | 0.22 | 0.12 | | 2,395 | |
| 15:45 | 8.23 | 0.41 | 0.22 | 0.12 | 5.3 | 2,439 | |
| 16:00 | 8.22 | 0.4 | 0.22 | 0.12 | 5.3 | 2,557 | |
| 16:10 | 7.58 | 0.42 | 0.22 | 0.12 | 5.3 | 2,632 | |
| 16:20 | 8.34 | 0.42 | 0.24 | 0.13 | | 2,716 | |
| 16:30 | 8.28 | 0.42 | 0.24 | 0.13 | 5.3 | 2,796 | |
| 16:40 | 8.26 | 0.42 | 0.25 | 0.13 | 5.29 | 2,877 | |
| 16:50 | 8.28 | 0.42 | 0.25 | 0.14 | 5.29 | 2,960 | Water off |
| 16:52 | | 0.42 | 0.25 | 0.13 | | | |
| 16:54 | | 0.42 | 0.24 | 0.12 | 5.31 | | |
| 17:00 | | 0.38 | 0.2 | 0.1 | | | |
| 17:03 | | 0.36 | 0.18 | 0.08 | 5.35 | | Water on surface appears to flow to north. |
| 17:06 | | 0.36 | 0.18 | 0.06 | | | Ponded water murky, full of leaf litter |
| 17:10 | | 0.34 | 0.16 | 0.05 | | | |
| 17:13 | | 0.33 | 0.15 | 0.03 | 5.38 | | |

| | | | | | | |
|-------|--|------|------|------|------|------------------|
| 17:16 | | 0.32 | 0.14 | 0.02 | | |
| 17:19 | | 0.32 | 0.13 | 0.01 | | SG-3 damp ground |
| 17:22 | | 0.3 | 0.1 | 0.01 | | |
| 17:25 | | 0.3 | 0.1 | 0.01 | | |
| 17:28 | | 0.28 | 0.1 | 0.01 | | |
| 17:31 | | 0.27 | 0.1 | 0.01 | | |
| 17:34 | | 0.25 | 0.09 | 0 | 5.45 | |
| 17:37 | | 0.24 | 0.06 | | | |
| 17:41 | | 0.23 | 0.04 | | 5.48 | |
| 17:43 | | 0.22 | 0.03 | | | |
| 17:45 | | 0.2 | 0.02 | | | |
| 17:48 | | 0.19 | 0.01 | | | |
| 17:50 | | 0.18 | 0.01 | | 5.52 | |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.7 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 2.9 |
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.6 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 3.0 |
| SG-3 Average Infiltration Rate (in/hr) during last hour of inflow: | 2.6 |
| SG-3 Average Infiltration Rate (in/hr) during falling head: | 3.3 |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 2.9 |
| WP Average Infiltration Rate (in/hr) during falling head: | 2.8 |

Yauger Park Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- SG #1 Logger
- SG #2 Hand
- Flow Rate (gpm)
- × SG #1 Hand
- ◇ SG #3 Hand
- Wellpoint Logger
- △ Wellpoint Hand

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)
Cell: Cell 1

Assessed On:
June 14, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2010 and collects road runoff from the adjacent roadway through a series of curb cut inlets. The cell is constructed with 1.5' of bioretention soil placed above the native subgrade. The tested cell is the second in a series of three bioretention swales which grade to the west. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness 1.1-2'

The apparent thickness of the bioretention soil ranges from 1.1-2' with an average of 1.5'. This is consistent with the design plans.

Composition: No soil specifications were received in the design plan documents. In comparison to the 2019 Ecology specifications, the sand gradation and silt content exceeded the standard while the organic content fell within the acceptable range.

Organic Matter Content (% by weight): 7.6

Percent passing #200 sieve: 8.5

Coefficient of Uniformity (Cu): 3.9

Coefficient of Curvature (Cc): 1.8

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Loose, slightly moist, light brown, silty fine SAND, trace gravel (SM)

BUILT PER PLAN:

HA-2 encountered a gravelly fill layer from 1.4-2' below ground surface which was not found in other hand augers. Generally, the cell conditions were observed to be consistent with the plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell. The temporary wellpoint, screened from 3.0-4.5' below ground surface. Once the surface pool expanded to the wellpoint, the water level in the wellpoint rose to the same elevation as the surface water within an hour and remained there for the duration of the test.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >17.4

Subgrade Soil Rate (in/hr): 17.4

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)
Cell: Cell 1

Assessed On:
June 14, 2023



The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | 60's cloudy | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 4 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230614-175812.jpg



Site Photo: FA_SitePhotos-20230614-175930.jpg



Site Photo: FA_SitePhotos-20230614-175906.jpg



Site Photo: FA_SitePhotos-20230614-180006.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)

Cell: Cell 1

Assessed On:

June 14, 2023



Cell Construction

| | |
|---|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No The irrigation line runs the length of the cell on road side.. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell via curb cuts along Yelm Highway. The water is designed to infiltrate through the bioretention soil before reaching the native soils. The cell consists of three bioretention cells linked to one another via surface culverts. Cells are graded down towards the easternmost cell, where they meet an overflow catch basin at surface elevation and join the city storm drain network. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)
Cell: Cell 1

Assessed On:
June 14, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.35'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230614-190447.jpg

Erosion Present? Yes No
Severity: Minor
Slight scouring into cell.

Blockage Present? Yes No
Approximately 35% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Significant sediment & organic buildup was observed on the uphill side of curb cut.



FA_INBLPhoto-20230614-190630.jpg


Additional Details: No energy dissipation was observed on any of the curb cut inlets.


BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)
 Cell: Cell 1

Assessed On:
 June 14, 2023



| | | |
|---|--|--|
| IN-2 <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.25' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230614-190904.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation was observed on any of the curb cut inlets. | | |

| | | |
|--|--|--|
| IN-3 <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 1.4' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230614-191007.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation was observed on any of the curb cut inlets. | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)

Cell: Cell 1

Assessed On:

June 14, 2023



IN-4

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.68'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230615-010218.jpg

Erosion Present? Yes No

Severity: Minor

Some scouring was observed where the pipe meets the cell.

Blockage Present? Yes No

Approximately 15% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Newspaper and leaf litter were observed blocking the bottom of pipe. *Blockage photograph is upside down?



FA_INBLPhoto-20230615-010345.jpg

Additional Details: No energy dissipation was observed.


BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)
Cell: Cell 1


Assessed On:
June 14, 2023



Design Overflow/Outlet

| | | |
|--|---------------|--|
| DO - 1 | |  |
| Shape: | Dimensions: | |
| <input type="checkbox"/> Round | Length: 1.85' | |
| <input checked="" type="checkbox"/> Rectangular | Width: 1.45' | |
| <input type="checkbox"/> Other | | |
| Additional Details: | | |
| Stickup (ft) From Ground: 0 Relative from staff gauge: 0 | | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 90% blocked Additional Details: This overflow feature is outside of the tested cell and is in the easternmost cell, which flows out to the city's storm drain network. The trash rack was completely covered with grass from recent mowing with only some sediment blockage. On prior site visits, no grass was observed covering the trash rack. | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

FA_DOPhoto-20230614-192246.jpg

| | | |
|---|-----------------|--|
| DO - 2 | |  |
| Shape: | Dimensions: | |
| <input checked="" type="checkbox"/> Round | Diameter: 0.68' | |
| <input type="checkbox"/> Rectangular | | |
| <input type="checkbox"/> Other | | |
| Additional Details: | | |
| Stickup (ft) From Ground: 0 Relative from staff gauge: 0 | | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Additional Details: | | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

FA_DOPhoto-20230615-011509.jpg

Cell Surface and Geotech Probe Observations

| | | | | | |
|---------------|--|--|-------------------------------------|---------------------------------------|---|
| Mulch: | <input type="checkbox"/> None | <input checked="" type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth (ft): 0.3 |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)
Cell: Cell 1

Assessed On:
June 14, 2023



The natural mulch is from the decay of grasses in the cell.

Pest Evidence

- Animal Burrows Yes No
- Animal Plant Damage Yes No
- Large Deposition of Feces Yes No

Additional Details:

Vegetation Description

The entire cell is covered in grasses.

Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 1.1-2.0' of bioretention soil, with an average of 1.5', before encountering the underdrain gravels. This is consistent with the 1.5' specified by the plans. The southwestern 30 feet of the cell had probe measurements from 0.4-0.5' of soil before encountering gravels.

Hand Auger

HA-1-WP

- Zone 1 Zone 2 Zone 3
- Outside Cell

Depth (ft)

| | |
|-----------------------|-----|
| to Bioretention Soil: | 0.3 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 4.9 |

Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine-medium SAND, some silt, trace gravel, abundant organics, rootlets (SP-SM)

Native Soil Texture: Vashon Recessional Outwash: Loose, slightly moist, light brown, silty fine to medium SAND, trace fine gravel (SM).

- | | |
|---|---|
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Well Point Detail

- Is the well point dry? Yes No
- Depth to water from TOC (ft):
- Respond to Testing: Yes No
- Shallowest Depth to water during testing from Ground Surface (ft): 0.12

Additional Details

Native soil becomes very silty from 4-4.9 feet in depth.



FA_FPhoto-20230614-124335.jpg

HA-2

- Zone 1 Zone 2 Zone 3
- Outside Cell

Depth (ft)

| | |
|-----------------------|-----|
| to Bioretention Soil: | 0.3 |
| to Native Soil: | 2 |
| to Import/Underdrain: | |

BIORETENTION CELL FIELD ASSESSMENT


Site: Yelm Highway (OLYE)

Cell: Cell 1

Assessed On:

June 14, 2023



| | |
|---|---|
| HA-2 | |
| Total Depth: | 2.8 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine-medium SAND, some silt, trace gravel. Abundant fine organics, rootlets (SP-SM) Native Soil Texture: Vashon Recessional Outwash: Loose, slightly moist, light brown, silty fine to medium SAND, trace gravel (SP-SM). Oxidation present. | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| FA_FPhoto-20230614-131348.jpg | |
| Additional Details More than one unit is present Fill encountered at 1.4-2 feet depth: Moist, medium dense, brownish grey, coarse-medium SAND, some gravel, trace silt. Scattered angular rock chips. Fill not found in other explorations. | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.3 |
| to Native Soil: | 1.7 |
| to Import/Underdrain: | |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine-medium SAND, some silt, trace gravel. Abundant fine organics, rootlets (SP-SM) Native Soil Texture: Vashon Recessional Outwash: Loose, slightly moist, light brown, silty fine to medium SAND, trace gravel (SP-SM). Oxidation present. | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| FA_FPhoto-20230614-170011.jpg | |
| Additional Details 0-0.3: Grasses 0.3-1.4: Bioretention Soil 1.4-1.7: Dark brown, moist, medium-coarse SAND, some gravel, heavily organic with distinct mulch layer composed of bark and compost. 1.7-1.9: Vashon Recessional Outwash. | |

Infiltration Test

| |
|------|
| IT-1 |
|------|

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)

Cell: Cell 1

Assessed On:

June 14, 2023



| | |
|--|--------|
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 401 |
| Ponded Depth (ft) | 0.44 |
| Total Gallons | 29,512 |
| Steady State Flow Rate (GPM) | 74 |

Additional Details:

A temporary berm was constructed out of sandbags blocking the outlet to the neighboring cell. This mechanism did not hold up and instead the flow rate was turned down mid-way through the test to prevent water from flowing into the neighboring cell via this outlet. Additional test details can be found in the executive summary.



IT_Photo-20230614-235845.jpg



IT_Photo-20230614-235901.jpg



IT_Photo-20230614-235941.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Yelm Highway (OLYE)

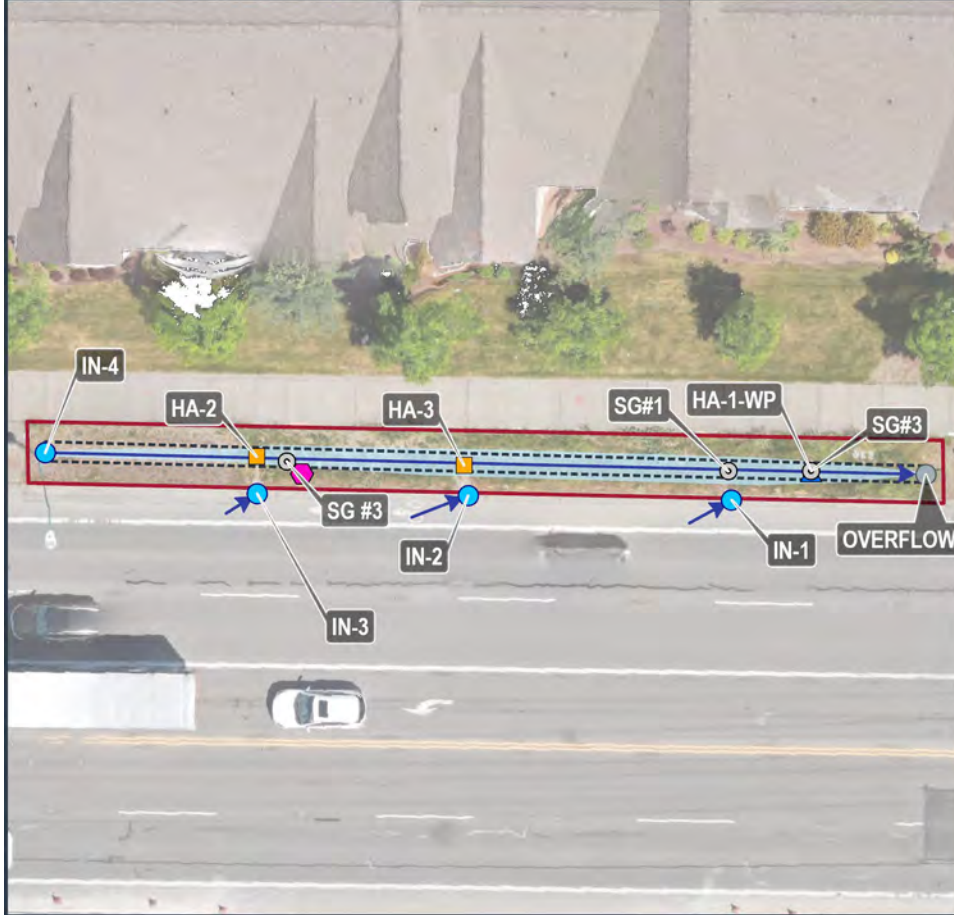
Cell: Cell 1

Assessed On:

June 14, 2023



SITE: YELM HIGHWAY (OLYE) CELL: CELL 1



LEGEND

- WELL POINT
- HAND AUGER
- TEMPORARY STAFF GAUGE
- INLET
- DIFFUSER
- OTHER
- FLOW DIRECTION
- TOP OF FACILITY
- BASE OF FACILITY
- WETTED AREA

N
1 in = 30 ft
LOCATION AND DISTANCES ARE APPROXIMATE.



associated
earth sciences
incorporated

Well Point

OLYE-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/14/2023

Logged By: APJ

20150387H008

Ending Date: 6/14/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 4.9

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 4.9

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 102.4

Water Level Elevation (ft): N/A

Datum: Project Datum

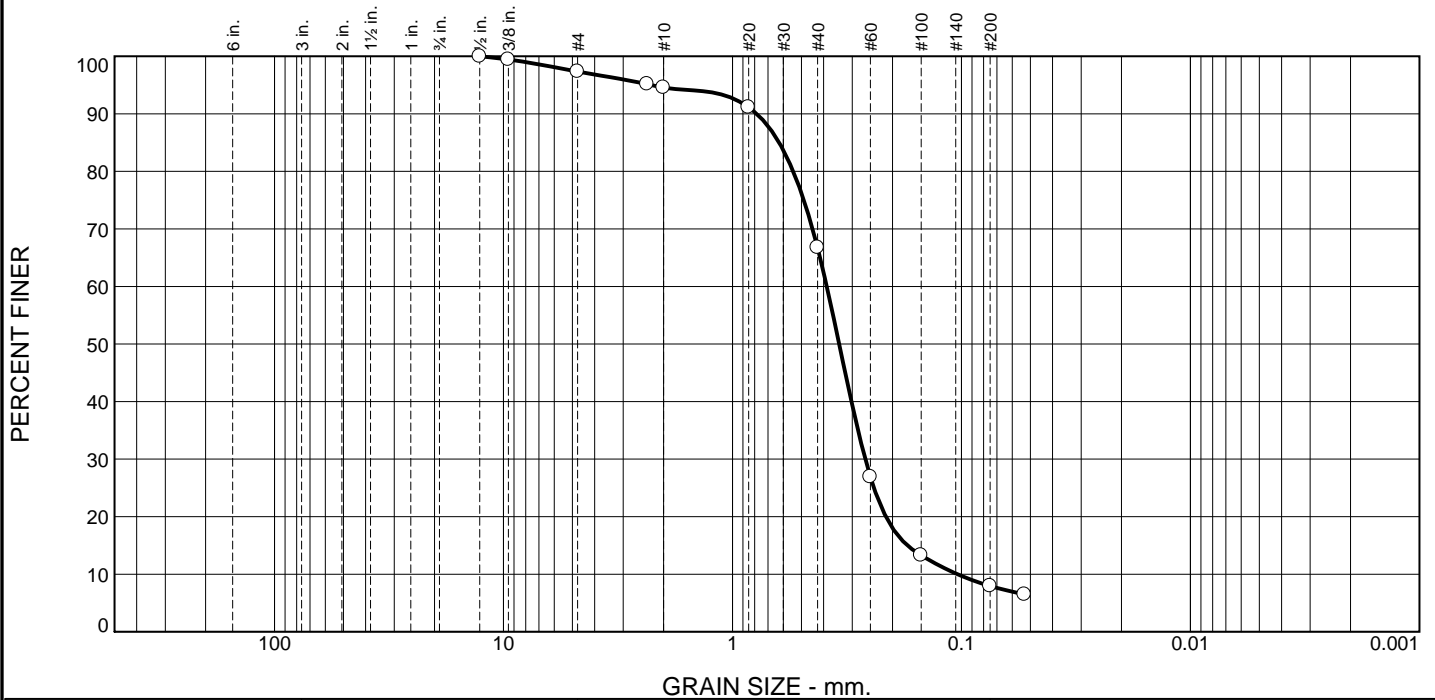
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): N/A ()

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | <p>Grasses Long, fibrous natural mulch and leafy debris.</p> | | | | | | | <p>Stick up -2.4 to 0 feet Existing bioretention soils 0 to 1.5 feet</p> <p>1.25-inch I.D. threaded galvanized steel casing -2.4 to 2.1 feet; duct tape covers screen 2.1 to 3.0 feet</p> <p>3/8-inch bentonite chips 1.5 feet to 2 feet</p> <p>Medium grain silica sand 2 to 5.1 feet</p> <p>1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 3.0 to 4.5 feet</p> <p>Cast iron endcap 4.5 to 4.8 feet Cast iron drivepoint 4.8 to 5.1 feet</p> |
| 1 | Hand | 1 | | <p>Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some silt, trace gravel; abundant fine organics; rootlets (SP-SM).</p> | | | | | | | |
| 2 | Hand | 2 | | <p>Vashon Recessional Outwash Loose, slightly moist, light brown, silty, fine SAND, trace gravel (SM).</p> | | | | | | | |
| 3 | Hand | 3 | | <p>As above; becomes very silty (SP-SM).</p> | | | | | | | |
| 4 | Hand | 4 | | <p>As above; becomes very silty (SP-SM).</p> | | | | | | | |
| 5 | | | | <p>No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. Hole terminated due to time constraints.</p> | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/13/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.7 | 2.7 | 27.8 | 58.8 | 8.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.4 | | |
| #4 | 97.3 | | |
| #8 | 95.2 | | |
| #10 | 94.6 | | |
| #20 | 91.1 | | |
| #40 | 66.8 | | |
| #60 | 26.9 | | |
| #100 | 13.3 | | |
| #200 | 8.0 | | |
| #270 | 6.5 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-3

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 0.7836 | D ₈₅ = 0.6251 | D ₆₀ = 0.3874 |
| D ₅₀ = 0.3421 | D ₃₀ = 0.2631 | D ₁₅ = 0.1722 |
| D ₁₀ = 0.1041 | C _u = 3.72 | C _c = 1.72 |

Remarks

Date Received: 6/16/2023 Date Tested: 7/25/2023

Tested By: EW

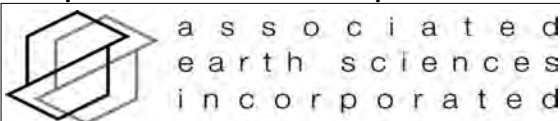
Checked By: APJ/JHS

Title: _____

Location: Onsite - Yelm
Sample Number: HA-1

Depth: 0-1'

Date Sampled: 6/14/2023

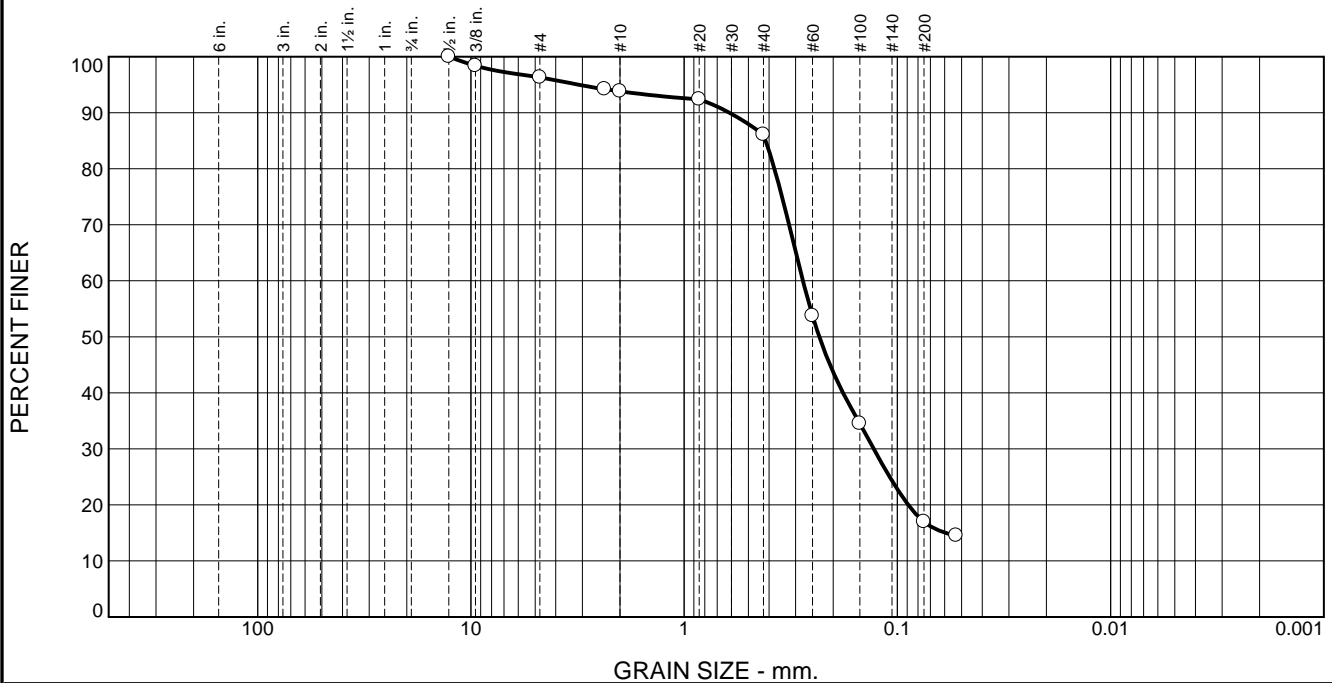


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 3.7 | 2.5 | 7.7 | 69.1 | 17.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 98.4 | | |
| #4 | 96.3 | | |
| #8 | 94.2 | | |
| #10 | 93.8 | | |
| #20 | 92.4 | | |
| #40 | 86.1 | | |
| #60 | 53.8 | | |
| #100 | 34.5 | | |
| #200 | 17.0 | | |
| #270 | 14.5 | | |

Material Description

Native silty SAND, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 0.6137 D₈₅= 0.4147 D₆₀= 0.2773
 D₅₀= 0.2325 D₃₀= 0.1291 D₁₅= 0.0593
 D₁₀= C_u= C_c=

Remarks

Date Received: 6/16/2023 Date Tested: 6/27/2023

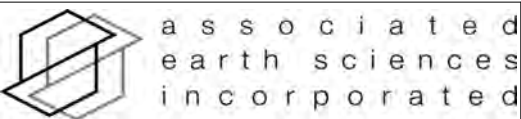
Tested By: EW

Checked By: APJ/JHS

Title: _____

* (no specification provided)

Location: Onsite - Yelm Date Sampled: 6/14/2023
 Sample Number: HA-1 Depth: 1.4-2.5'



Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study
 Project No: 20150387 H008 Figure



associated
earth sciences
incorporated

Exploration Boring

OLYE-HA-2

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 06/14/23

Logged By: APJ

20150387H008

Ending Date: 06/14/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 4

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

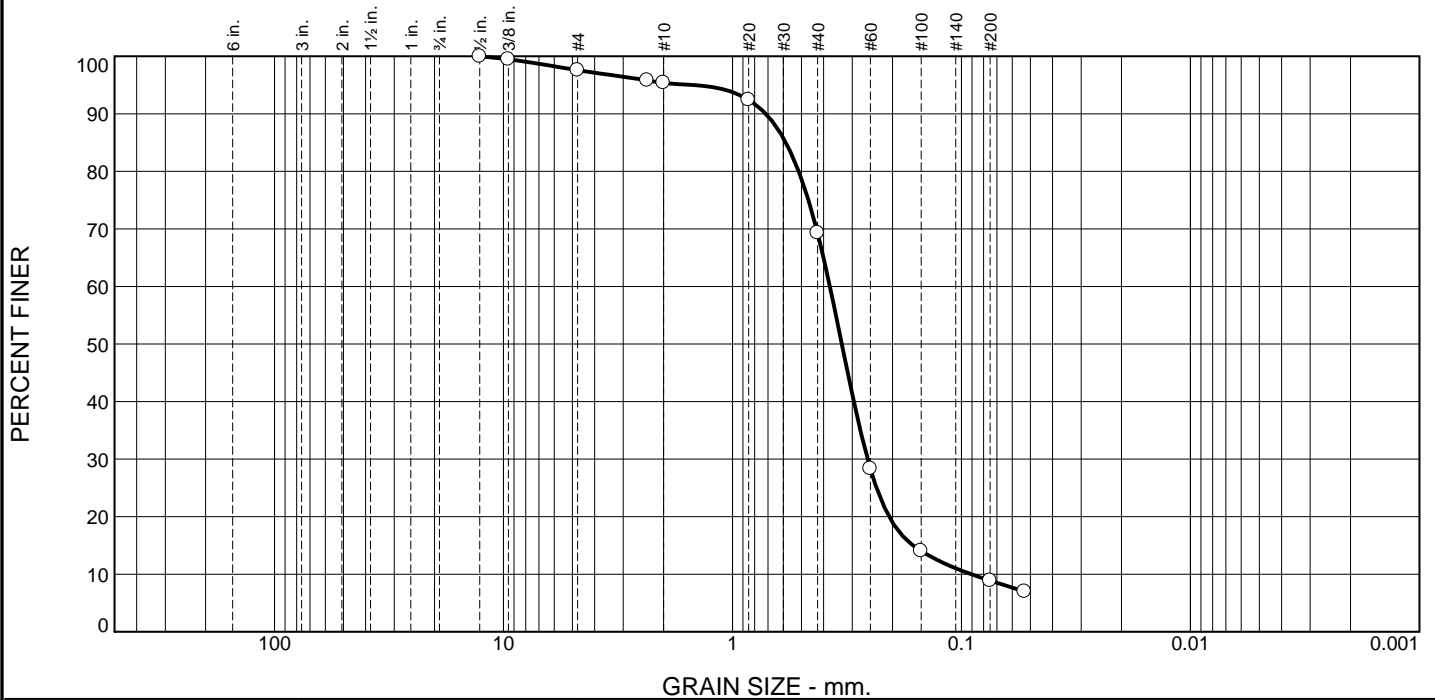
Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | | | | Grasses Long, fibrous natural mulch and leafy debris. | | | | | | | | | |
| 0 | | | | | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some silt, trace gravel; abundant fine organics and rootlets (SM). | | | | | | | | | |
| 1 | Hand | 1 | | | Fill Moist, medium dense, brownish gray, coarse to medium SAND, some gravel, trace silt; scattered angular rock chips (SP). | | | | | | | | | |
| 2 | | | | | Vashon Recessional Outwash Loose, moist, light brown with oxidation present, silty, fine to medium SAND, trace gravel (SM). | | | | | | | | | |
| 3 | Hand | 2 | | | | | | | | | | | | |
| 3 | Hand | 3 | | | | | | | | | | | | |
| 4 | Hand | 4 | | | As above, becomes very silty (SP-SM). | | | | | | | | | |
| 4 | Hand | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.4 | 2.2 | 26.1 | 60.4 | 8.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.5 | | |
| #4 | 97.6 | | |
| #8 | 95.8 | | |
| #10 | 95.4 | | |
| #20 | 92.4 | | |
| #40 | 69.3 | | |
| #60 | 28.3 | | |
| #100 | 14.0 | | |
| #200 | 8.9 | | |
| #270 | 7.0 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-3

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 0.7147 | D ₈₅ = 0.5844 | D ₆₀ = 0.3756 |
| D ₅₀ = 0.3331 | D ₃₀ = 0.2570 | D ₁₅ = 0.1627 |
| D ₁₀ = 0.0907 | C _u = 4.14 | C _c = 1.94 |

Remarks

Large wood/rootlets taken out

Date Received: 6/16/2023 Date Tested: 7/18/2023

Tested By: CI/EW

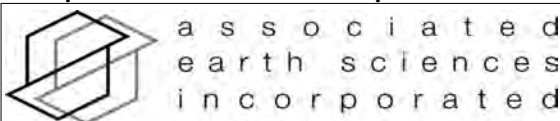
Checked By: APJ/JHS

Title: _____

Location: Onsite - Yelm
Sample Number: HA-3

Depth: 0-1.4'

Date Sampled: 6/14/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|----------------------|--|
| Date Sampled 6/14/2023 | Project BPHS - Yelm Hwy | Project No. 20150387 H008 | | Soil Description Bioretention Soil Mix |
| Tested By CSI | Location Onsite | EB/EP No. HA-1 | Depth 0-1' | |

Moisture Content

| Sample ID | HA-1 @ 0-1' | HA-3 @ 0-1.4' |
|--------------------|--------------|---------------|
| Wet Weight + Pan | 823.3 | 1083.5 |
| Dry Weight + Pan | 771.8 | 957.1 |
| Weight of Pan | 247.1 | 358.0 |
| Weight of Moisture | 51.5 | 126.4 |
| Dry Weight of Soil | 524.7 | 599.2 |
| % Moisture | 9.8 | 21.1 |

Organic Matter and Ash Content

| | | |
|----------------------------|--------------|--------------|
| Dry Soil Before Burn + P. | 771.8 | 957.1 |
| Dry Soil After Burn + Par | 730.0 | 913.5 |
| Weight of Pan | 247.1 | 358.0 |
| Wt. Loss Due to Ignition | 41.8 | 43.6 |
| Actual Wt. Of Soil After E | 482.9 | 555.6 |
| % Organics | 8.0 | 7.3 |

ASSOCIATED EARTH SCIENCES

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--------------|--------------------------------|---|
| Project Name: | Yelm Highway | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) / FM-6 (10-100) |
| Date: | 6/14/2023 | Wetted Area (sq. feet): | 11:10: 162.5 ft^2 / 14:16: 487 ft^2 / 16:21: 401.5 ft^2 |
| Weather: | Clear, 60's | Underdrain | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.46 |
| Performed By: | APJ / CSI | Receptor Soils: | Qvr |

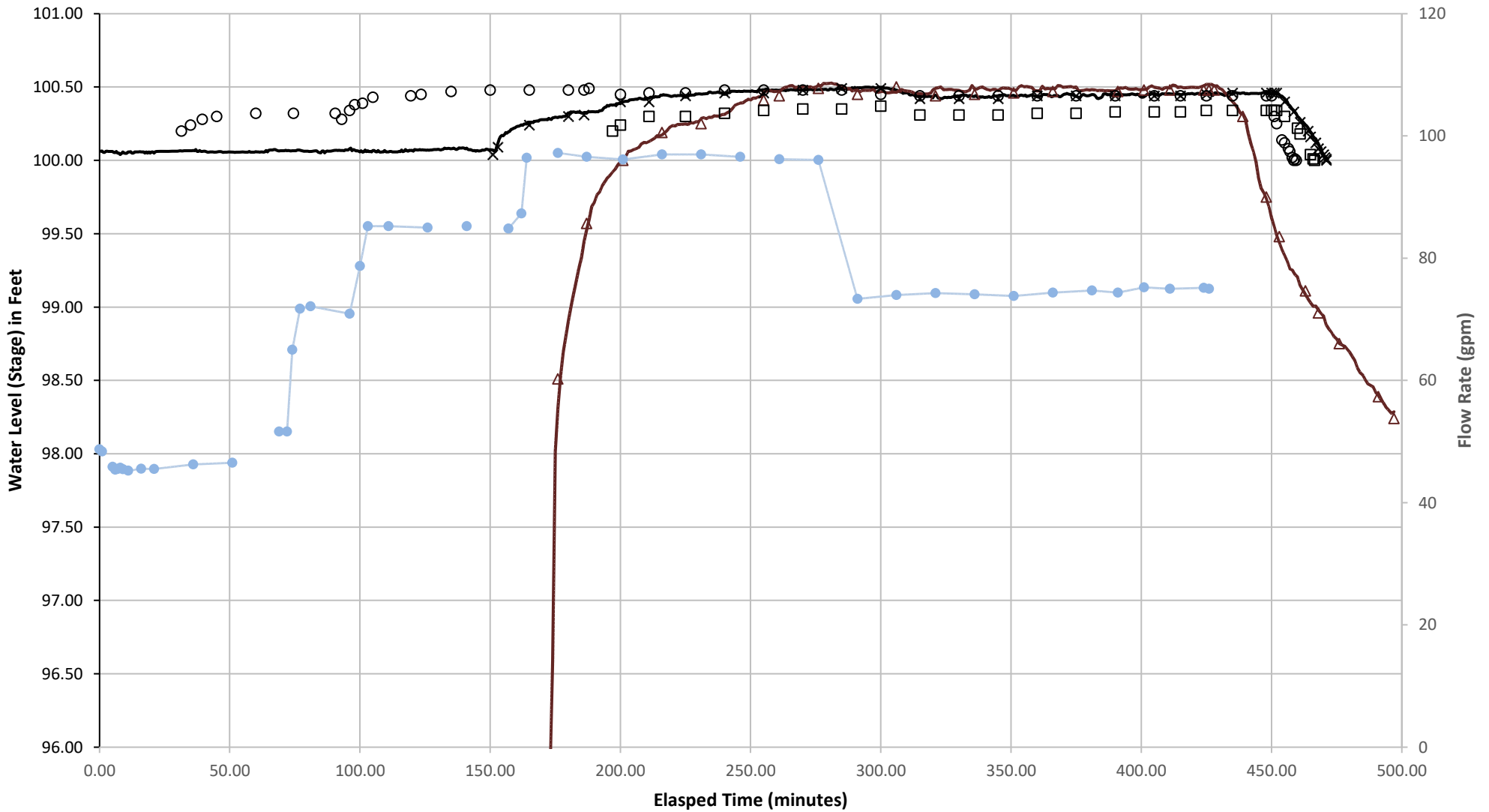
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Staff Gauge #3 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|---------------------|----------------------|---------------------|---|
| 10:09 | 48.75 | | | | | | Water on |
| 10:10 | 48.4 | | | | | 50 | Moved diffuser to inlet |
| 10:11 | | | | | | 87 | Water off, leaky hose connection |
| 10:14 | 45.9 | | | | | | Water on. Slightly leaky fire hose to flow meter connection contributing <.5 gpm into cell. |
| 10:15 | 45.4 | | | | | 143 | |
| 10:16 | 45.54 | | | | | 192 | |
| 10:17 | 45.72 | | 0.2 | | | 218 | |
| 10:18 | 45.48 | | | | | 276 | |
| 10:20 | 45.24 | | 0.24 | | | 363 | |
| 10:25 | 45.55 | | 0.28 | | | 592 | |
| 10:30 | 45.52 | | 0.3 | | | 820 | Ponding in uphill culvert |
| 10:45 | 46.26 | | 0.32 | | | 1,506 | |
| 11:00 | 46.53 | | 0.32 | | | 2,227 | |
| 11:15 | | | 0.32 | | | 2,900 | Water off. Switch to FM-6 |
| 11:18 | 51.65 | | 0.28 | | | 2,900 | Water On |
| 11:21 | 51.65 | | 0.34 | | | 3,070 | |
| 11:23 | 65.05 | | 0.38 | | | 3,246 | |
| 11:26 | 71.73 | | 0.39 | | | 3,445 | Adjust diffuser at 11:29 |
| 11:30 | 72.13 | | 0.43 | | | 3,694 | |
| 11:45 | 70.94 | | 0.44 | | | 4,760 | |
| 11:49 | 78.72 | | 0.45 | | | 5,085 | Increase flow rate to 78 gpm |
| 11:52 | 85.24 | | | | | 5,263 | Increase flow rate to 85 gpm |
| 12:00 | 85.25 | | 0.47 | | | 5,950 | Water less than 15 feet from SG-1 |
| 12:15 | 85 | | 0.48 | | | 7,210 | |
| 12:16 | | 0.04 | | | | 2,900 | Water reaches SG-1 |
| 12:18 | | 0.09 | | | | 2,900 | |
| 12:30 | 85.23 | 0.24 | 0.48 | | | 8,490 | |
| 12:45 | | 0.3 | 0.48 | | | 2,900 | |
| 12:46 | 84.84 | | | | | 9,885 | |
| 12:51 | 87.34 | 0.31 | 0.48 | | | 10,330 | Increase flow rate to 87 gpm |
| 12:53 | 96.43 | | 0.49 | | | 10,506 | Increase flow rate to 97 gpm |
| 13:02 | | | | 0.2 | | 2,900 | Adjust diffuser away from inlet, some water pooling on street |
| 13:05 | 97.24 | 0.4 | 0.45 | 0.24 | 4.49 | 11,570 | |
| 13:16 | 96.6 | 0.4 | 0.46 | 0.3 | 3.43 | 12,673 | |
| 13:30 | 96.15 | 0.44 | 0.46 | 0.3 | 0.3 | 14,045 | |
| 13:45 | 97 | 0.46 | 0.48 | 0.32 | 2.81 | 15,469 | Water reaches outlet |
| 14:00 | 97 | 0.46 | 0.48 | 0.34 | 2.75 | 16,950 | |
| 14:15 | 96.6 | 0.48 | 0.48 | 0.35 | | 18,438 | |
| 14:24 | | | | | 2.59 | 2,900 | |
| 14:30 | 96.2 | 0.49 | 0.48 | 0.35 | 2.56 | 19,823 | |
| 14:45 | 96.09 | 0.49 | 0.45 | 0.37 | 2.51 | 21,288 | Flow down to limit ponding at constructed berm near outlet |
| 15:00 | 73.37 | 0.42 | 0.44 | 0.31 | 2.55 | 22,385 | Pond retreating from berm |
| 15:15 | 73.98 | 0.42 | 0.44 | 0.31 | 2.5 | 23,544 | Stagnant water observed in outlet pipe, <1" head at berm |
| 15:30 | 74.28 | 0.42 | 0.44 | 0.31 | 2.56 | 24,621 | |
| 15:45 | 74.1 | 0.44 | 0.44 | 0.32 | 2.55 | 25,809 | |
| 16:00 | 73.82 | 0.44 | 0.44 | 0.32 | 2.54 | 26,871 | |
| 16:15 | 74.39 | 0.44 | 0.44 | 0.33 | 2.53 | 28,006 | |
| 16:30 | 74.72 | 0.44 | 0.44 | 0.33 | | 29,100 | |
| 16:40 | 74.39 | 0.44 | 0.44 | 0.33 | 2.53 | 29,795 | Stagnant water in inlet pipe |
| 16:50 | 75.25 | 0.45 | 0.44 | 0.34 | 2.52 | 30,600 | |
| 17:00 | 75 | 0.46 | 0.44 | 0.34 | 2.52 | 31,332 | |
| 17:13 | 75.16 | 0.46 | 0.44 | 0.34 | 2.52 | 32,260 | |
| 17:15 | 75 | 0.46 | 0.44 | 0.34 | 2.52 | 32,412 | Water off |

| | | | | | | |
|----------|--|------|------|------|------|---|
| 17:16:00 | | 0.46 | 0.3 | 0.34 | | |
| 17:17:00 | | 0.46 | 0.25 | 0.34 | 2.52 | |
| 17:19:00 | | | 0.14 | | | |
| 17:20:00 | | 0.4 | 0.12 | 0.3 | | |
| 17:21:30 | | | 0.08 | | | |
| 17:22:00 | | | 0.06 | | | |
| 17:23:00 | | | 0.02 | | | |
| 17:23:30 | | 0.33 | | | | |
| 17:24:00 | | | 0.01 | | | |
| 17:24:30 | | | 0 | | | |
| 17:25:00 | | | | 0.22 | | Soils around SG-3 hydrocompacted, staff gauge suspended above pond bottom |
| 17:26:00 | | 0.26 | | 0.18 | | |
| 17:28:00 | | | | | 2.7 | |
| 17:29:00 | | 0.2 | | | | |
| 17:30:00 | | 0.16 | | 0.04 | | |
| 17:31:00 | | | | 0.01 | | |
| 17:31:30 | | | | Dry | | |
| 17:32:00 | | 0.12 | | | | |
| 17:33:00 | | 0.08 | | | | |
| 17:34:00 | | 0.06 | | | | |
| 17:35:00 | | 0.04 | | | | |
| 17:35:30 | | 0.02 | | | | |
| 17:36:00 | | 0.01 | | | | |
| 17:36:30 | | 0 | | | | |
| 17:37:00 | | | | | 3.25 | |
| 17:42:00 | | | | | 3.52 | |
| 17:52:00 | | | | | 3.89 | |
| 17:57:00 | | | | | 4.04 | |
| 18:05:00 | | | | | 4.25 | |
| 18:20:00 | | | | | 4.61 | |
| 18:26:00 | | | | | 4.76 | |

| | |
|---|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 17.4 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 15.4 |
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 17.6 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 34.4 |
| SG-3 Average Infiltration Rate (in/hr) during last hour of inflow: | 17.5 |
| SG-3 Average Infiltration Rate (in/hr) during falling head: | 14.9 |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 17.7 |
| WP Average Infiltration Rate (in/hr) during falling head: | 23.9 |
| SG-2 Average Infiltration Rate (in/hr) 10:20-11:00: | 26.2 |
| WP Average Infiltration Rate (in/hr) during falling head (Logger 17:39-18:25) | 20.8 |

Yelm Highway Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- Staff Gauge #2 Hand Data
- Staff Gauge #3 Hand Data
- Wellpoint Logger
- △ Wellpoint Hand
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
Cell: Bioretention Cell

Assessed On:
June 20, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and collects stormwater runoff from the adjacent roundabout through a single piped inlet. The cell is constructed with 1.5' of bioretention soil above a 4-6" of gravel backfill for drains above a 1' layer of gravel backfill for dry wells, in which the perforated underdrain pipe is placed. The underdrain gravels are designed to be 6' wide. An overflow structure allows for 1' of maximum ponding. All water is designed to infiltrate through the bioretention soil and enter the underdrain where it is conveyed to the storm drain network.

BIORETENTION SOIL:

Thickness: 1-1.7'

The apparent thickness of the bioretention soil based on hand auger explorations and probes ranged from 1-1.7' with an average of 1.3'. This is slightly less than the 1.5' specified by the plans.

Composition: The design plans call for the soil specifications from the 2012 Ecology stormwater manual, which are equivalent to the 2019 edition. In comparison to the 2019 Ecology standards, the sand gradation and organic matter content met the specifications while the silt content exceeded them by 0.1%. Soil samples taken from the northeast corner of the facility near the inlet found wet, silty sediments (Fines content=10.6%).

Organic Matter Content (% by weight): 5.0

Percent passing #200 sieve: 5.1

Coefficient of Uniformity (Cu): 7.8

Coefficient of Curvature (Cc): 1.3

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Subgrade soils were not encountered in hand auger explorations.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans. One unique feature of the design was the approximately 6'x4' zone in between the inlet and the catch basin. No underdrain gravels were encountered in this portion of the cell and standing water was observed after rainfall events the day prior. This portion of the cell was not inundated with water from the infiltration test and likely has a far slower infiltration rate than the rest of the cell. The soil in this area was much siltier than the rest of the cell.

GROUNDWATER CONDITIONS:

No groundwater was encountered in the cell base. Some standing water was observed in the northeast corner of the facility near the inlet from recent rainfall which infiltrated poorly through the silty sediments encountered in HA-2.

The temporary wellpoint was screened from 1.6-2.6' below ground surface and did not respond to testing.

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
 Cell: Bioretention Cell

Assessed On:
 June 20, 2023



INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 99.8
 Subgrade Soil Rate (in/hr): N/A

No subgrade soil rate can be measured due to the presence of the underdrain.

This cell was tested during phase one of the study in 2016. The measured infiltration rate of the bioretention soil was 58 in/hr.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The silty materials described above may be worthy of remediation, otherwise, the cell was in generally working condition.

Field Conditions

| | | | |
|-----------------|-------------------------|-----------------|---------------------------|
| Weather | Rain, 60s | | |
| Recent Rainfall | Today: 0.3" | Yesterday: 0.1" | Two Days Ago: 0.38" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 4 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230620-201006.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
 Cell: Bioretention Cell

Assessed On:
 June 20, 2023



Site Photo: FA_SitePhotos-20230620-201120.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation presence noted by Rick Jordan (Poulsbo PUD representative). Irrigation not found on-site. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Partial Width Width 6' The width of the underdrain trench was determined by subsurface probing. The trench is not the full width of the pond base. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments Cleanout could not be opened during site visit. | |

Cleanouts

| | |
|------------------------------------|---|
| CL-1 | |
| Condition | Accessible: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Distance from overflow/outlet: 60' | |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)

Cell: Bioretention Cell

Assessed On:

June 20, 2023



IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.9'

Energy Dissipation

Angular Rock: Buried

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230620-201903.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
Cell: Bioretention Cell

Assessed On:
June 20, 2023



Erosion Present? Yes No

Severity: Major

The swail immediately adjacent to inlet pipe appears to be the lowest elevation in the cell and the underlying sediments are silty. Elevation dip likely due to scour and deposition of fines.

Blockage Present? Yes No

Approximately 35% blocked

Types:

Sediment Organic Rock

Trash Vegetation

Additional Details: Bottom 1/3 of pipe full of dark grey silty material. Standing water observed in pipe after today's rain event.



FA_INBLPhoto-20230620-234417.jpg

Additional Details: Angular rock scattered up to 5 feet away from cell and buried in silty organic material was present at the base of the inlet.


BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
Cell: Bioretention Cell

Assessed On:
June 20, 2023



Design Overflow/Outlet

| | |
|---|---|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2' Width: 0.65' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.35 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| FA_DOPhoto-20230620-203835.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|--|--|---|-----------------------------------|--|------------------------------------|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | | |
| Cell Coverage | | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Two scours were observed off Lincoln Ave perpendicular to street. A linear scour with sediment deposition in cell bottom akin to turbidite deposition was observed. Natural mulch and grasses cover much of the cell. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Additional Details: Dead animal in catch basin. | | | | | | |
| Vegetation Description | | | | | | |
| Lots of vegetation covering cell. Would have limited observation of ponded area should the pond have expanded further towards the catch basin. | | | | | | |
| Additional Details | | | | | | |
| Geotech Probe Observation: Probe depths from the center of the cell ranged from 1.0-1.7 feet (plans call for 1.5' of bioretention soil). Probe depths were measured to be the shallowest in the southern portion of the cell near the cleanout (1.0'). | | | | | | |
| The width of the underdrain trench was found to be about 6' wide and the length was estimated to be approximately 60'. No zones of excessive compaction were observed. | | | | | | |

Hand Auger

| | |
|--|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 | <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
 Cell: Bioretention Cell

Assessed On:
 June 20, 2023



HA-1-WP

| | |
|-----------------------|-----|
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.2 |
| Total Depth: | 2 |

Rain/Garden Mix Soil Texture: Loose, moist-very moist, dark brown, medium to fine SAND, trace gravel, some silt. Scattered rootlets and abundant organics (SP)

Native Soil Texture: Underdrain: Loose, gray, GRAVEL (GP)

| | |
|---|---|
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft):



FA_FPhoto-20230620-203901.jpg



IMG_2919.jpg

Additional Details

0-1.2: Bioretention soil

1.2-1.5: Underdrain gravels, average gravel diameter 1"

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
 Cell: Bioretention Cell

Assessed On:
 June 20, 2023



HA-1-WP

1.5-2: Underdrain gravels, average gravel diameter 2"

No groundwater was encountered.

HA-2

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1 |
| to Import/Underdrain: | |
| Total Depth: | 2.5 |

Rain/Garden Mix Soil Texture: Loose, very moist, dark brown, fine-medium SAND, some silt, trace gravel. Abundant organics (SW-SM).
 Native Soil Texture: Wet, loose, orange-ish brown, sandy GRAVEL, some silt (GP-GM)

| | |
|---|---|
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|---|---|



IMG_2923.jpg

Additional Details

0-1: Bioretention Soil Mix
 1-1.7: Fill, described above
 1.7-2.5: Fill: Loose, wet, grey, medium SAND, trace silt, trace gravel (SP)

Groundwater encountered at 2'.

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 2.5 |


Rain/Garden Mix Soil Texture: Loose, dark brown, fine to medium SAND, some coarse sand, some silt, trace gravel. Abundant organics. (SP-SM)

BIORETENTION CELL FIELD ASSESSMENT


Site: Noll Road Roundabout (PUNR)
Cell: Bioretention Cell

Assessed On:
June 20, 2023



| | |
|---|---|
| HA-3 | |
| Native Soil Texture: Loose, moist, orangeish brown, fine to medium SAND, silty, some gravel. | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| <p>Additional Details</p> <p>0-1.4: Bioretention Soil</p> <p>1.4-2.0: Fill: Described above</p> <p>2.0-2.5: Fill: Loose, very moist, greyish brown, GRAVEL, some silt, some sand, some silt.</p> <p>No groundwater encountered. Review with physical log.</p> | |

IMG_2946.jpg

| | |
|---|---|
| HA-4 | |
| <input type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 0.7 |
| Total Depth: | 1.3 |
| Rain/Garden Mix Soil Texture: Loose, moist-very moist, dark brown, medium to fine SAND, trace gravel, some silt. Scattered rootlets and abundant organics (SP) Native Soil Texture: Loose, slightly moist, brown GRAVEL, some medium sand, trace silt (GP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| <p>Additional Details</p> <p>0-0.7': BSM</p> <p>0.7': Mixed sand and gravel encountered</p> <p>0.7-1.3': Underdrain Gravels</p> | |

IMG_2928.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Noll Road Roundabout (PUNR)
Cell: Bioretention Cell

Assessed On:
June 20, 2023



Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-7 (50-300)

Wetted Pond Area (sq. ft) 143

Ponded Depth (ft) 0.33

Total Gallons 44,799

Steady State Flow Rate (GPM) 148

Additional Details:

Flow started below 100 gpm per agreements with Poulsbo PUD (Keith). Flow increased to 150 gpm upon approval from PUD mid-way through test.



IT_Photo-20230620-223036.jpg



IT_Photo-20230620-223100.jpg



IT_Photo-20230620-223128.jpg

Additional Comments

Seems as though the ~6x4 area between the inlet and the catch basin is disconnected from the hydraulics of the rest of the cell. NO underdrain gravels encountered in this area and standing water was observed in this zone after

BIORETENTION CELL FIELD ASSESSMENT

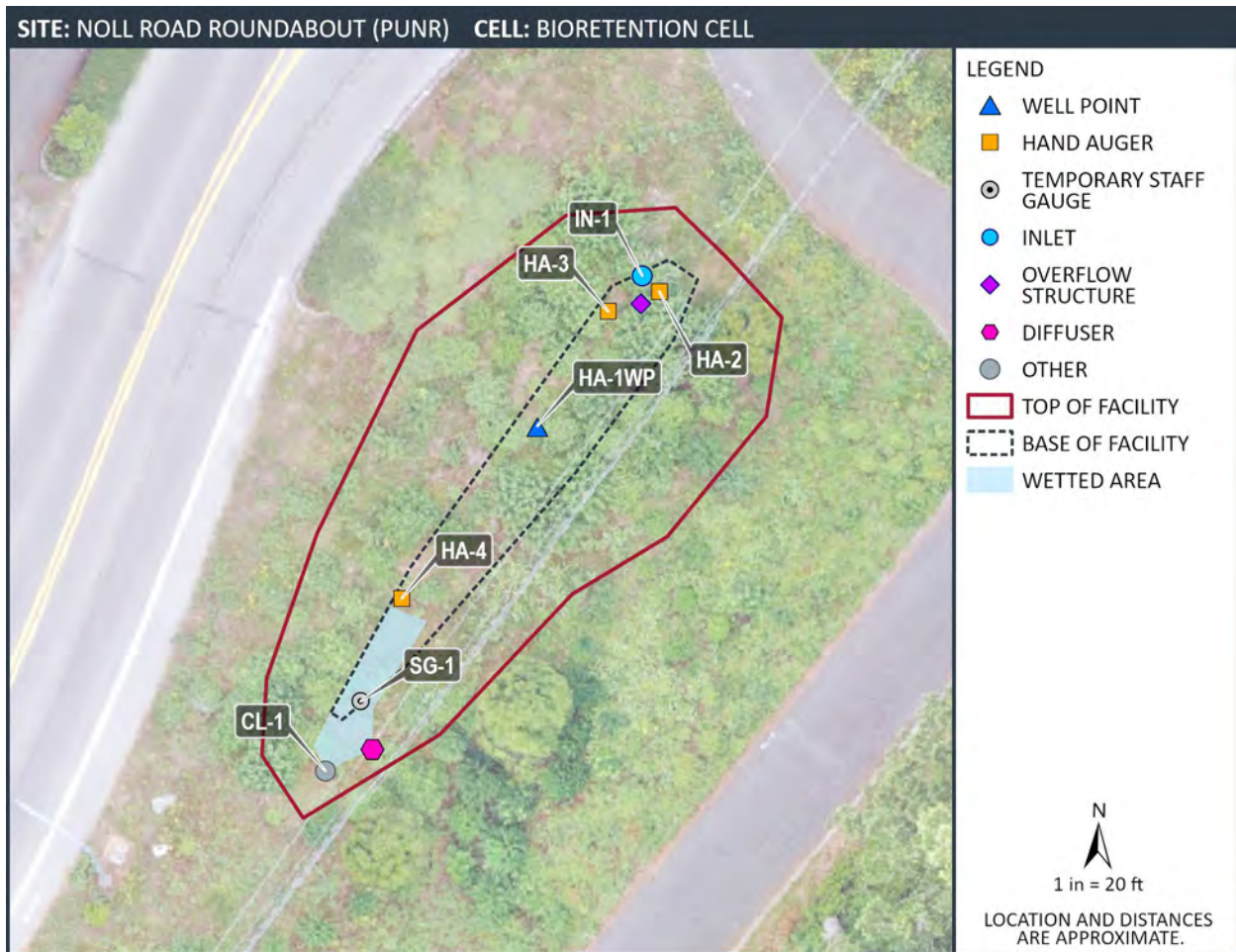
Site: Noll Road Roundabout (PUNR)
Cell: Bioretention Cell

Assessed On:
June 20, 2023



rainfall events last night and mid-day. Hand augers yielded water below surface. IN complete contrast with 100 in/hr of rest of site. Seems that for most small-ish storm events the cell does not function as intended and only a small portion of the cell recieves water. Biosoil was much siltier in this region as well.

Field infiltration rate is in contrast to phase one results. Infiltration rate much higher in 2023.





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Well Point

PVNR-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/20/2023

Logged By: APJ

20150387H008

Ending Date: 6/20/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.2

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.5

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----------|----------|----------|----------|---|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Bioretention Soil Mix Loose, very moist to moist, dark brown, fine to medium SAND, some coarse SAND, trace gravel, trace silt; scattered rootlets; abundant organics (SP). Becomes moist, brown; trace rootlets. | | | | | | | <p>Stick up -4.5 to 0 feet Existing bioretention soil 0 to 0.3 feet 3/8-inch bentonite chips 0.3 to 1 feet 1.25-inch I.D. threaded galvanized steel casing -4.5 to 0.2 feet; duct tape covers screen 0.2 to 1.6 feet Medium grained silica sand 1 to 3.2 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.6 to 2.6 feet Cast iron drive point end cap 2.6 to 2.9 feet Cast iron drive point 2.9 to 3.2 feet</p> |
| 1 | | 1 | | | | | | | | | |
| | | 2 | | | | | | | | | |
| | | 3 | | Underdrain Gravel Loose, gray, GRAVEL; gravel rounded (GP). Excavation resistance increases; gravel rounded (GP). | | | | | | | |
| | | 4 | | | | | | | | | |
| 2 | | 5 | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

11/16/2023

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Exploration Boring

PVNR-HA-2

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 06/20/23

Logged By: APJ

20150387H008

Ending Date: 06/20/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.5

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

▼ Groundwater Depth ATD (ft): 2

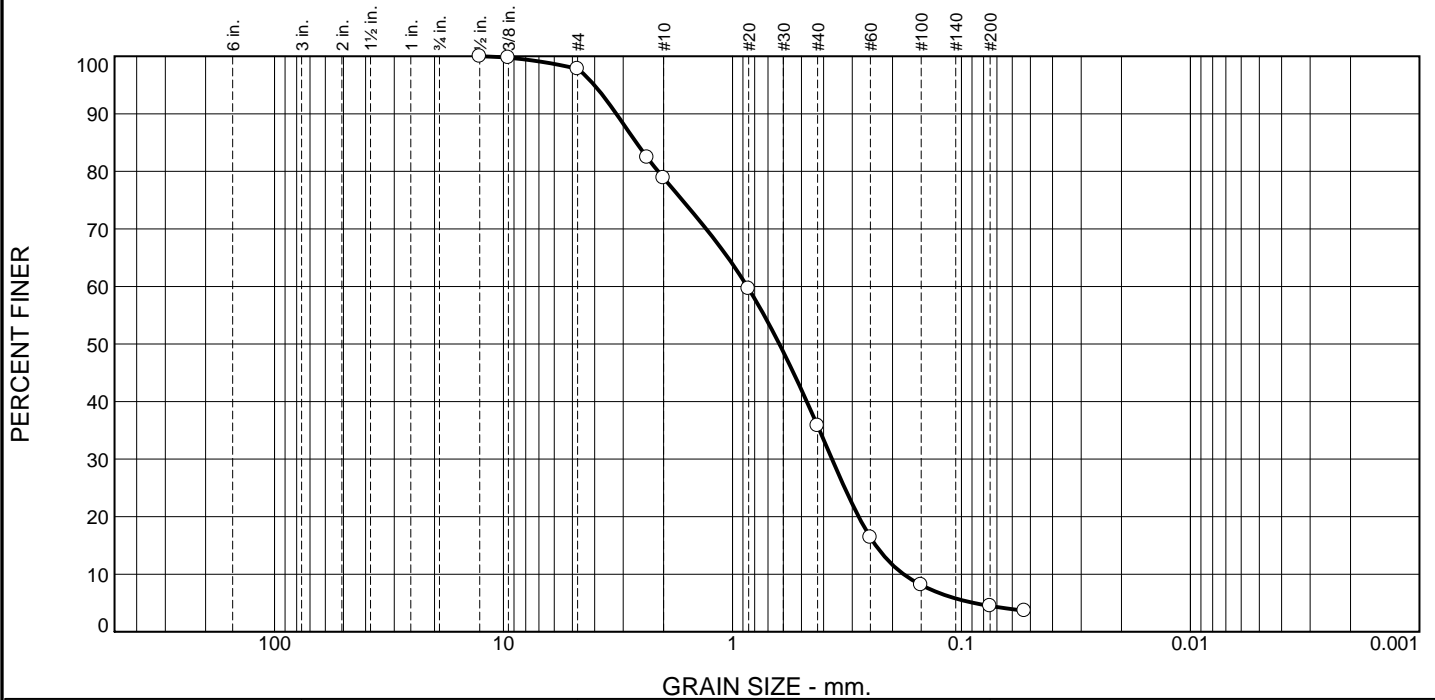
∇ Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|---|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | | | | Bioretention Soil Mix Loose, very moist, dark brown, fine to medium SAND, some silt, trace gravel; abundant organics (SW-SM). | | | | | | | | | |
| 1 | | | | | Import Fill Wet, loose, orangish brown, sandy, GRAVEL, some silt (GP-GM). | | | | | | | | | |
| 2 | | | | | Loose, wet, gray, SAND, trace silt, trace gravel (SP). | ▼ | | | | | | | | |
| 3 | | | | | Perched groundwater encountered at 2 feet ATD. Hole terminated due to caving at 2.5 feet. | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

12/13/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.2 | 18.9 | 43.1 | 31.3 | 4.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 97.8 | | |
| #8 | 82.4 | | |
| #10 | 78.9 | | |
| #20 | 59.6 | | |
| #40 | 35.8 | | |
| #60 | 16.4 | | |
| #100 | 8.1 | | |
| #200 | 4.5 | | |
| #270 | 3.7 | | |

* (no specification provided)

Material Description

SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.2153 D₈₅= 2.6300 D₆₀= 0.8617
 D₅₀= 0.6240 D₃₀= 0.3677 D₁₅= 0.2367
 D₁₀= 0.1789 C_u= 4.82 C_c= 0.88

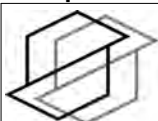
Remarks

Date Received: 6/20/2023 Date Tested: 7/25/2023
 Tested By: CI
 Checked By: APJ/JHS
 Title: _____

Location: Onsite - Noll Rd
 Sample Number: HA-1

Depth: 0-0.5'

Date Sampled: 6/20/2023



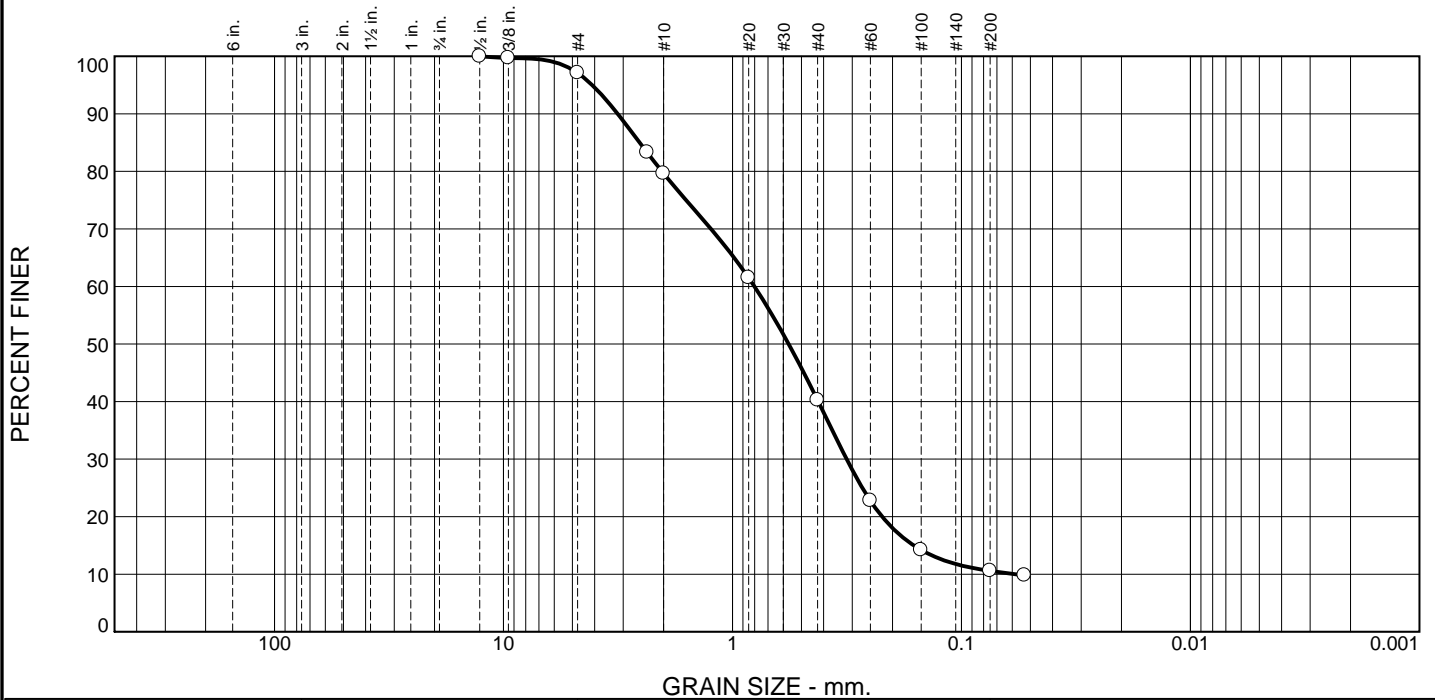
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.9 | 17.4 | 39.4 | 29.7 | 10.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 97.1 | | |
| #8 | 83.3 | | |
| #10 | 79.7 | | |
| #20 | 61.5 | | |
| #40 | 40.3 | | |
| #60 | 22.8 | | |
| #100 | 14.2 | | |
| #200 | 10.6 | | |
| #270 | 9.8 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.1726 | D ₈₅ = 2.5429 | D ₆₀ = 0.8015 |
| D ₅₀ = 0.5683 | D ₃₀ = 0.3174 | D ₁₅ = 0.1615 |
| D ₁₀ = 0.0582 | C _u = 13.78 | C _c = 2.16 |

Remarks

Date Received: 6/20/2023 Date Tested: 9/21/2023

Tested By: FEW

Checked By: APJ/JHS

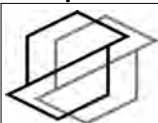
Title: _____

Location: Onsite - Noll Rd

Sample Number: HA-2

Depth: 0-0.4'

Date Sampled: 6/20/2023



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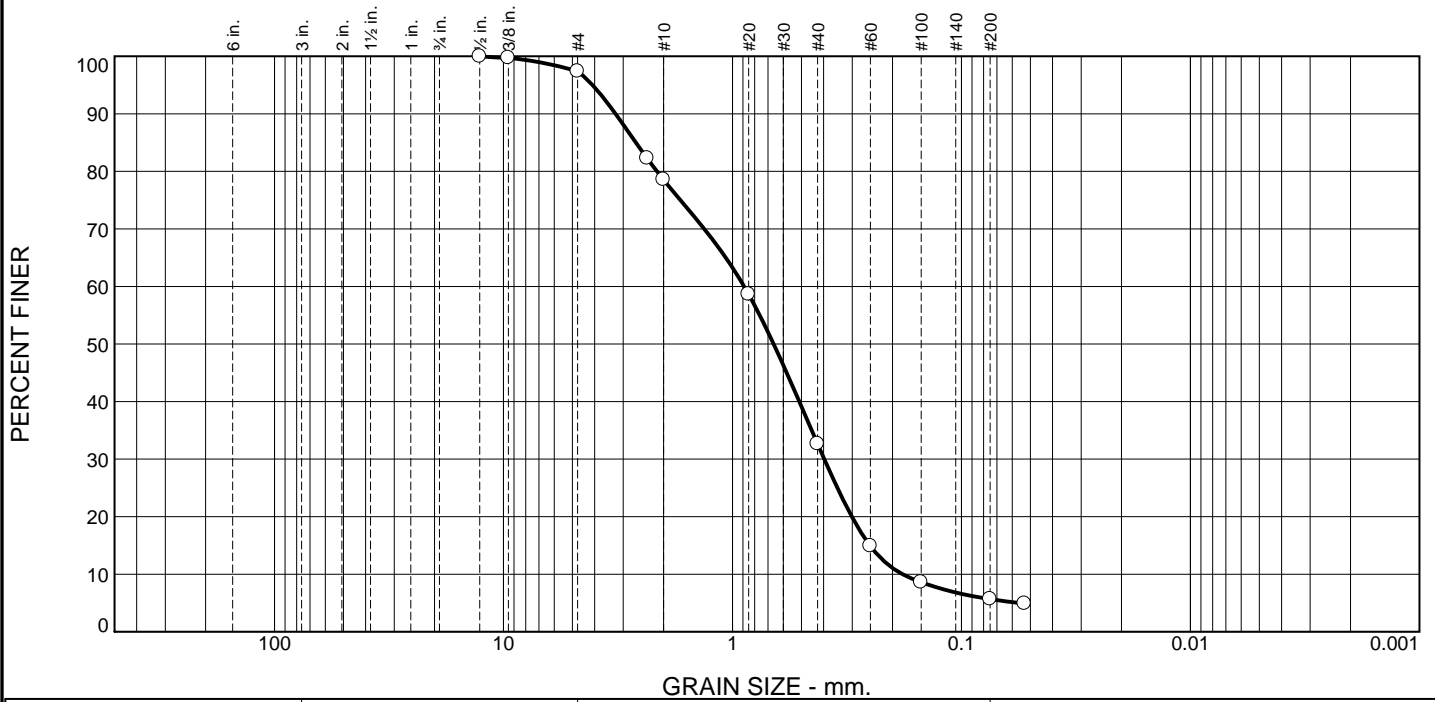
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.6 | 18.8 | 45.9 | 27.0 | 5.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 97.4 | | |
| #8 | 82.3 | | |
| #10 | 78.6 | | |
| #20 | 58.6 | | |
| #40 | 32.7 | | |
| #60 | 14.9 | | |
| #100 | 8.6 | | |
| #200 | 5.7 | | |
| #270 | 4.9 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.2410 | D ₈₅ = 2.6421 | D ₆₀ = 0.8891 |
| D ₅₀ = 0.6607 | D ₃₀ = 0.3972 | D ₁₅ = 0.2513 |
| D ₁₀ = 0.1810 | C _u = 4.91 | C _c = 0.98 |

Remarks

Date Received: 6/20/2023 Date Tested: 9/21/2023

Tested By: FEW

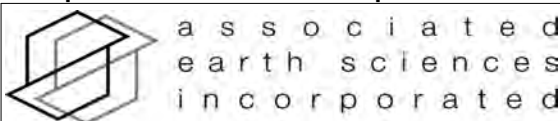
Checked By: APJ/JHS

Title: _____

Location: Onsite - Noll Rd
Sample Number: HA-3

Depth: 0-0.75

Date Sampled: 6/20/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|---------------------------------|--------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 7/5/2023 | Project BHPS - PUNR | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Poulsbo, WA | EB/EP No. PUNR-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0-0.4' | HA-3 @ 0-0.75' |
|--------------------|---------------|----------------|
| Wet Weight + Pan | 914.3 | 1483.1 |
| Dry Weight + Pan | 800.1 | 1364.9 |
| Weight of Pan | 247.1 | 392.0 |
| Weight of Moisture | 114.2 | 118.3 |
| Dry Weight of Soil | 553.0 | 972.9 |
| % Moisture | 20.7 | 12.2 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|--------|
| Dry Soil Before Burn + Pan | 800.1 | 1364.9 |
| Dry Soil After Burn + Pan | 772.5 | 1342.0 |
| Weight of Pan | 247.1 | 392.0 |
| Wt. Loss Due to Ignition | 27.5 | 22.8 |
| Actual Wt. Of Soil After Burn | 525.5 | 950.1 |
| % Organics | 5.0 | 2.3 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|----------------------|--------------------------------|----------------------------------|
| Project Name: | Noll Road Roundabout | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | 50-300 |
| Date: | 6/20/2023 | Wetted Area (sq. feet): | 13:45: 143 ft^2 |
| Weather: | Scattered showers | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.33 |
| Performed By: | APJ / CSI | Receptor Soils: | Underdrain Gravels / Vashon Till |

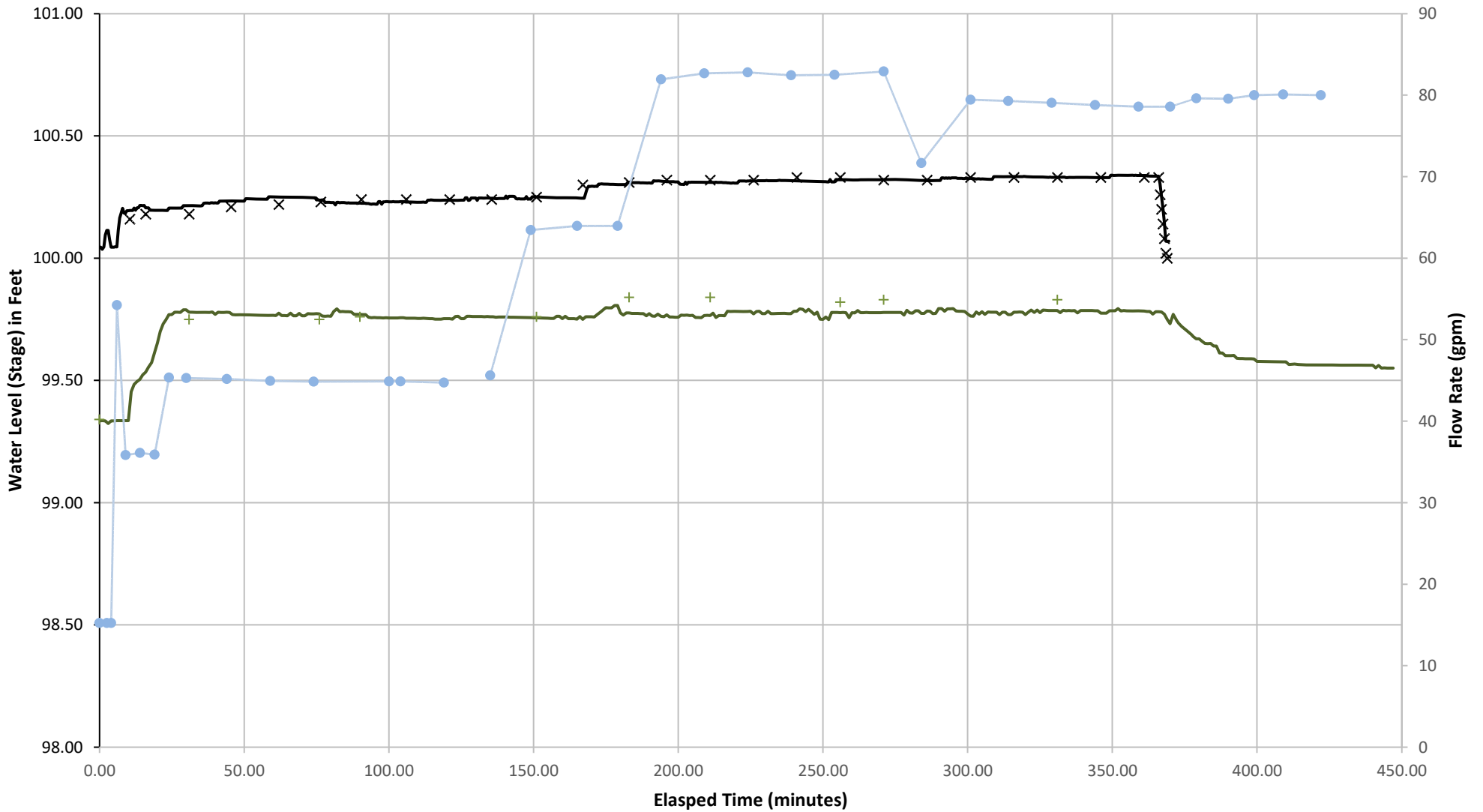
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Catch Basin (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|------------------|---------------------|---|
| 9:29 | 69 | | Dry | 4.66 | | Water on |
| 9:32 | | | | | 150 | Water off - leaky hose |
| 9:34 | | | | | | Water on |
| 9:35 | 105.3 | | | | 184 | |
| 9:36 | 105.45 | | | | 288 | Moved diffuser to east edge of cell |
| 9:38 | 105.12 | | | | 476 | |
| 9:39 | 104.74 | | | | 582 | Leaky hose fitting |
| 9:40 | 93 | 0.16 | | | 690 | |
| 9:41 | 93 | | | | 779 | |
| 9:45 | 93.18 | 0.18 | | | 1,161 | Water flowing into underdrain/CB |
| 10:00 | 93.02 | 0.18 | | 4.25 | 2,539 | 10:10 water discolored |
| 10:15 | 93.35 | 0.21 | | | 3,933 | |
| 10:31 | 93.16 | 0.22 | | | 5,425 | 10:35 water clear |
| 10:46 | 93.35 | 0.23 | | 4.25 | 6,828 | |
| 11:00 | 93.52 | 0.24 | | 4.24 | 8,061 | |
| 11:15 | 93.18 | 0.24 | | | 9,524 | |
| 11:30 | 93.35 | 0.24 | | | 10,941 | |
| 11:45 | 93.87 | 0.24 | | | 12,383 | |
| 12:00 | 93.35 | 0.25 | | 4.24 | 13,748 | |
| 12:16 | 93.7 | 0.3 | | | 15,248 | Increase flow rate to 150 gpm |
| 12:32 | 149.36 | 0.31 | | 4.16 | 17,768 | |
| 12:45 | 149.56 | 0.32 | | | 19,558 | Outfall increased flow, cleanout submerged |
| 13:00 | 147.2 | 0.32 | | 4.16 | 21,778 | |
| 13:15 | 148.46 | 0.32 | | | 24,000 | |
| 13:30 | 147.73 | 0.33 | | | 26,222 | Water flow from inlet <1gpm due to rainfall |
| 13:45 | 149.56 | 0.33 | | 4.18 | 28,466 | |
| 14:00 | 148.46 | 0.32 | | 4.17 | 30,709 | |
| 14:15 | 148.28 | 0.32 | | | 32,937 | |
| 14:30 | 149.02 | 0.33 | | | 35,163 | |
| 14:45 | 147.9 | 0.33 | | | 37,386 | |
| 15:00 | 148.5 | 0.33 | | 4.17 | 39,609 | |
| 15:15 | 147.97 | 0.33 | | | 41,979 | |
| 15:30 | 148.1 | 0.33 | | | 44,049 | |
| 15:35 | 148 | 0.33 | | | 44,799 | Water off |
| 15:35 | | 0.26 | | | | |
| 15:36 | | 0.2 | | | | |
| 15:36 | | 0.14 | | | | |
| 15:37 | | 0.08 | | | | |

| | | | | | |
|-------|--|------|-----|--|---------------|
| 15:37 | | 0.02 | | | |
| 15:38 | | 0 | Dry | | SG sunk 0.02' |

| | |
|--|------|
| Average Infiltration Rate (in/hr) during last hour of inflow SG-1: | 99.8 |
| Average Infiltration Rate (in/hr) during falling head SG-1: | 89.3 |

Noll Road Roundabout Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
Cell: BioCell 1 (Upper)

Assessed On:
June 22, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2009 and collects stormwater runoff from the adjacent roadway through sheet flow and from a piped inlet. The cell is constructed with 1.5' of bioretention soil above a 4-6" of gravel backfill for drains above a 1' layer of gravel backfill for dry wells, in which the perforated underdrain pipe is placed. The cell is graded at a 1% slope and the overflow structure is designed to allow for 0.5' of ponding. Water is designed to infiltrate through the bioretention soil and enter the underdrain, which connects all five cells in series. Water which enters the overflow structure is designed to enter the next cell in series.

BIORETENTION SOIL:

Thickness: 0.3-2.1

The average thickness of the bioretention soil ranged from 0.3' to 2.1' with an average soil thickness of 1.5'. There is a wide variation in soil thickness due to scouring of bioretention soil in the south end of the cell and re-deposition in the northern end of the cell.

Composition: The design plans call for a soil mix of 30-35% composted material and 65-70% gravelly sand meeting the specification ASTM D422. In comparison to the design plans, the tested soil met the specifications for the sand gradation but exceeded the maximum specified fines content (3%). In comparison to the 2019 Ecology specifications, the tested material fell below the specifications for sand gradation and exceeded the specifications for silt content. The organic matter content exceeded both the design plans and 2019 Ecology specifications.

Organic Matter Content (% by weight): 6.4

Percent passing #200 sieve: 5.2

Coefficient of Uniformity (Cu): 12.3

Coefficient of Curvature (Cc): 0.5

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Hand auger explorations completed in the cell did not penetrate the underdrain gravels.

BUILT PER PLAN:

The catch basin was not set with 0.5' of freeboard. Only 0.14' of ponding was able to sit in the cell base before water entered the overflow structure.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell, though the sampled underdrain gravels were classified as wet. The temporary wellpoint was screened from 1.5-2.5' below ground surface and did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 4.3

Subgrade Soil Rate (in/hr): N/A

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 1 (Upper)

Assessed On:
 June 22, 2023



No subgrade soil rate can be measured due to the presence of the underdrain. Because of the low elevation of the overflow structure, only the southernmost portion of the cell was wetted by the infiltration test. These sediments were especially silty as they are downgradient from the rest of the cell and many fines and organic debris had settled on the surface.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Significant scouring of bioretention soil was observed in the northern upgradient portion of the cell which led to organic debris and fines accumulation in the southern portion of the cell, especially surrounding the catch basin.

Field Conditions

| | | | |
|-----------------|---------------|---------------|--------------------|
| Weather | Sunny, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0.3" |
| Field Reps | Full Day: APJ | | Half Day: CSI |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230622-203944.jpg



Site Photo: FA_SitePhotos-20230622-204006.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
Cell: BioCell 1 (Upper)

Assessed On:
June 22, 2023



Site Photo: FA_SitePhotos-20230622-204027.jpg

Cell Construction

| | |
|-----------------------------|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation pipes are present along perimeter of cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width 6' Deep underdrain pipe not encountered during WP installation, full width drain rock |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | This cell is the first cell in a series of stepped bioretention cells with a shared underdrain pipe. This cell collects sheet flow from the adjacent roadway which infiltrates through the bioretention soil and into the underdrain. There is an overflow structure which conveys water not infiltrated to the next cell in series. |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)

Cell: BioCell 1 (Upper)

Assessed On:

June 22, 2023



IN-1

Curb cut Sheet Flow

Dispersed Flow Pipe

Other:

Pipe:

Material

PVC Metal Concrete Other

Diameter: 1'

Energy Dissipation

Angular Rock: Buried

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230622-204239.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)

Cell: BioCell 1 (Upper)

Assessed On:

June 22, 2023



Erosion Present? Yes No

Severity: Major

Depression at base of inlet. Inlet clogged with sediment

Blockage Present? Yes No

Approximately 65% blocked

Types:

Sediment Organic Rock

Trash Vegetation

Additional Details:



FA_INBLPhoto-20230622-214025.jpg


Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 1 (Upper)

Assessed On:
 June 22, 2023



| | |
|---|--|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 67' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230622-204341.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Sheet flow into the cell. No energy dissipation observed. | |

Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other Additional Details: Stickup (ft) From Ground: 0.25 Relative from staff gauge: Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Additional Details: Overflow Blocked? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 10% blocked Additional Details: Trash rack on overflow CB is blocked by sediment and leaf litter at the base of the cb | Dimensions: Length: 1.3' Width: 1.3'  <p>FA_DOPhoto-20230622-215543.jpg</p> |

Cell Surface and Geotech Probe Observations

| |
|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): |
| Cell Coverage |

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
Cell: BioCell 1 (Upper)

Assessed On:
June 22, 2023



Mulch None < 25% 25 - 50% 50 - 75% 75 - 100%
Bare Ground None < 25% 25 - 50% 50 - 75% 75 - 100%
Other None < 25% 25 - 50% 50 - 75% 75 - 100%

Natural mulch (pine needles) covers the cell to a depth of 0.4 ft. Vegetation covers approximately 70% of the cell. Some bare ground patches are seen sporadically throughout the cell

Pest Evidence

Animal Burrows Yes No
Animal Plant Damage Yes No
Large Deposition of Feces Yes No

Additional Details:

Vegetation Description

Vegetation covers approximately 70% of the cell. Obstructs observations of entire cell

Additional Details

Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 0.3-2.1' with the shallowest depths on the south end of the cell as you get further away from the inlet (plans call for 1.5' of BSM). The width and length of the underdrain trench is estimated to be the full width and length of the cell (6.5' wide, 67' long).

Erosion was present at the south end of the cell and is shown by the shallow depths in the probe data.

Hand Auger

HA-1-WP

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.9

to Native Soil:

to Import/Underdrain: 2.1

Total Depth: 2.7

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly medium to fine SAND, some coarse sand, some silt. Scattered organics, rootlets (SP-SM).

Native Soil Texture: Loose, wet, brown, GRAVEL, (1" average diameter, rounded). some medium sand, some silt

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft):



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Additional Details

0-0.4': Surface cover

0.4-0.9': surface cover

0.9-2.1': BSM

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 1 (Upper)

Assessed On:
 June 22, 2023



HA-1-WP

2.1-2.5': Mixed BSM and Underdrain Gravels
 2.5-2.6': Underdrain Gravels
 2.6-2.7': Underdrain Gravels

No groundwater encountered

HA-2


Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0.9 |
| to Native Soil: | |
| to Import/Underdrain: | 1.4 |
| Total Depth: | 1.8 |

Rain/Garden Mix Soil Texture: Loose, moist, dark brown f- m SAND, some silt, abundant organics (SP)
 Native Soil Texture: Medium dense, wet, gray, f SAND, some silt-silty, some c sand (SP-SM)

| | |
|---|---|
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 0.7 |
| Total Depth: | 2.1 |



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Additional Details

0-0.9': Surface cover: Loose, moist, dark-brown-gray, silty, medium SAND, abundant organics, occasional brick fragment and plastic debris
 0.9-1.4': BSM
 1.4-1.6': BSM/Fill contact
 1.6-1.8': Fill

No groundwater encountered.

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 0.7 |
| Total Depth: | 2.1 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 1 (Upper)


Assessed On:
 June 22, 2023



| | |
|--|---|
| HA-3 | |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brownish grey, gravelly, very fine sandy, SILT. Abundant fine organics (ML). | |
| Native Soil Texture: Loose, moist, dark brown medium SAND, some silt, some gravel (SP-SM). | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| Additional Details 0-0.7':BSM 0.7-1.6':Fill: Loose, moist, dark-brown, f-m SAND, some silt, some gravel 1.6-1.9':loose, wet, dark-brown, SAND, some gravel, tr silt 1.9-2.1':loose, wet, brown, gravelly med SAND, tr silt Gravel content increases with depth. No groundwater. | |

FA_FPhoto-20230622-154704.JPG

Infiltration Test

| | |
|--|----------|
| IT-1 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-1 (0.3-3) | |
| Wetted Pond Area (sq. ft) | 54 |
| Ponded Depth (ft) | 0.2 |
| Total Gallons | 1,321.96 |
| Steady State Flow Rate (GPM) | 2.42 |
| Additional Details: 10:31 water on near inlet 10 gpm. Water flowing through existing scour channels with little ponding. Water covering ~1 foot of 6 foot wide cell base. 10:45 water off, move diffuser to near WellPoint, lose one length of hose with the hope of increasing flow rate 10:52 water on, flow rate up to 14. Staff gauge. Near WellPoint. Water flowing towards CB and beginning to pond 11:18: water quickly ponds near catch basin and begins trickling into catch basin at <.5 gpm. Flow still at ~15 gpm. Cut flow rate to 8 gpm 11:21 water off entirely to allow pond to retreat from CB 11:30 water back on at 5 gpm, adjust diffuser closer to CB in hopes of creating a small, well defined pond. 11:38 water trickles again 11:48 switch to lo flow. Flow 2.5 gpm. Pond retreats from | |
|  | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 1 (Upper)

Assessed On:
 June 22, 2023



the CB.
 12:15 switch back to 3-50 FM. Attempting to stabilize pond just below CB.

IT_Photo-20230622-222240.jpg



IT_Photo-20230622-222309.jpg

Additional Comments





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Well Point

PUVI-1-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/22/23

Logged By: APJ

20150387H008

Ending Date: 6/22/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.7

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.1

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.5

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----------|----------|----------|----------|---|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Surface cover Loose, moist, dark gray, silty, fine SAND, trace gravel; abundant fine organics (predominantly pine needles) (SM). | | | | | | | <p>Stick up monument -4.5 to 0.1 feet Existing bioretention soil 0 to 0.1 feet 3/8-inch bentonite chips 0.1 to 0.7 feet 1.25-inch I.D. threaded galvanized steel casing -4.5 to 0.2 feet, duct tape covers screen 0.2 to 1.5 feet Medium grained silica sand 0.7 to 3.1 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.5 to 2.5 feet Cast iron drive endcap 2.5 to 2.8 feet Cast iron drive point 2.8 to 3.1 feet</p> |
| 1 | | 1 | | Loose, moist, mixed dark gray and tannish brown, gravelly, silty, fine to medium SAND; abundant fine organics (predominantly pine needles) (SM). | | | | | | | |
| | | 2 | | Bioretention Soil Mix Loose, moist, dark brown, gravelly, medium to fine SAND, some coarse sand, some silt; scattered organics; rootlets (SP-SM). | | | | | | | |
| | | 3 | | | | | | | | | |
| | | 4 | | | | | | | | | |
| 2 | | 5 | | Mixed Bioretention Soil and Underdrain Gravel Loose, wet, brown, GRAVEL, some medium sand, some silt, gravel rounded (GP-GM). | | | | | | | |
| | | 6 | | Underdrain Gravel Loose, wet, brown, GRAVEL, trace sand, trace silt; gravel coated in silty sand (GP). Becomes brownish gray. | | | | | | | |
| 3 | | 7 | | No seepage. Gravels caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

11/15/2023

20150387H008



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Exploration Boring

PUVI-1-HA-3

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/22/23

Logged By: APJ

20150387H008

Ending Date: 6/22/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.1

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

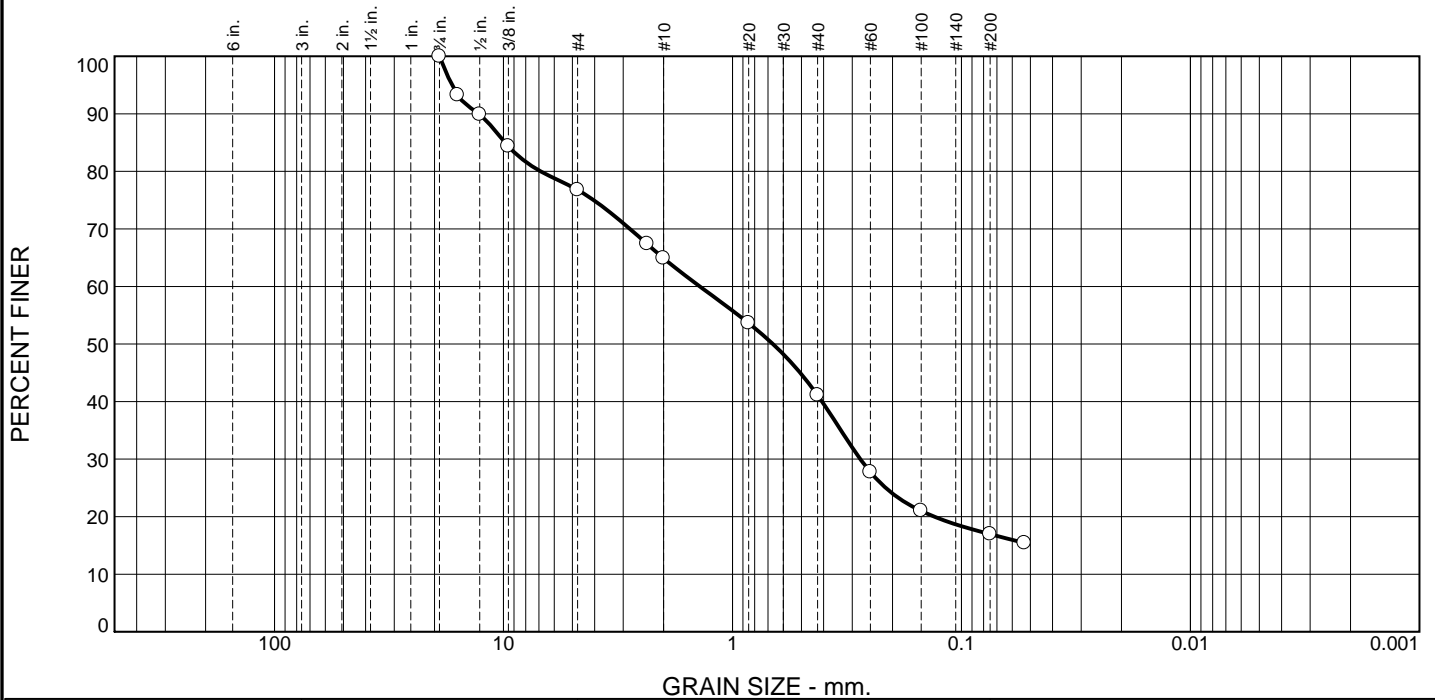
Groundwater Depth ATD (ft): Not encountered

Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|--|--|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | 1 | | | Bioretention Soil Mix (Silty) Loose, moist, dark brownish gray, gravelly, very fine sandy, SILT; abundant organics (ML). | | | | | | | | | |
| 1 | | | | | Import Fill Loose, moist, dark brown, medium SAND, some silt, some gravel (SP-SM). | | | | | | | | | |
| 2 | | 2 | | | | | | | | | | | | |
| 2 | | 3 | | | | Loose, wet, dark brown, medium SAND, some gravel, trace silt (SP). | | | | | | | | |
| 2 | | 4 | | | | Loose, wet, brown, gravelly, medium SAND, trace silt (SP). | | | | | | | | |
| 2 | 5 | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

20150387H008 1/24/2024

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 23.2 | 11.9 | 23.8 | 24.1 | 17.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 93.3 | | |
| 1/2" | 89.9 | | |
| 3/8" | 84.4 | | |
| #4 | 76.8 | | |
| #8 | 67.4 | | |
| #10 | 64.9 | | |
| #20 | 53.6 | | |
| #40 | 41.1 | | |
| #60 | 27.8 | | |
| #100 | 21.0 | | |
| #200 | 17.0 | | |
| #270 | 15.4 | | |

* (no specification provided)

Material Description

gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 12.7993 D₈₅= 9.8436 D₆₀= 1.3882
D₅₀= 0.6660 D₃₀= 0.2765 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 6/27/2023 Date Tested: 7/27/2023

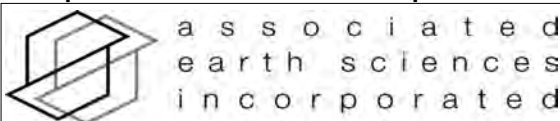
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Upper)
Sample Number: HA-1WP Depth: 0.4-0.9'

Date Sampled: 6/22/2023

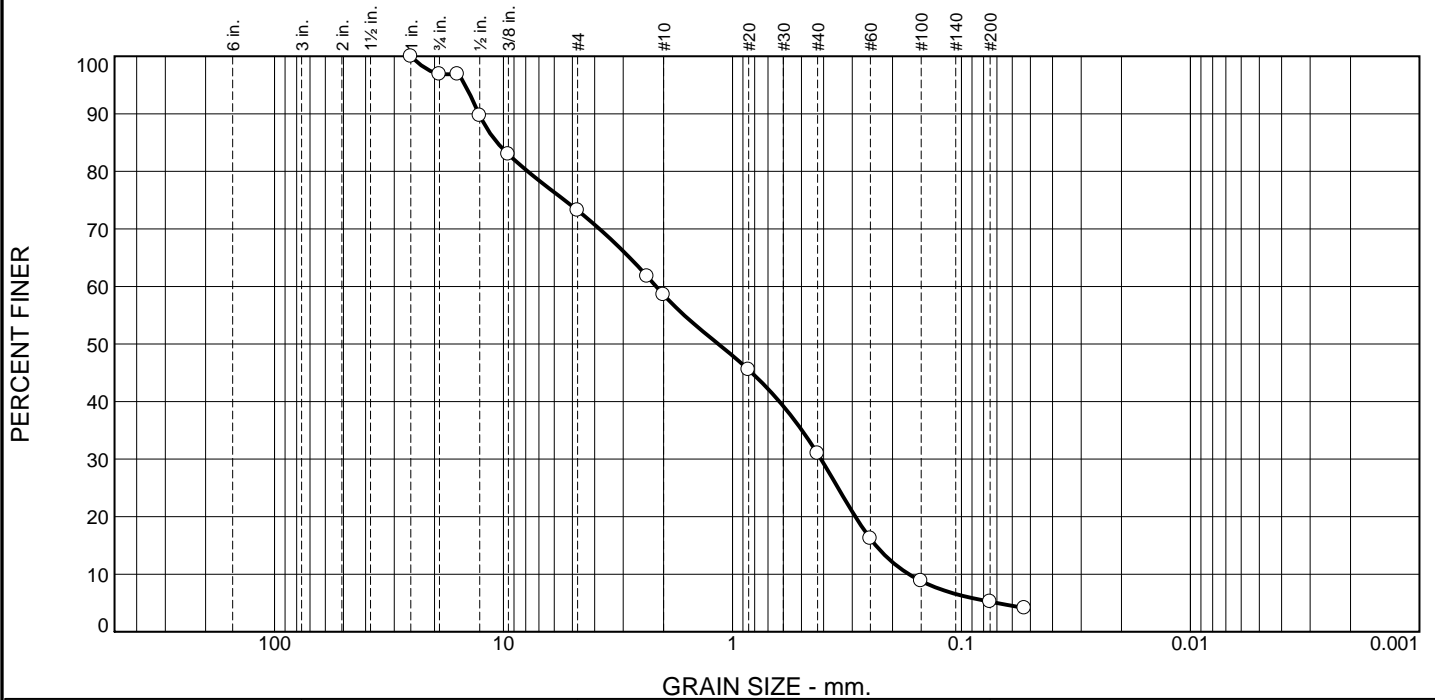


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 3.1 | 23.7 | 14.6 | 27.6 | 25.8 | 5.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 96.9 | | |
| 5/8" | 96.9 | | |
| 1/2" | 89.7 | | |
| 3/8" | 83.0 | | |
| #4 | 73.2 | | |
| #8 | 61.8 | | |
| #10 | 58.6 | | |
| #20 | 45.5 | | |
| #40 | 31.0 | | |
| #60 | 16.2 | | |
| #100 | 8.8 | | |
| #200 | 5.2 | | |
| #270 | 4.1 | | |

* (no specification provided)

Material Description

BSM
gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 12.8176 D₈₅= 10.6579 D₆₀= 2.1559
D₅₀= 1.1524 D₃₀= 0.4105 D₁₅= 0.2366
D₁₀= 0.1698 C_u= 12.70 C_c= 0.46

Remarks

Date Received: 6/27/2023 Date Tested: 9/20/2023

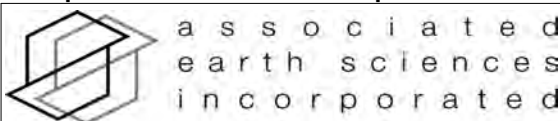
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Upper)
Sample Number: HA-1 Depth: 0.9-1.4'

Date Sampled: 6/22/2023

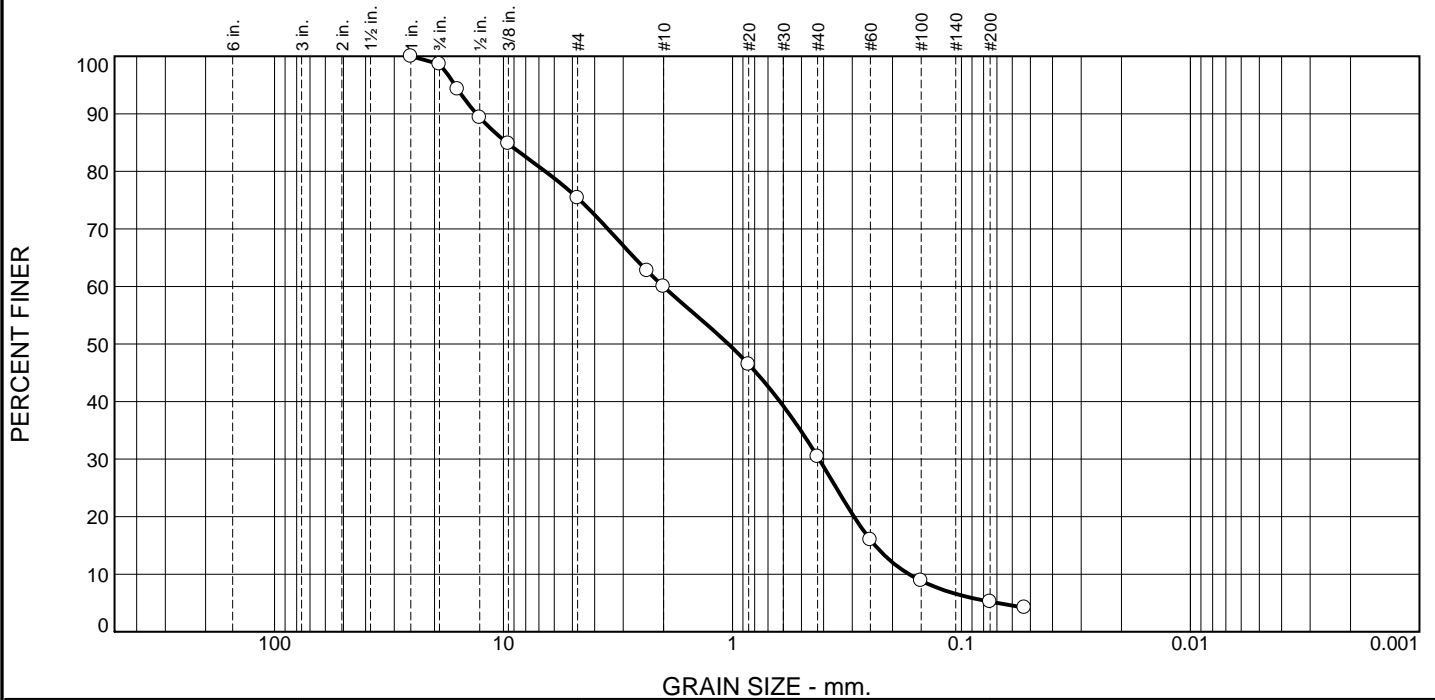


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 1.3 | 23.3 | 15.4 | 29.6 | 25.2 | 5.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 98.7 | | |
| 5/8" | 94.3 | | |
| 1/2" | 89.3 | | |
| 3/8" | 84.8 | | |
| #4 | 75.4 | | |
| #8 | 62.7 | | |
| #10 | 60.0 | | |
| #20 | 46.5 | | |
| #40 | 30.4 | | |
| #60 | 16.0 | | |
| #100 | 8.9 | | |
| #200 | 5.2 | | |
| #270 | 4.2 | | |

* (no specification provided)

Material Description

gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 13.1364 D₈₅= 9.6557 D₆₀= 2.0032
D₅₀= 1.0420 D₃₀= 0.4185 D₁₅= 0.2384
D₁₀= 0.1694 C_u= 11.83 C_c= 0.52

Remarks

Date Received: 6/27/2023 Date Tested: 7/25/2023

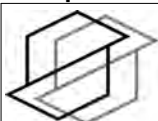
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Upper)
Sample Number: HA-1WP Depth: 1.4-1.9'

Date Sampled: 6/22/2023



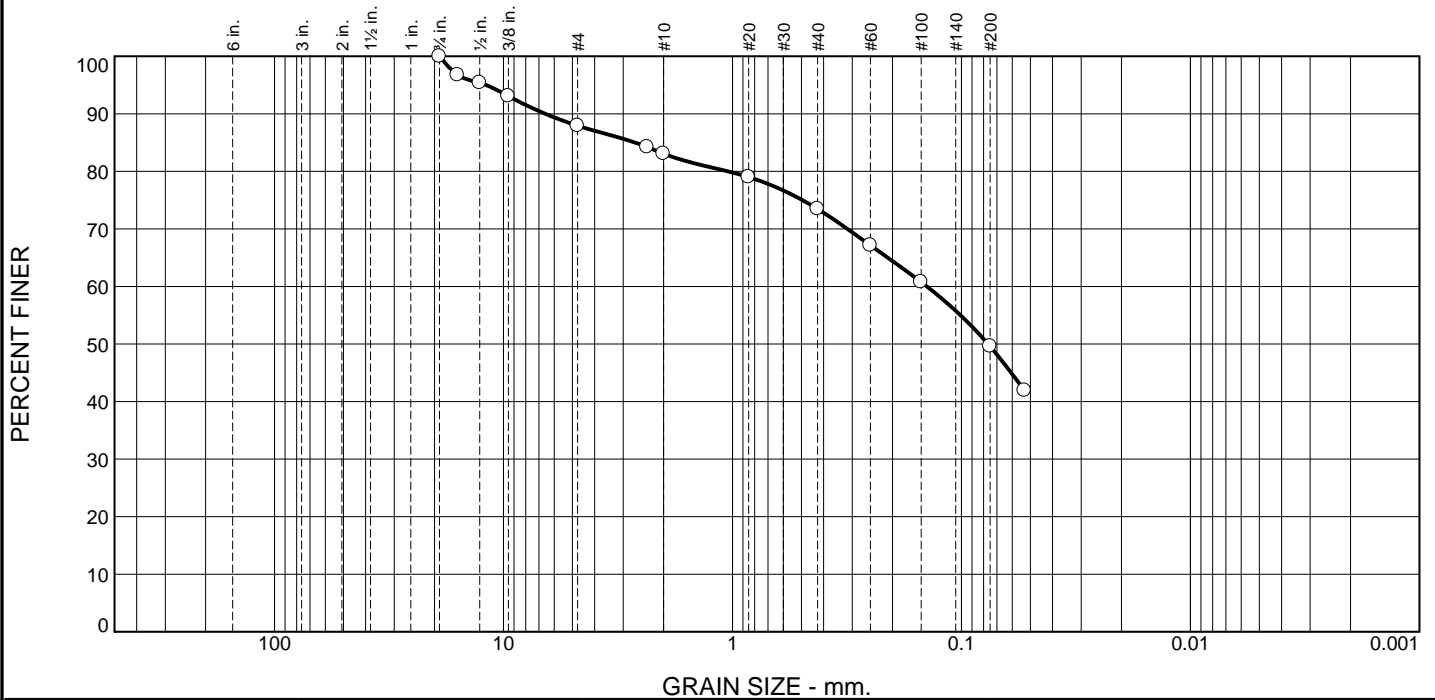
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 12.1 | 4.8 | 9.6 | 23.9 | 49.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 96.8 | | |
| 1/2" | 95.4 | | |
| 3/8" | 93.1 | | |
| #4 | 87.9 | | |
| #8 | 84.2 | | |
| #10 | 83.1 | | |
| #20 | 79.0 | | |
| #40 | 73.5 | | |
| #60 | 67.1 | | |
| #100 | 60.8 | | |
| #200 | 49.6 | | |
| #270 | 41.9 | | |

* (no specification provided)

Material Description

BSM
gravelly, very sandy SILT

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-4(0)

Coefficients

D₉₀= 6.5659 D₈₅= 2.6588 D₆₀= 0.1415
D₅₀= 0.0765 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 6/27/2023 Date Tested: 9/18/2023

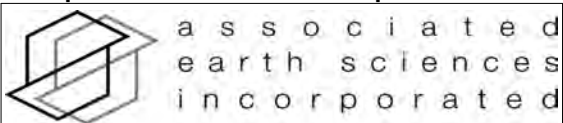
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Upper)
Sample Number: HA-3 Depth: 0-0.7'

Date Sampled: 6/22/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|---|-------------------------------------|-------------------------|--|
| Date Sampled 6/22/2023 | Project BHPS - Viking Ave Upper | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Poulsbo, WA | EB/EP No. PUVI-1-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1WP @ 0.4-0.9' | HA-1WP @ 0.9-1.4' | HA-3 @ 0-0.7' |
|--------------------|-------------------|-------------------|---------------|
| Wet Weight + Pan | 1412.3 | 1099.5 | 783.3 |
| Dry Weight + Pan | 1260.7 | 1019.8 | 631.2 |
| Weight of Pan | 392.0 | 247.1 | 247.5 |
| Weight of Moisture | 151.6 | 79.7 | 152.2 |
| Dry Weight of Soil | 868.8 | 772.8 | 383.7 |
| % Moisture | 17.4 | 10.3 | 39.7 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|--------|--------|-------|
| Dry Soil Before Burn + Pan | 1260.7 | 1019.8 | 631.2 |
| Dry Soil After Burn + Pan | 1228.0 | 1007.9 | 578.3 |
| Weight of Pan | 392.0 | 247.1 | 247.5 |
| Wt. Loss Due to Ignition | 32.7 | 11.9 | 52.9 |
| Actual Wt. Of Soil After Burn | 836.1 | 760.9 | 330.8 |
| % Organics | 3.8 | 1.5 | 13.8 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------------------------|--------------------------------|-------------------------|
| Project Name: | Viking Avenue Biocell 1 (Upper) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) FM-X (.3-3) |
| Date: | 6/22/2023 | Wetted Area (sq. feet): | 13:30: 54 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.14 |
| Performed By: | APJ / CSI | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|---|
| 10:31 | | | Dry | | Water on |
| 10:32 | 10.74 | | | 12 | Moved diffuser ~20 ft toward middle of cell |
| 10:35 | 10.71 | | | 42 | Flow direction: South through scours |
| 10:37 | 10.7 | | | 64 | |
| 10:41 | 10.7 | | | 106 | |
| 10:45 | 10.7 | | | 149 | Water off - moved diffuser |
| 10:52 | 14.5 | | | 157 | Water on |
| 10:55 | 14.3 | | | 190 | |
| 11:02 | 14.22 | 0.04 | | 288 | |
| 11:15 | 14.54 | 0.12 | | 475 | Water approaching CB |
| 11:18 | | | | | Water trickling into overflow |
| 11:19 | 8.48 | 0.22 | | 545 | Decreased flow rate; level quickly jumped to~0.22 |
| 11:21 | | 0.22 | | 566 | Water off to stop overflow |
| 11:24 | | 0.2 | | | |
| 11:25 | | 0.18 | | | |
| 11:27 | | 0.16 | | | Water still trickling into overflow |
| 11:30 | | | | | No more trickle; adjusted diffuser; water on |
| 11:30:30 | 5.22 | | | 567 | |
| 11:32 | 5.25 | 0.14 | | 573 | |
| 11:35 | 3.52 | 0.15 | | 591 | Decrease flow to 4 gpm |
| 11:38 | | | | 603 | Trickle; switch flow meter |
| 11:41 | 2.18 | 0.13 | | 603 | Water on |
| 11:45 | 2.2 | 0.11 | | 612 | |
| 11:55 | 2.8 | 0.08 | | 631 | |
| 12:00 | 2.84 | 0.07 | | 645 | |
| 12:15 | 2.8 | 0.06 | | 690 | Increase flow - change flowmeter |
| 12:17 | | | | 696 | Final low flow total |
| 12:31 | | | | | Cleared FM-7 (3-50) |
| 12:34 | | | | | Water on, toggling flow |
| 12:36 | 5 | | | 710 | |
| 12:38 | 5.5 | 0.04 | | 718 | Stable flow, pond growing |
| 12:40 | 5.5 | 0.04 | | 729 | Decrease flow to 3.5 gpm |
| 12:43 | 5.5 | 0.08 | | 745 | |
| 12:45 | 3.59 | 0.08 | | 753 | |
| 13:00 | 3.59 | 0.13 | | 806 | |
| 13:06 | 3.59 | 0.16 | | 830 | Toggling flow to 3.05 gpm |

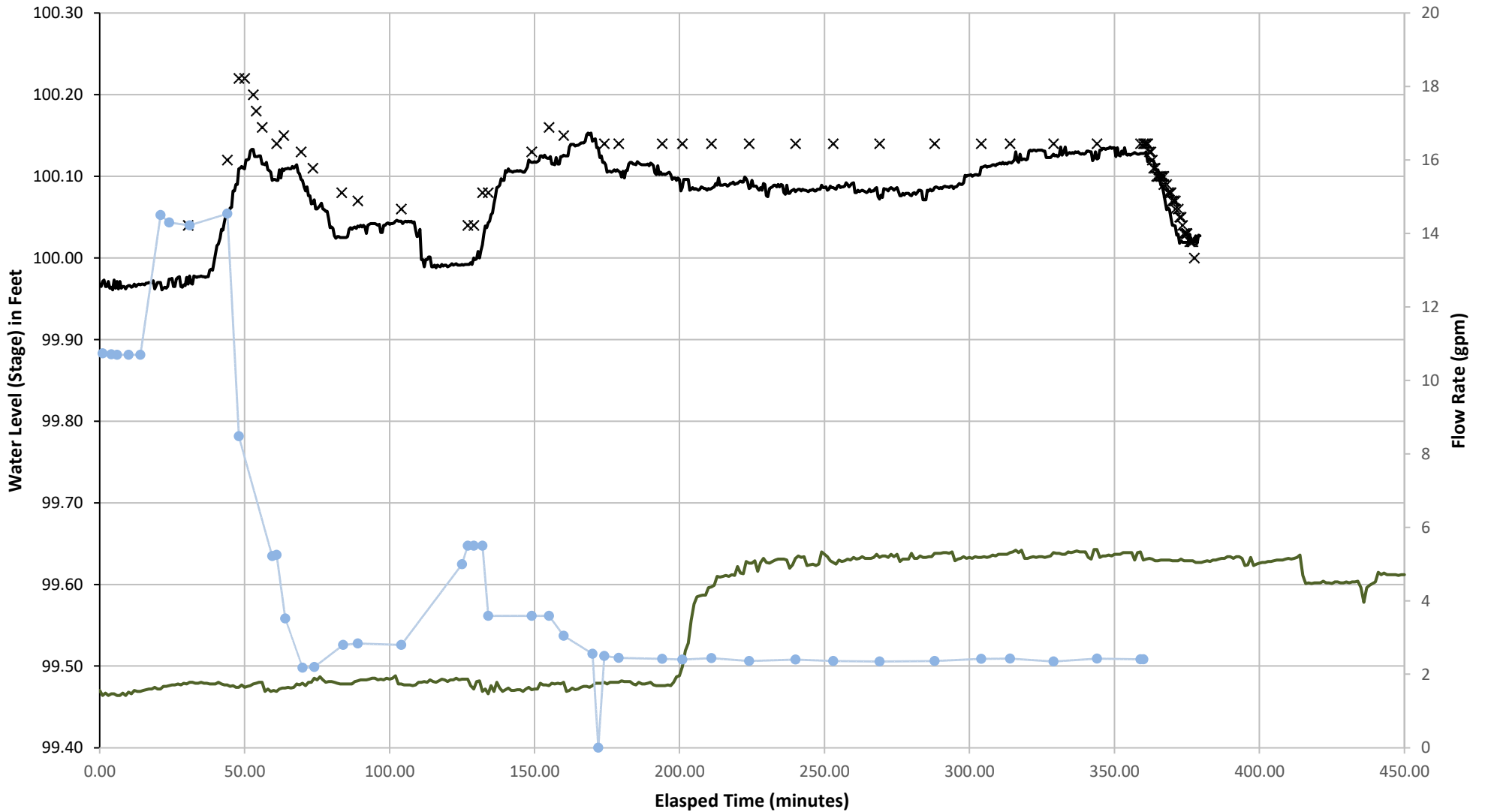
| | | | | | |
|----------|------|------|--|-------|--|
| 13:11 | 3.05 | 0.15 | | 844 | |
| 13:19 | | | | | |
| 13:20 | | | | 869 | Water off. Flow trickling into catch basin, switch to low flow meter |
| 13:21 | 2.56 | | | 869 | Water on; slight trickle into CB |
| 13:23 | 0 | | | 874 | Water off to stop trickle into catch basin |
| 13:25 | 2.5 | 0.14 | | 874 | Water on; trickle stopped |
| 13:30 | 2.45 | 0.14 | | 886 | |
| 13:45 | 2.42 | 0.14 | | 922 | |
| 13:52 | 2.4 | 0.14 | | | Flow in underdrain at 13:50; CB=4.86' |
| 14:02 | 2.44 | 0.14 | | 963 | |
| 14:15 | 2.36 | 0.14 | | 995 | |
| 14:31 | 2.4 | 0.14 | | 1,033 | |
| 14:44 | 2.36 | 0.14 | | 1,067 | |
| 15:00 | 2.35 | 0.14 | | 1,103 | CB=4.78' |
| 15:19 | 2.36 | 0.14 | | 1,148 | |
| 15:35 | 2.42 | 0.14 | | 1,187 | |
| 15:45 | 2.43 | 0.14 | | 1,211 | |
| 16:00 | 2.35 | 0.14 | | 1,247 | |
| 16:15 | 2.43 | 0.14 | | 1,283 | CB=4.78' |
| 16:30 | 2.41 | 0.14 | | 1,319 | |
| 16:31 | 2.41 | 0.14 | | 1,321 | Water off |
| 16:31:30 | | 0.14 | | | |
| 16:32:00 | | 0.14 | | | |
| 16:32:30 | | 0.14 | | | |
| 16:33:00 | | 0.13 | | | |
| 16:33:30 | | 0.13 | | | |
| 16:34:00 | | 0.12 | | | |
| 16:34:30 | | 0.11 | | | |
| 16:35:00 | | 0.11 | | | |
| 16:35:30 | | 0.1 | | | |
| 16:36:00 | | 0.1 | | | |
| 16:36:30 | | 0.1 | | | |
| 16:37:00 | | 0.1 | | | |
| 16:37:30 | | 0.1 | | | |
| 16:38:00 | | 0.1 | | | |
| 16:38:30 | | 0.09 | | | |
| 16:39:00 | | 0.09 | | | |
| 16:39:30 | | 0.08 | | | |
| 16:40:00 | | 0.08 | | | |
| 16:40:30 | | 0.08 | | | |
| 16:41:00 | | 0.07 | | | |
| 16:41:30 | | 0.07 | | | |
| 16:42:00 | | 0.07 | | | |
| 16:42:30 | | 0.06 | | | |
| 16:43:00 | | 0.06 | | | |
| 16:43:30 | | 0.05 | | | |
| 16:44:00 | | 0.05 | | | |
| 16:44:30 | | 0.04 | | | |

| | | | | | |
|----------|--|------|-----|--|---|
| 16:45:00 | | 0.03 | | | |
| 16:45:30 | | 0.03 | | | |
| 16:46:00 | | 0.03 | | | |
| 16:46:30 | | 0.03 | | | |
| 16:47:00 | | 0.02 | | | |
| 16:47:30 | | 0.02 | | | |
| 16:48:00 | | 0.02 | | | |
| 16:48:30 | | 0 | Dry | | SG#1 sunk 0.02'; CB=4.78'; ponded area dry approx 17:00 |

| | |
|--|-----|
| Average Infiltration Rate (in/hr) during last hour of inflow SG-1: | 4.3 |
| Average Infiltration Rate (in/hr) during falling head SG-1: | 5.4 |

Viking Avenue Cell 1 (Upper) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and should be used as relative reference. Elevation 100 represents ground surface.

x Staff Gauge #1 Hand Data
— Staff Gauge #1 Logger
— Catch Basin Logger
— Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
Cell: BioCell 4 (Lower)

Assessed On:
June 23, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2009 and collects stormwater runoff from the adjacent roadway through sheet flow and from a piped inlet. The cell is constructed with 1.5' of bioretention soil above a 4-6" of gravel backfill for drains above a 1' layer of gravel backfill for dry wells, in which the perforated underdrain pipe is placed. The cell is graded at a 1% slope and the overflow structure is designed to allow for 0.5' of ponding. Water is designed to infiltrate through the bioretention soil and enter the underdrain, which connects all five cells in series. Water which enters the overflow structure is designed to enter the next cell in series.

BIORETENTION SOIL:

Thickness: 1.5'

The average thickness of the bioretention soil was 1.5'. This is consistent with the design plans.

Composition: The design plans call for a soil mix of 30-35% composted material and 65-70% gravelly sand meeting the specification ASTM D422. The sand gradation met the design specifications though the silt content exceeded the standard and the organic content fell below the standard. In comparison to the 2019 Ecology standards, the sand gradation and organic matter content fell below the specifications while the silt content exceeded them.

Organic Matter Content (% by weight): 2

Percent passing #200 sieve: 6.2

Coefficient of Uniformity (Cu): 13

Coefficient of Curvature (Cc): 0.5

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Hand auger explorations completed in the cell did not penetrate the underdrain gravels.

BUILT PER PLAN:

Water was observed entering the catch basin through leaky joints in the cement concrete structure. The flow rate was turned down to limit the water lost to leaks. Otherwise, the observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell, though the sampled underdrain gravels were classified as wet. The temporary wellpoint was screened from 1-2' below ground surface and did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 20.8

Subgrade Soil Rate (in/hr): N/A

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 4 (Lower)

Assessed On:
 June 23, 2023



No subgrade soil rate can be measured due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Besides the leaky catch basin, the cell was generally consistent with the design plans.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|------------------|
| Weather | Clear, 70's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | Half Day: | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230623-154637.jpg



Site Photo: FA_SitePhotos-20230623-154651.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 4 (Lower)

Assessed On:
 June 23, 2023



Site Photo: FA_SitePhotos-20230623-154713.jpg



Site Photo: FA_SitePhotos-20230623-154731.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation line runs down sidewalk side of cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 6' Full Width Width 6' The underdrain pipes connects all 5 cells. This cell is the second to last in the line. |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments This cell is the second to last cell in series. Sheet flow roadway runoff is conveyed to the cell and infiltrates through the bioretention soil before reaching the underdrain. Water is also conveyed to the cell during overflow conditions from the cell above it in series. There is an overflow structure which conveys water during overflow conditions to the next cell in series. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
Cell: BioCell 4 (Lower)

Assessed On:
June 23, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Other: Other

Diameter: 1'

Energy Dissipation

Angular Rock: Buried

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230623-162311.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 1% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Trace sediment at base of inflow pipe.



FA_INBLPhoto-20230623-162212.jpg

Additional Details: Angular rock, partially buried by sediment discharge.

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
Cell: BioCell 4 (Lower)

Assessed On:
June 23, 2023



| | |
|--|--|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 21' Energy Dissipation Angular Rock: Eroded Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230623-214833.jpg</p> |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Ravelled gravels. | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Angular rock placed around cell perimeter. Some of this rock has ravelled into the cell base but over 50% is intact | |

Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round Dimensions: <input checked="" type="checkbox"/> Rectangular Length: 1.78' <input type="checkbox"/> Other Width: 1.46' |  <p>FA_DOPhoto-20230623-204220.jpg</p> |
| Additional Details: Stickup (ft) From Ground: 0.35 Relative from staff gauge: 0.49 | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

Cell Surface and Geotech Probe Observations

| |
|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): |
|--|

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 4 (Lower)

Assessed On:
 June 23, 2023



Cell Coverage

Mulch None < 25% 25 - 50% 50 - 75% 75 - 100%

Bare Ground None < 25% 25 - 50% 50 - 75% 75 - 100%

Other None < 25% 25 - 50% 50 - 75% 75 - 100%

Predominantly bare ground with scattered dead vegetative debris (stems, leaves, etc). Also some gravel raveling off side slopes into cell base.
 Blackberries have overtaken much of the cell. Abundant leaf litter.

Pest Evidence

Animal Burrows Yes No

Animal Plant Damage Yes No

Large Deposition of Feces Yes No

Additional Details: Snake (<1' length) observed in angular rocks near catch basin on 6/22.

Vegetation Description

90%. Was unable to probe much of facility. Thorny blackberryies and dense stems.

Additional Details

Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 0.6-0.8 feet. Probing was limited due to dense vegetation and blackberry vines.

Hand Auger

HA-1-WP

Zone 1 Zone 2 Zone 3

Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | 1.7 |
| Total Depth: | 2 |

Rain/Garden Mix Soil Texture: Loose, moist, dark brownish gray, gravelly fine to medium SAND, some silt. Scattered organics, rootlets (SP-SM).
 Native Soil Texture: Loose, moist, greyish-brown, GRAVEL (rounded, 1" average diameter), trace sand, trace silt (GP).

Liner Present: Yes No Filter Fabric Present: Yes No

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft): 1.81

HA-1.jpg

Additional Details

0-0.1': Leaf litter

0.1-1.5': BSM

1.5-1.7': transitional layer

1.7-2': Underdrain gravels

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 4 (Lower)

Assessed On:
 June 23, 2023



| |
|---|
| HA-1-WP |
| Stickup for WP = 5.02 |
| Shallowest depth to water (bgs) = 6.83-5.02 = 1.81' |

| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | 1.9 |
| Total Depth: | 2 |
| Rain/Garden Mix Soil Texture: Loose, moist, grayish-brown, m SAND, some gravel, trace silt, some organics (SP-SM) Native Soil Texture: Loose, moist, brownish-gray, GRAVEL, trace silt, trace sand. Gravels between 0.5-1" (GP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| Additional Details 0-0.1': Leaf litter 0.1-1.6': BSM 1.6-1.9': Mixed BSM and underdrain gravels 1.9-2': Underdrain gravels Gravel content increasing with depth | |

HA-22.jpeg


| | |
|---|-----|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.5 |
| Total Depth: | 1.6 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brownish-gray, m SAND, some gravel, trace silt, some organics, scattered rootlets (SP-SM) Native Soil Texture: Loose, moist, GRAVEL, trace silt, trace sand coatings on gravels | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)
 Cell: BioCell 4 (Lower)

Assessed On:
 June 23, 2023



| | |
|--|---|
| HA-3 | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| HA-3.jpg | |
| <p>Additional Details</p> <p>0-0.75': BSM</p> <p>0.75-1.5': Same as above, becomes dark brown-brown; possibly different BSM batch</p> <p>1.5-1.6': Gravels</p> | |

Infiltration Test

| | |
|--|-------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-3 (3-50) | |
| Wet ed Pond Area (sq. ft) | 90.5 |
| Ponded Depth (ft) | 0.35 |
| Total Gallons | 6,954 |
| Steady State Flow Rate (GPM) | 19.98 |
| Additional Details: | |
| Leaky catch basin both through joint where metal trash rack meets cement base and within cement itself. Flow was turned down at 10:20. | |
|  | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)

Cell: BioCell 4 (Lower)

Assessed On:

June 23, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Viking Ave (PUVI)

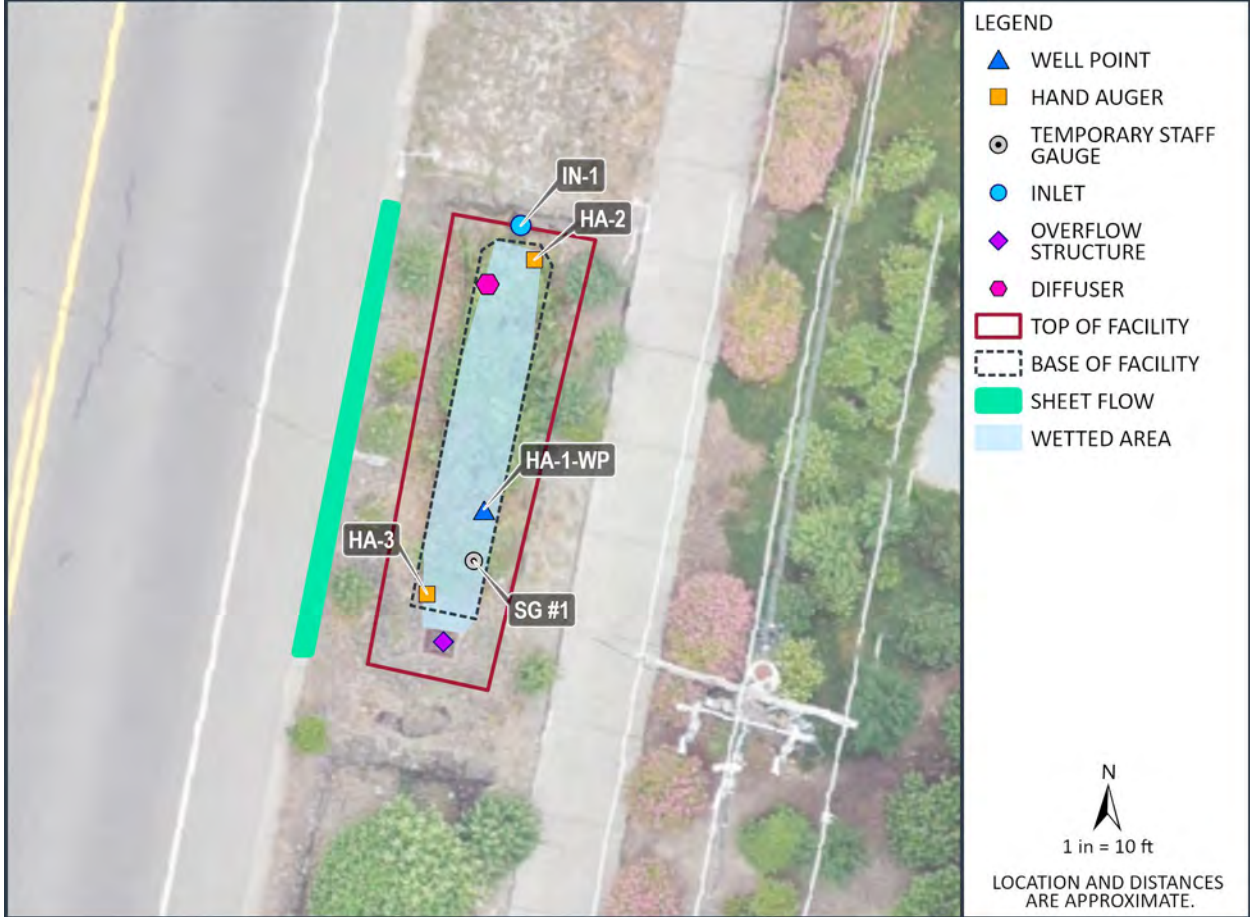
Cell: BioCell 4 (Lower)

Assessed On:

June 23, 2023



SITE: VIKING AVE (PUVI) CELL: BIOCELL 4 (LOWER)





associated
earth sciences
incorporated

Well Point

PUVI-4-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/22/2023

Logged By: APJ

20150387H008

Ending Date: 6/22/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.6

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

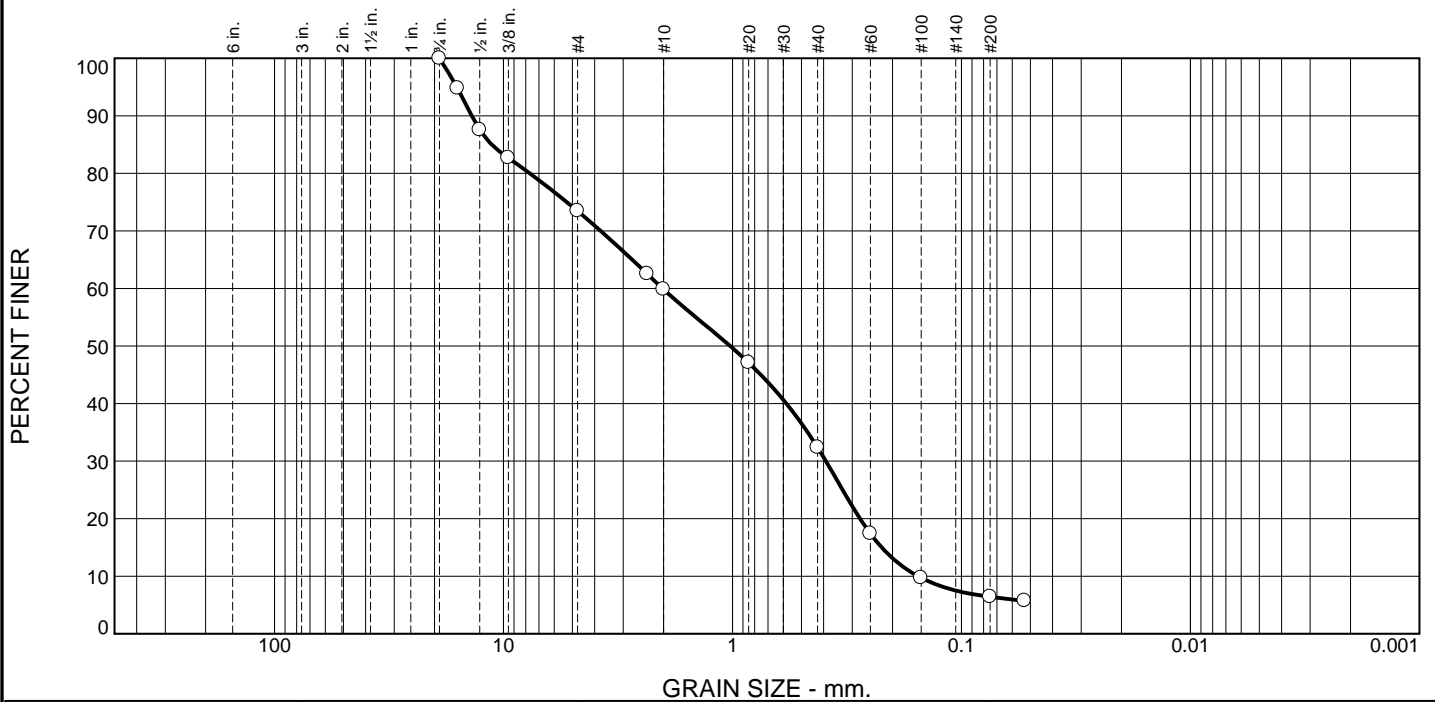
Groundwater Depth Post Drilling (ft) (Date): N/A ()

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Surface Cover Leaf litter; abundant rootlets. | | | | | | | Stick up -5.0 to 0.2 feet Existing bioretention soil 0 to 0.2 feet 3/8-inch bentonite chips 0.2 to 0.9 feet 1.25-inch I.D. threaded galvanized steel casing -5.0 to 0.7 feet, duct tape covers screen -0.7 to 1 feet Medium grain silica sand 0.9 to 2.6 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze feet welded to perforated steel 1 to 2 feet Cast iron endcap 2 to 2.3 feet Cast iron drivepoint 2.3 to 2.6 feet |
| 1 | | 1 | | Bioretention Soil Mix Loose, moist, dark brownish gray, gravelly, fine to medium SAND, some silt; scattered organics; rootlets (SP- SM). | | | | | | | |
| 1 | | 2 | | | | | | | | | |
| 1 | | 3 | | | | | | | | | |
| 1 | | 4 | | Loose, moist, light grayish brown, gravelly, medium SAND, trace silt; coarsening downwards transition between bioretention soil and underdrain gravel (SP). | | | | | | | |
| 2 | | 5 | | | | | | | | | |
| 2 | | 6 | | Underdrain Gravel Loose, moist, grayish brown, GRAVEL, trace sand, trace silt coating gravel; rounded gravel (GP). No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

11/14/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 26.5 | 13.6 | 27.5 | 26.0 | 6.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 94.8 | | |
| 1/2" | 87.6 | | |
| 3/8" | 82.7 | | |
| #4 | 73.5 | | |
| #8 | 62.6 | | |
| #10 | 59.9 | | |
| #20 | 47.1 | | |
| #40 | 32.4 | | |
| #60 | 17.4 | | |
| #100 | 9.7 | | |
| #200 | 6.4 | | |
| #270 | 5.7 | | |

* (no specification provided)

Material Description

gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 13.7711 D₈₅= 11.2717 D₆₀= 2.0178
D₅₀= 1.0232 D₃₀= 0.3910 D₁₅= 0.2231
D₁₀= 0.1547 C_u= 13.04 C_c= 0.49

Remarks

Date Received: 6/27/2023 Date Tested: 7/24/2023

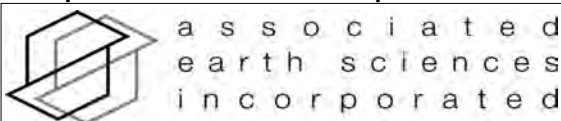
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Lower)
Sample Number: HA-1 **Depth:** 0.5-1'

Date Sampled: 6/22/2023

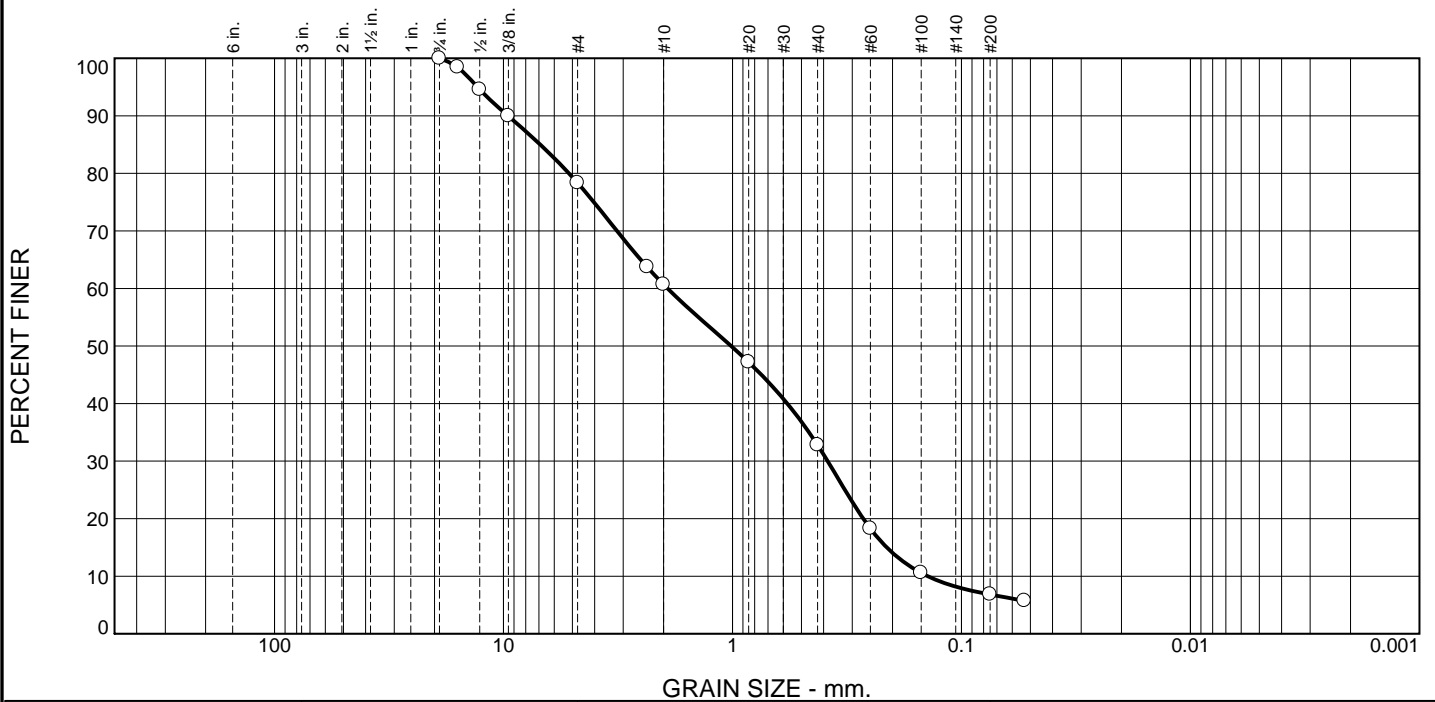


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 21.7 | 17.6 | 27.9 | 26.0 | 6.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 98.5 | | |
| 1/2" | 94.6 | | |
| 3/8" | 90.0 | | |
| #4 | 78.3 | | |
| #8 | 63.7 | | |
| #10 | 60.7 | | |
| #20 | 47.2 | | |
| #40 | 32.8 | | |
| #60 | 18.3 | | |
| #100 | 10.6 | | |
| #200 | 6.8 | | |
| #270 | 5.7 | | |

* (no specification provided)

Material Description

gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 9.5496 D₈₅= 6.9118 D₆₀= 1.9199
D₅₀= 1.0133 D₃₀= 0.3841 D₁₅= 0.2120
D₁₀= 0.1402 C_u= 13.69 C_c= 0.55

Remarks

Date Received: 6/27/2023 Date Tested: 8/9/2023

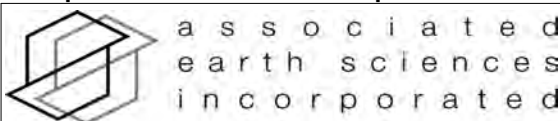
Tested By: EW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Lower)
Sample Number: HA-3 **Depth:** 0.3'

Date Sampled: 6/22/2023

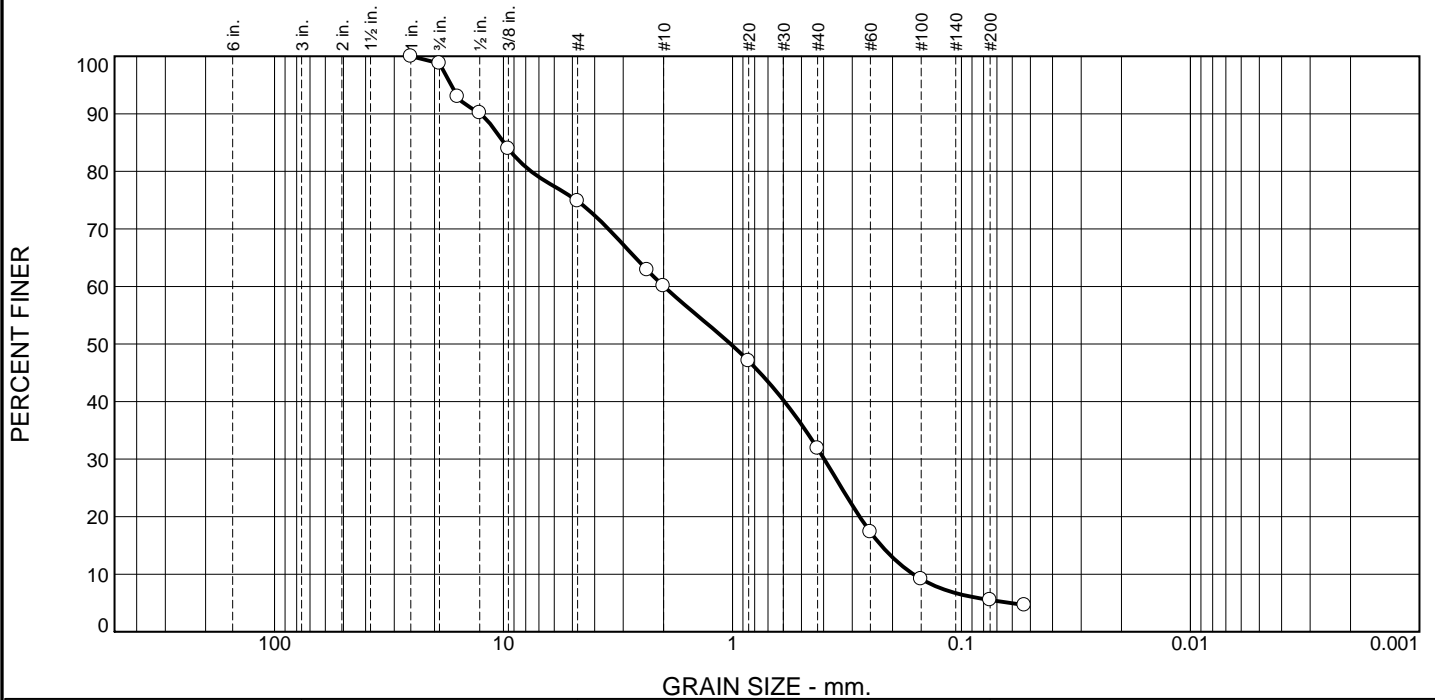


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 1.2 | 24.0 | 14.7 | 28.2 | 26.4 | 5.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 98.8 | | |
| 5/8" | 93.0 | | |
| 1/2" | 90.2 | | |
| 3/8" | 84.0 | | |
| #4 | 74.8 | | |
| #8 | 62.9 | | |
| #10 | 60.1 | | |
| #20 | 47.1 | | |
| #40 | 31.9 | | |
| #60 | 17.3 | | |
| #100 | 9.2 | | |
| #200 | 5.5 | | |
| #270 | 4.6 | | |

* (no specification provided)

Material Description

gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 12.5549 D₈₅= 9.9659 D₆₀= 1.9902
 D₅₀= 1.0178 D₃₀= 0.3974 D₁₅= 0.2242
 D₁₀= 0.1622 C_u= 12.27 C_c= 0.49

Remarks

Date Received: 6/27/2023 Date Tested: 7/25/2023

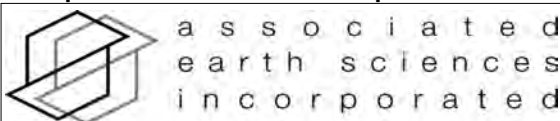
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Viking Ave (Lower)
 Sample Number: HA-3 Depth: 1'

Date Sampled: 6/22/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|---|-------------------------------------|-------------------------|--|
| Date Sampled 6/22/2023 | Project BHPS Viking Ave Lower | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Poulsbo, WA | EB/EP No. PUVI-4-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.5-1' | HA-3 @ 0.3' |
|--------------------|---------------|-------------|
| Wet Weight + Pan | 1473.3 | 1013.0 |
| Dry Weight + Pan | 1392.0 | 951.6 |
| Weight of Pan | 358.0 | 247.5 |
| Weight of Moisture | 81.3 | 61.4 |
| Dry Weight of Soil | 1034.0 | 704.1 |
| % Moisture | 7.9 | 8.7 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|-------|
| Dry Soil Before Burn + Pan | 1392.0 | 951.6 |
| Dry Soil After Burn + Pan | 1376.1 | 933.9 |
| Weight of Pan | 358.0 | 247.5 |
| Wt. Loss Due to Ignition | 15.9 | 17.8 |
| Actual Wt. Of Soil After Burn | 1018.2 | 686.4 |
| % Organics | 1.5 | 2.5 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|------------------------------|--------------------------------|---|
| Project Name: | Viking Avenue-Cell 4 (Lower) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 6/23/2023 | Wetted Area (sq. feet): | 10:28: 9 ft^2 / 12:10: 90.5 ft^2 / 15:00: 90.5 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.34 |
| Performed By: | APJ | Receptor Soils: | Gravel Underdrain |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | CB-1 [Staff Gauge #2 (ft)] | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------------|----------------------|---------------------|---|
| 9:37 | | | 4.91 | | | Water on |
| 9:40 | 35.6 | | | | 86 | |
| 9:45 | 35.9 | 0.24 | | | 248 | Decrease flow to 23gpm; water approaching overflow |
| 9:49 | 23.14 | 0.24 | | | 344 | Increase flow to 30gpm; CB dry |
| 9:54 | 27 | 0.29 | | | 474 | CB leaky |
| 10:05 | 27 | 0.34 | | | 772 | Outflowing to lowest cell at ~1gpm throughout entire test |
| 10:12 | | | | | | Underdrain flowing |
| 10:18 | 26.98 | 0.38 | | | 1,138 | |
| 10:24 | 27 | 0.38 | 4.7 | | 1,283 | Decrease flow to 20 gpm to lower head near CB |
| 10:45 | 19.96 | 0.3 | | | 1,719 | Flow decreased in leaky CB |
| 11:00 | 20.16 | 0.28 | 4.69 | | 2,014 | |
| 11:17 | 20.18 | 0.29 | | | 2,350 | |
| 11:33 | 20.02 | 0.29 | | | 2,680 | |
| 11:45 | 20.08 | 0.29 | | | 2,922 | |
| 12:00 | 19.96 | 0.3 | | | 3,226 | |
| 12:15 | 20.06 | 0.31 | | | 3,530 | |
| 12:31 | 19.94 | 0.31 | | | 3,854 | |
| 12:45 | 19.98 | 0.31 | | | 4,135 | |
| 13:00 | 20.04 | 0.31 | | | 4,411 | |
| 13:15 | 20.09 | 0.32 | | 6.9 | 4,795 | |
| 13:30 | 20.09 | 0.32 | | 6.89 | 5,025 | |
| 13:45 | 20.11 | 0.32 | | 6.87 | 5,330 | |
| 14:00 | 20.03 | 0.32 | | 6.85 | 5,622 | |
| 14:20 | 20 | 0.34 | | 6.84 | 6,035 | |
| 14:33 | 19.98 | 0.34 | | 6.83 | 6,284 | |
| 14:40 | 19.89 | 0.34 | | 6.84 | 6,419 | |
| 14:51 | 20.04 | 0.34 | | 6.85 | 6,652 | |
| 15:01 | 19.96 | 0.34 | | 6.84 | 6,854 | |
| 15:07 | 19.99 | 0.35 | | 6.84 | 6,954 | Water off |
| 15:08 | | 0.32 | | | | |
| 15:09 | | | 4.7 | 6.84 | | |
| 15:10 | | 0.24 | | | | |
| 15:12 | | 0.16 | | | | |
| 15:13 | | 0.12 | | | | |
| 15:14 | | 0.08 | | | | |

| | | | | | | |
|-------|--|---|------|------|--|--|
| 15:15 | | 0 | | 6.84 | | |
| 15:38 | | 0 | | 6.85 | | |
| 15:59 | | 0 | 4.77 | 6.85 | | |
| 16:07 | | 0 | | 6.85 | | |

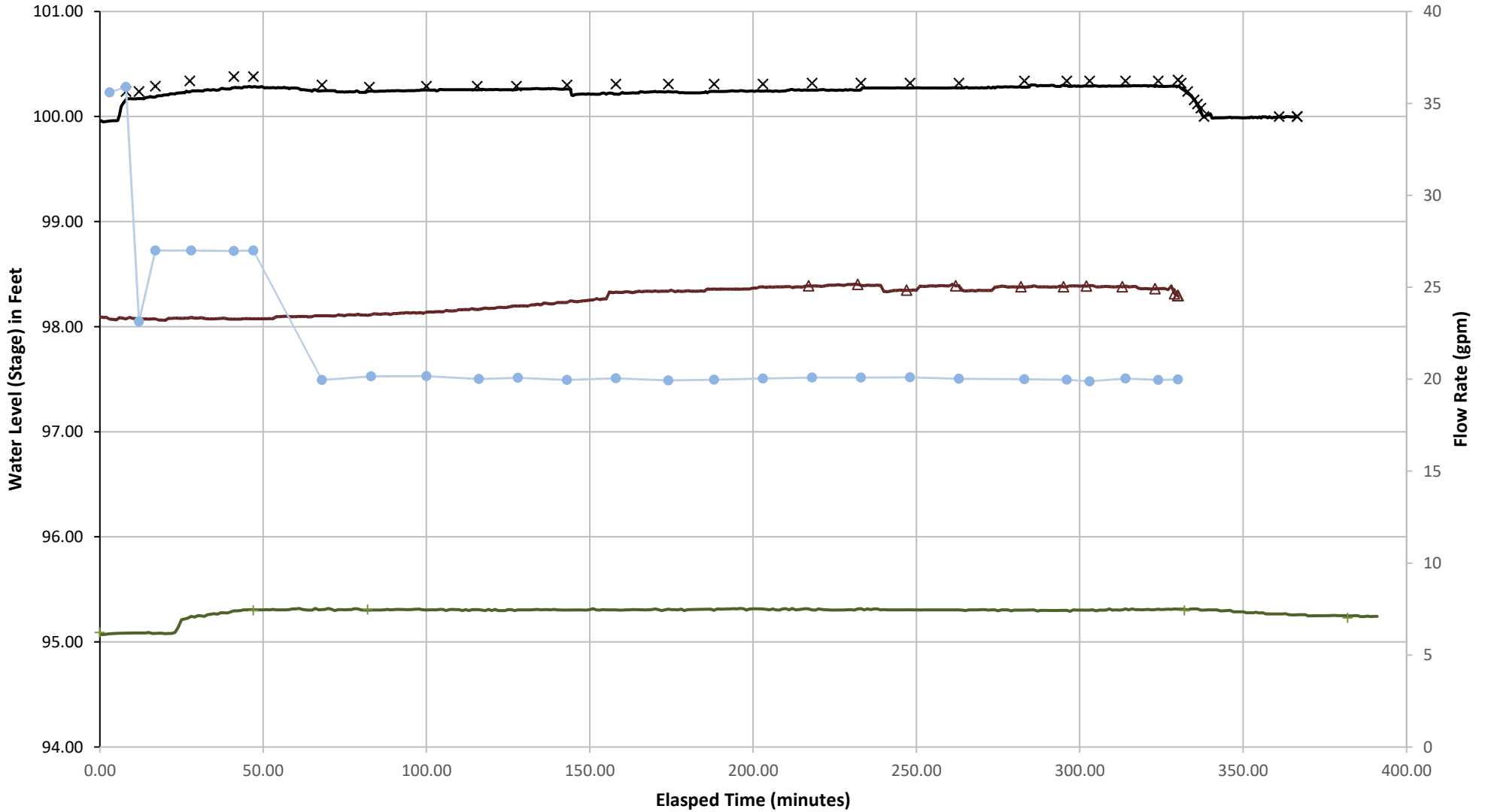
| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 20.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 27.8 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 21.2 |
| WP Average Infiltration Rate (in/hr) during falling head: | - |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow (Accounting for leakages): | 19.8 |
|--|------|

Viking Avenue Cell 4 (Lower) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and should be used as relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
Cell: Anderson Parkway

Assessed On:
June 21, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2012 and receives sheet flow runoff from the adjacent parking lot. The cell is constructed with 2" of mulch set above 1.5' of bioretention soil. Beneath the bioretention soil sits 2" of gravel backfill for drains above a variable depth of gravel backfill for drywells, in which the underdrain pipe is set into. A geomembrane liner surrounds the entire gravel backfill and bioretention soil assembly, separating the cell from the underlying native soils. 0.5' of ponded depth is available before water flows into the overflow structure catch basin. Water is designed to infiltrate into the bioretention soil before entering the underdrain and out of the cell into the storm drain network.

BIORETENTION SOIL:

Thickness: 1.5'

The apparent thickness of the bioretention soil was 1.5'. This is consistent with the design plans.

Composition: The design plans call for the soil specifications from the 2012 Ecology stormwater manual. In comparison to the 2019 Ecology specifications, the sand gradation fell below the standard while the organic matter content and fines content met the specification.

Organic Matter Content (% by weight): 6.7

Percent passing #200 sieve: 3.6

Coefficient of Uniformity (Cu): 26.3

Coefficient of Curvature (Cc): 1.1

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: N/A

Hand auger explorations completed in the cell did not penetrate the underdrain gravels.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell. The temporary wellpoint was screened from 1.5-2.5' and did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 48.1 in/hr

Subgrade Soil Rate (in/hr): N/A

No subgrade soil rate can be measured due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be in generally working condition.

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



Field Conditions

| | | | |
|-----------------|-------------------------|-----------------|---------------------|
| Weather | Sunny, 70s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.3" | Two Days Ago: 0.13" |
| Field Reps | Full Day: Alex Johanson | Half Day: | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230621-173536.jpg

Site Photo: FA_SitePhotos-20230621-173625.jpg



Site Photo: FA_SitePhotos-20230621-173651.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



Cell Construction

| | |
|---|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation runs along waterfront side of cell. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Partial Width Width 3' Probes of cell cross sections penetrate ~.3 feet on outer 1-2 feet of 6 foot width. Probes penetrate soil column to gravel for interior 2.5-3 feet. Some sediment observed at base of outflow pipe <.5". 2 outflow pipes observed in catch basin, only lower one is a conduit for flow. Rick Jordan (Poulsbo City Rep) was unsure what upper pipe was. Did not see a second pipe specified in plans. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| <p>Additional Comments</p> <p>Cleanout was located but attempt to remove plate was unsuccessful.</p> <p>Cell consists of one long cell which collects flow in between parking lot blocks. Cell has underdrain underneath cell base.</p> | |

Cleanouts

| | |
|-------------------------------------|---|
| CL-1 | |
| Condition | Accessible: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Distance from overflow/outlet: 132' | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 3'

Energy Dissipation
 Angular Rock: n/a
 Stream Cobble: n/a
 Water Wheel: n/a
 Splash Block: n/a
 Concrete Apron: n/a



FA_INphoto-20230621-174500.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: No energy dissipation. Inlets consist of 15 individual 3' spaces in between 6' long parking curbs. In locations where there is no vegetation adjacent the inlet the space is filled with parking lot runoff in an alluvial fan shape. (See HA-2).

Design Overflow/Outlet

DO - 1

Shape:

- Round
- Rectangular
- Other

Dimensions:
 Length: 1.8'
 Width: 1.4'

Additional Details:

Stickup (ft)

From Ground: 0.7

Relative from staff gauge:

Damage Indicators:

- Yes No

Trash Rack:

- Yes No

Additional Details:

Overflow Blocked? Yes No



FA_DOPhoto-20230621-195404.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



Cell Surface and Geotech Probe Observations

| | | |
|---|--|-----------------|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input checked="" type="checkbox"/> Coarse Mulch | | Depth (ft): 0.2 |
| Cell Coverage | | |
| Mulch | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Other: angular gravel, leaf litter. Angular gravel scattered along sideslopes of cell. Some younger mulch on waterside of cell sloughed off above landscaped area. | | |
| Some trash observed within and scattered around the cell. Some sediment and organic material deposition from the parking lot observed in the cell, this is especially visible where there is no vegetation. | | |
| In situ mulch varies greatly, covered in portions by leaf litter and dead twigs. | | |
| Pest Evidence | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | | |
| Vegetation Description | | |
| 90% vegetated. Heavily vegetated with two types of dense blocky shrubs. Clearly maintained to keep shape. Vegetation limited ability to probe at regular intervals. | | |
| Additional Details | | |
| Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 0.9- 1.4' where they met resistance due to gravels (plans call for 1.5' of bioretention soil). Probe depths were measured to be shallowest approximately 18' from the catch basin (0.9' depth). The width of the underdrain trench ranged from 2.5-3' and the length of the underdrain pipe was estimated to be ~118'. No zones of excessive compaction were observed. | | |

Hand Auger

| | |
|---|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.4 |
| Total Depth: | 2.2 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium-coarse SAND, some gravel, trace silt, abundant organics, scattered rootlets (SW) | |
| Native Soil Texture: Loose, slightly moist, brown, GRAVEL, trace sand, trace silt (GP). Gravel diameter 1", becomes 2" at 2.9. | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



HA-1-WP

Well Point Detail

Is the well point dry? Yes No
 Depth to water from TOC (ft):
 Respond to Testing: Yes No
 Shallowest Depth to water during testing from Ground Surface (ft):



HA-1.jpg

Additional Details

Native soil description for underdrain.

0-1.4': BSM
 1.4-1.9': Underdrain Gravels (avg. diameter ~1")
 1.9-2.2': Underdrain Gravels (avg. diameter ~2")

No groundwater encountered.

HA-2

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.6

to Native Soil:

to Import/Underdrain: 1.4

Total Depth: 1.5

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly, medium to coarse SAND, trace silt. Abundant rootlets, organics. (SW).

Native Soil Texture: Loose, moist, brown, GRAVEL, some sand, trace silt (GP)

Liner Present:

Yes No

Filter Fabric Present:

Yes No

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



HA-2



HA-2.jpg

Additional Details

Native soil description for underdrain.

- 0-0.4': Surface runoff
- 0.4-0.6': Buried Mulch
- 0.6-1.4': BSM
- 1.4-1.5': Underdrain Gravel

No groundwater encountered.

HA-3

- Zone 1 Zone 2 Zone 3
- Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0.4 |
| to Native Soil: | |
| to Import/Underdrain: | 1.6 |
| Total Depth: | 1.7 |

Rain/Garden Mix Soil Texture: Loose, moist, dark brown, medium to coarse SAND, some gravel, trace silt. Abundant organics and rootlets (SW).

Native Soil Texture: Loose, moist, brown, GRAVEL, trace sand, trace silt. (GP)

- | | |
|---|---|
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)
 Cell: Anderson Parkway

Assessed On:
 June 21, 2023



HA-3



HA-3.jpg

Additional Details

0-0.4: Mulch: Blocky, rectangular woody debris and twigs.
 0.4-1.6: Bioretention Soil
 1.6-1.7: Underdrain gravels

No groundwater encountered

Infiltration Test

IT-1

| | |
|--|---------|
| Water Supply | |
| <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-3 (3-50) | |
| Wetted Pond Area (sq. ft) | 31 |
| Ponded Depth (ft) | 0.22 |
| Total Gallons | 5,670.2 |
| Steady State Flow Rate (GPM) | 15.5 |

Additional Details:
 Max flow off irrigation bib ~15gpm. Water connected to cell through garden hose. Flow estimate from Poulsbo PUD was upwards of 30. Ponded area only small portion of cell. Ponded area expanded to south during testing. Difficult to measure wetted area due to dense thorny vegetation.



BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)

Cell: Anderson Parkway

Assessed On:

June 21, 2023



IT_Photo-20230621-213830.jpg



IT_Photo-20230621-213846.jpg



IT_Photo-20230621-213904.jpg

Additional Comments

Heavily vegetated. Ponded area very small in relation to size of cell.

BIORETENTION CELL FIELD ASSESSMENT

Site: Waterfront Park (PUWA)

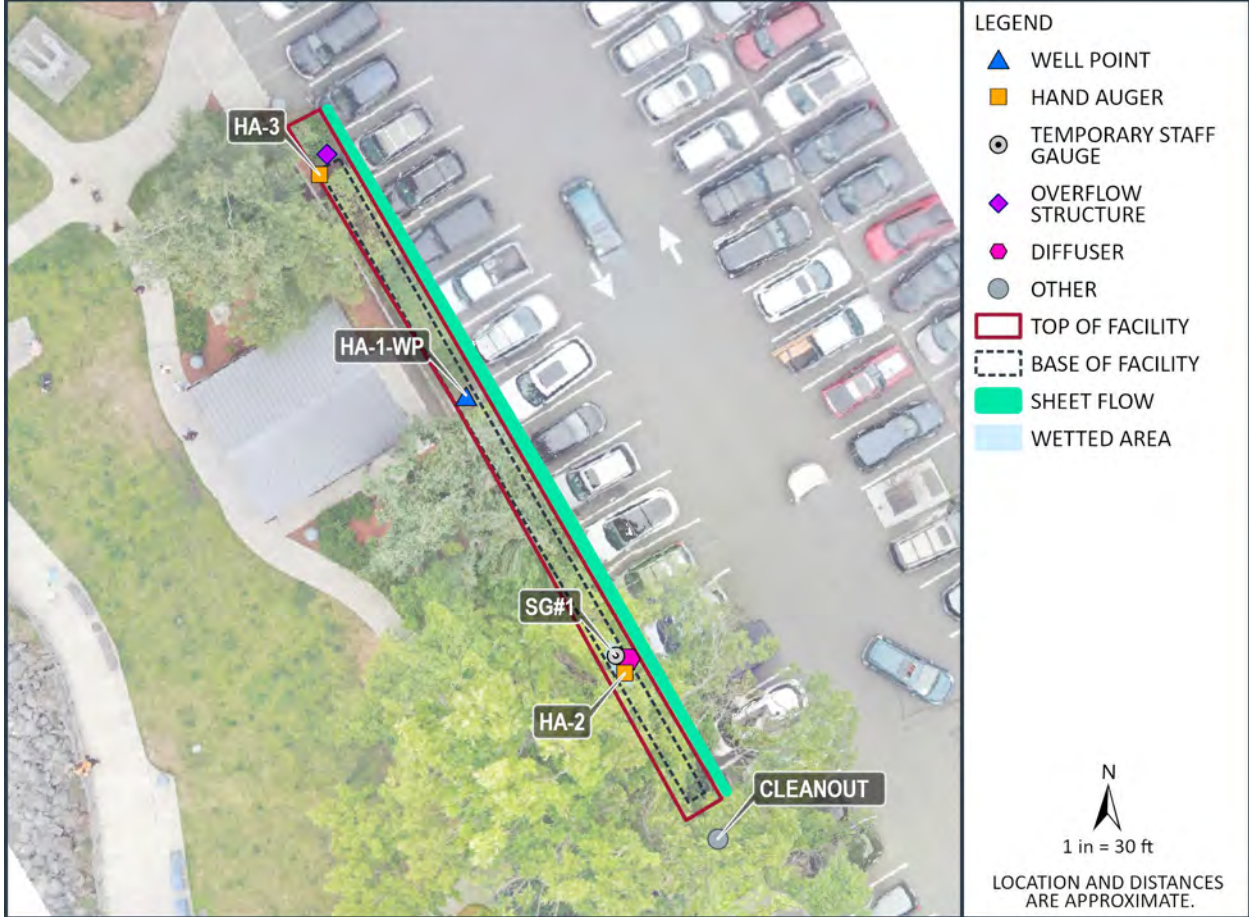
Cell: Anderson Parkway

Assessed On:

June 21, 2023



SITE: WATERFRONT PARK (PUWA) CELL: ANDERSON PARKWAY





associated
earth sciences
incorporated

Well Point

PUWA-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 6/20/2023

Logged By: APJ

20150387H008

Ending Date: 6/20/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.2

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 3.1

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.4

Water Level Elevation (ft): N/A

Datum: Project Datum

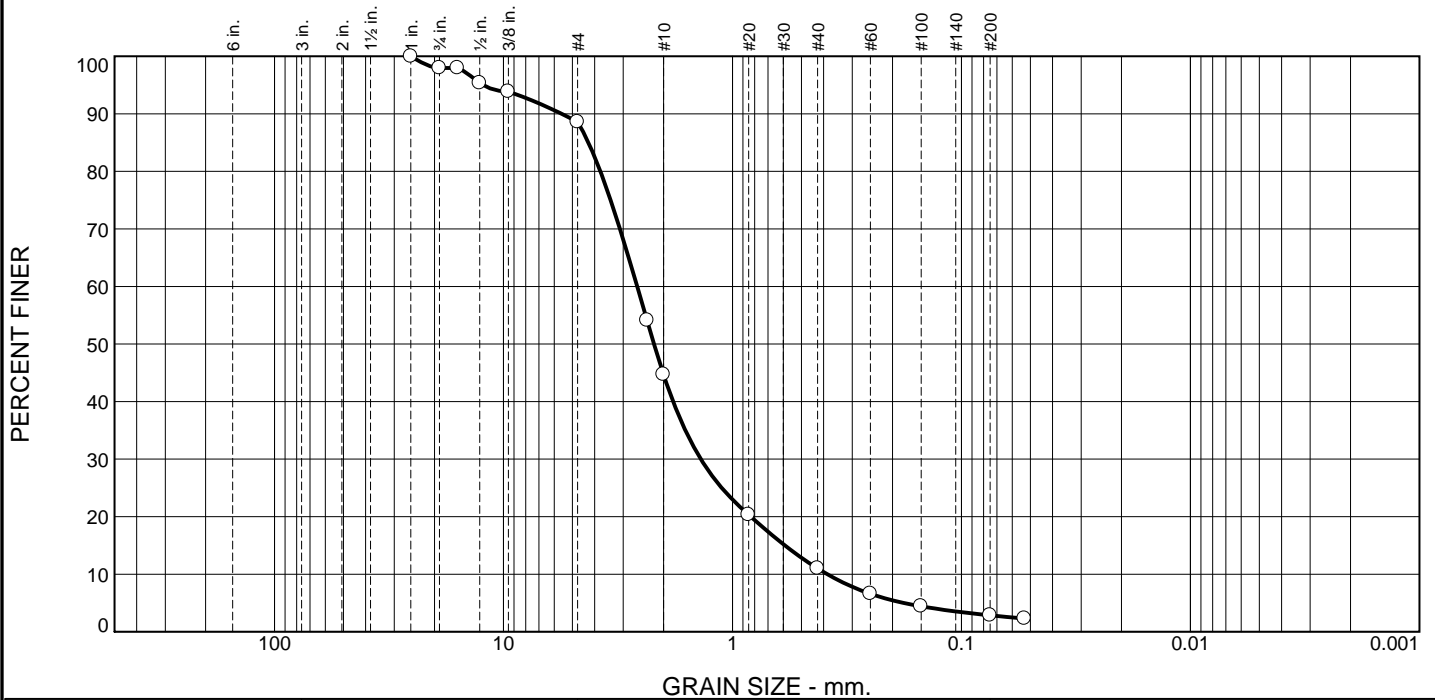
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----------|----------|----------|----------|--|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | Bioretention Soil Mix Loose, slightly moist, dark brown, medium to coarse SAND, some gravel, trace silt; abundant organics; scattered rootlets (SW). | | | | | | | Stick up -4.4 to 0 feet Existing bioretention soil 0 to 0.4 feet 3/8-inch bentonite chips 0.4 to 1 feet |
| 1 | Hand | 2 | | | | | | | | | Medium grain silica sand 1 to 1.6 feet 1.25-inch I.D. threaded galvanized steel casing -4.4 to 0.1 feet; duct tape covers screen 0.1 to 1.5 feet Existing gravel 1.6 to 3.1 feet |
| | Hand | 3 | | Underdrain Gravel Loose, slightly moist, brown, GRAVEL, trace silt, trace sand coating gravel; rounded gravel (GP). | | | | | | | 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.5 to 2.5 feet Cast iron endcap 2.5 to 2.8 feet Cast iron drive point 2.8 to 3.1 feet |
| 2 | Hand | 4 | | | | | | | | | |
| 3 | | | | No seepage. No caving. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

11/16/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 2.0 | 9.4 | 43.9 | 33.7 | 8.1 | 2.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 98.0 | | |
| 5/8" | 98.0 | | |
| 1/2" | 95.3 | | |
| 3/8" | 93.9 | | |
| #4 | 88.6 | | |
| #8 | 54.1 | | |
| #10 | 44.7 | | |
| #20 | 20.3 | | |
| #40 | 11.0 | | |
| #60 | 6.6 | | |
| #100 | 4.4 | | |
| #200 | 2.9 | | |
| #270 | 2.3 | | |

* (no specification provided)

Material Description

BSM
SAND, some gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 5.5725 D₈₅= 4.2558 D₆₀= 2.6066
D₅₀= 2.2012 D₃₀= 1.3746 D₁₅= 0.5900
D₁₀= 0.3855 C_u= 6.76 C_c= 1.88

Remarks

Date Received: 6/21/2023 Date Tested: 9/20/2023

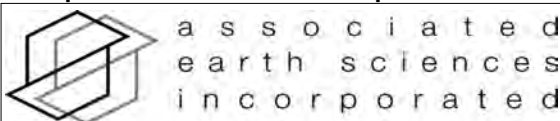
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Waterfront Park
Sample Number: HA-1 Depth: 1'

Date Sampled: 6/21/2023

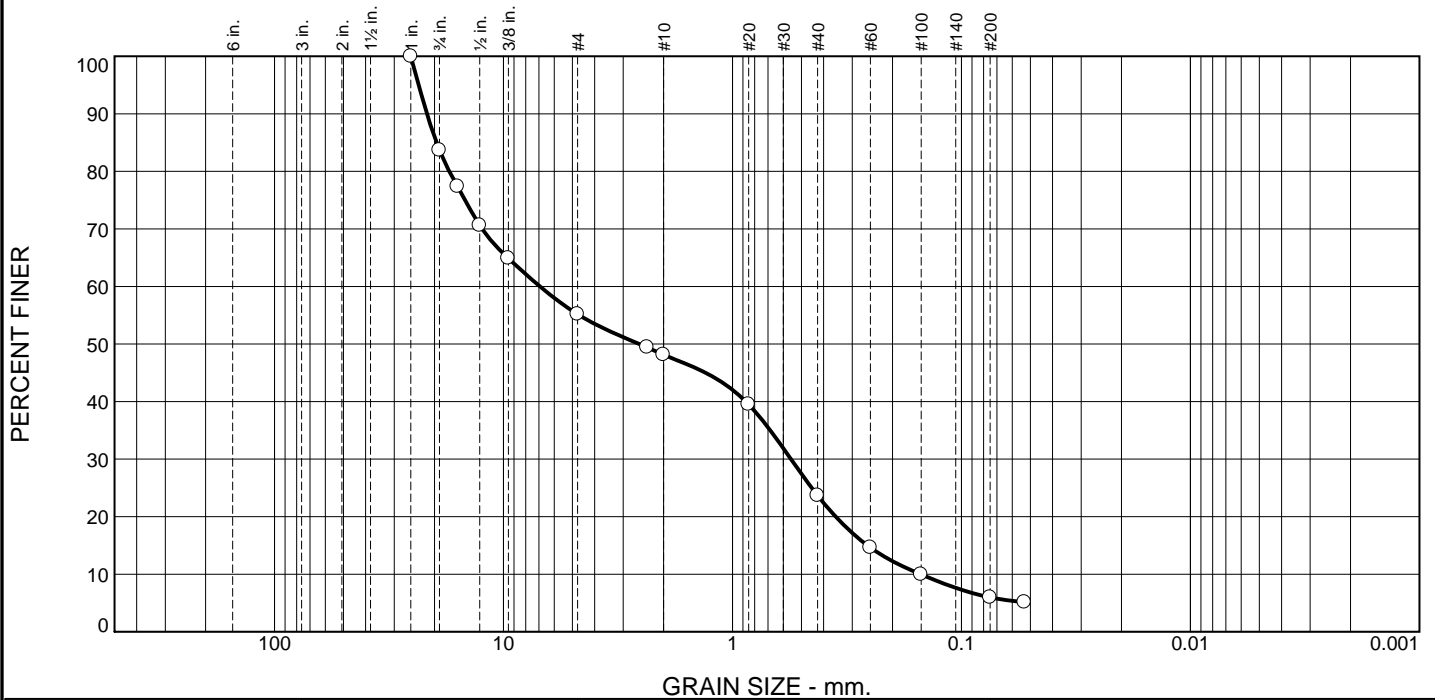


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 16.3 | 28.5 | 7.1 | 24.4 | 17.7 | 6.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 83.7 | | |
| 5/8" | 77.4 | | |
| 1/2" | 70.6 | | |
| 3/8" | 64.9 | | |
| #4 | 55.2 | | |
| #8 | 49.4 | | |
| #10 | 48.1 | | |
| #20 | 39.5 | | |
| #40 | 23.7 | | |
| #60 | 14.6 | | |
| #100 | 10.0 | | |
| #200 | 6.0 | | |
| #270 | 5.1 | | |

* (no specification provided)

Material Description

BSM
very gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 21.5942 D₈₅= 19.6284 D₆₀= 6.9311
D₅₀= 2.5520 D₃₀= 0.5551 D₁₅= 0.2573
D₁₀= 0.1509 C_u= 45.93 C_c= 0.29

Remarks

Date Received: 6/21/2023 Date Tested: 9/18/2023

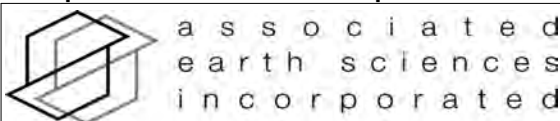
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Waterfront Park
Sample Number: HA-2 Depth: 0-0.4'

Date Sampled: 6/21/2023

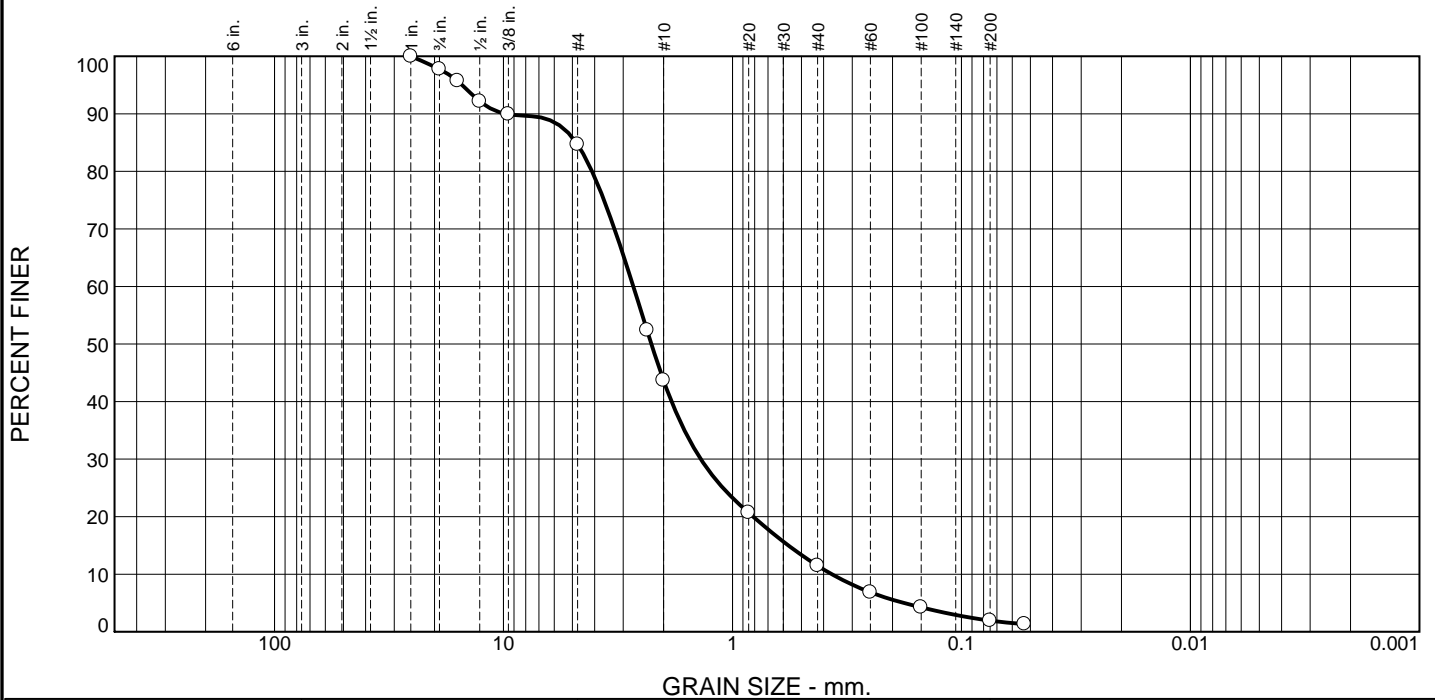


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 2.3 | 13.0 | 41.0 | 32.2 | 9.6 | 1.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 97.7 | | |
| 5/8" | 95.2 | | |
| 1/2" | 92.2 | | |
| 3/8" | 89.9 | | |
| #4 | 84.7 | | |
| #8 | 52.4 | | |
| #10 | 43.7 | | |
| #20 | 20.7 | | |
| #40 | 11.5 | | |
| #60 | 6.9 | | |
| #100 | 4.2 | | |
| #200 | 1.9 | | |
| #270 | 1.3 | | |

* (no specification provided)

Material Description

gravelly SAND, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 9.7668 D₈₅= 4.8132 D₆₀= 2.7104
D₅₀= 2.2598 D₃₀= 1.3753 D₁₅= 0.5700
D₁₀= 0.3681 C_u= 7.36 C_c= 1.90

Remarks

Large rootlets removed prior to burn/sieve

Date Received: 6/21/2023 Date Tested: 7/25/2023

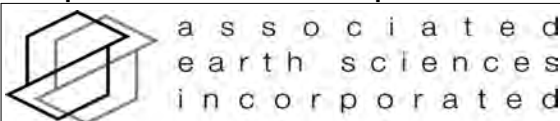
Tested By: CI

Checked By: APJ/JHS

Title: _____

Location: Onsite - Waterfront Park
Sample Number: HA-2 Depth: 1'

Date Sampled: 6/21/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 6/20/2023 | Project BHPS - Waterfront Park | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Poulsbo, WA | EB/EP No. PUWA-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 1' | HA-2 @ 0-0.4' |
|--------------------|-----------|---------------|
| Wet Weight + Pan | 1419.1 | 1003.6 |
| Dry Weight + Pan | 1310.0 | 876.6 |
| Weight of Pan | 358.0 | 247.5 |
| Weight of Moisture | 109.1 | 127.0 |
| Dry Weight of Soil | 952.0 | 629.1 |
| % Moisture | 11.5 | 20.2 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|-------|
| Dry Soil Before Burn + Pan | 1310.0 | 876.6 |
| Dry Soil After Burn + Pan | 1242.8 | 836.9 |
| Weight of Pan | 358.0 | 247.5 |
| Wt. Loss Due to Ignition | 67.2 | 39.7 |
| Actual Wt. Of Soil After Burn | 884.8 | 589.4 |
| % Organics | 7.1 | 6.3 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-----------------|--------------------------------|-----------------------------------|
| Project Name: | Waterfront Park | Water Source: | Hose bib |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 6/21/2023 | Wetted Area (sq. feet): | 11:53: 18.5 ft^2 / 14:50: 31 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.22 |
| Performed By: | APJ | Receptor Soils: | Underdrain Gravels |

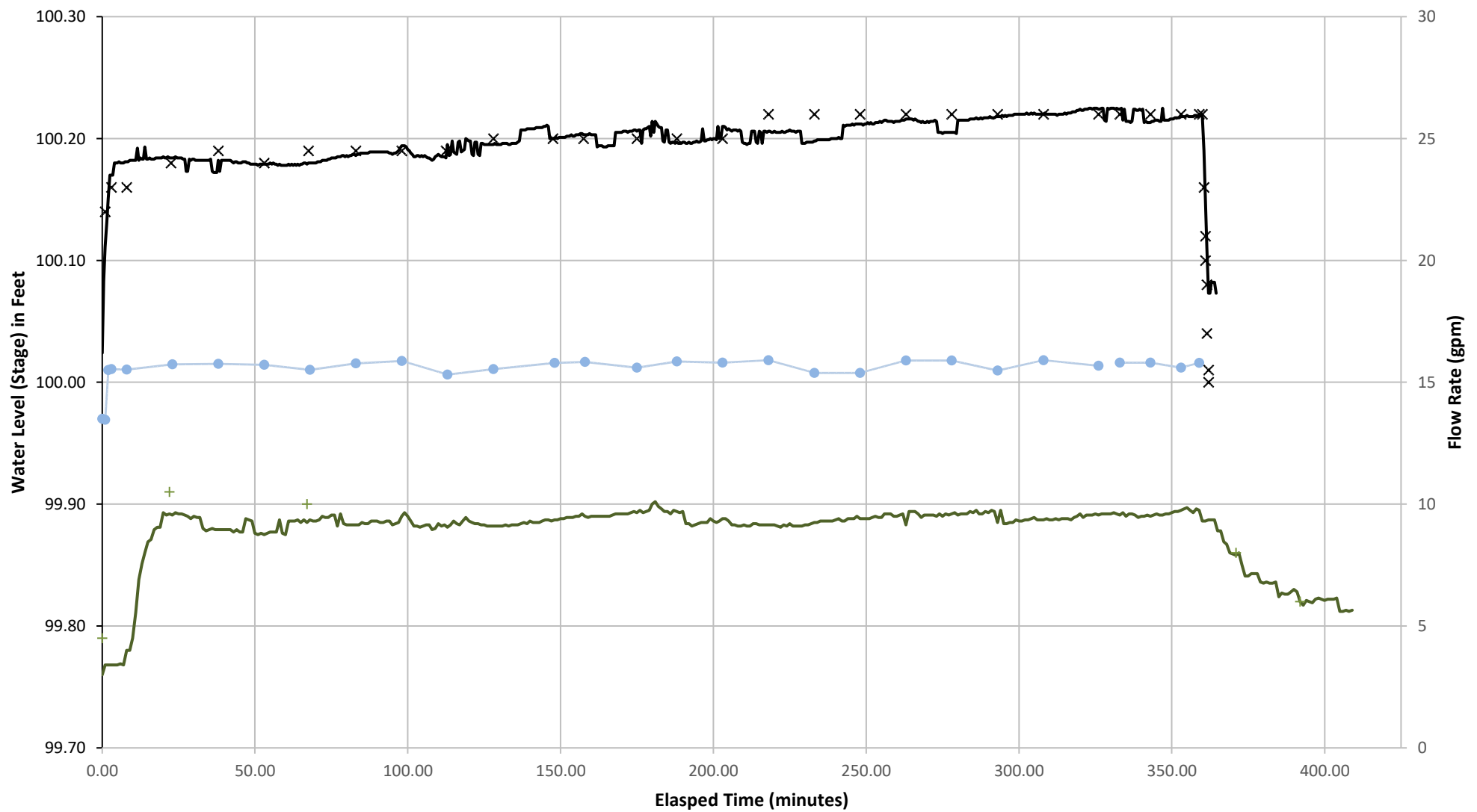
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|---|
| 9:07 | 13.5 | | 3.21 | Dry | | Water on |
| 9:08 | 13.46 | 0.14 | | | 14 | |
| 9:09 | 15.5 | | | | | Flow at maximum obtainable rate |
| 9:10 | 15.54 | 0.16 | | | 47 | |
| 9:15 | 15.52 | 0.16 | | | 118 | |
| 9:30 | 15.74 | 0.18 | 3.09 | | 367 | Water flowing out lower pipe in catch basin |
| 9:45 | 15.76 | 0.19 | | | 591 | CB smells like sulfur |
| 10:00 | 15.72 | 0.18 | | | 830 | |
| 10:15 | 15.51 | 0.19 | 3.1 | | 1,054 | |
| 10:30 | 15.78 | 0.19 | | | 1,295 | |
| 10:45 | 15.88 | 0.19 | | | 1,539 | |
| 11:00 | 15.32 | 0.19 | | | 1,779 | |
| 11:15 | 15.54 | 0.2 | | | 2,024 | |
| 11:35 | 15.8 | 0.2 | | | 2,314 | |
| 11:45 | 15.84 | 0.2 | | | 2,495 | Pond increasing slightly in size |
| 12:02 | 15.6 | 0.2 | | | 2,768 | |
| 12:15 | 15.86 | 0.2 | | | 2,965 | |
| 12:30 | 15.81 | 0.2 | | | 3,188 | |
| 12:45 | 15.91 | 0.22 | | | 3,440 | |
| 13:00 | 15.39 | 0.22 | | | 3,679 | |
| 13:15 | 15.39 | 0.22 | | | 3,924 | |
| 13:30 | 15.9 | 0.22 | | | 4,147 | |
| 13:45 | 15.9 | 0.22 | | | 4,383 | |
| 14:00 | 15.48 | 0.22 | | | 4,632 | |
| 14:15 | 15.91 | 0.22 | | | 4,859 | |
| 14:33 | 15.68 | 0.22 | | | 5,147 | |
| 14:35 | | | | | | Parkgoer turned off water for <1 min |
| 14:40 | 15.81 | 0.22 | | | 5,246 | |
| 14:50 | 15.81 | 0.22 | | | 5,408 | |
| 15:00 | 15.6 | 0.22 | | | 5,570 | |
| 15:06 | 15.8 | 0.22 | | | 5,654 | |
| 15:07:00 | | 0.22 | | | 5,670 | Water off |
| 15:07:30 | | 0.16 | | | | |
| 15:08:00 | | 0.12 | | | | |

| | | | | | | |
|----------|--|------|------|-----|--|---------------------------|
| 15:08:15 | | 0.1 | | | | |
| 15:08:30 | | 0.08 | | | | |
| 15:08:45 | | 0.04 | | | | |
| 15:09:00 | | 0.01 | | | | |
| 15:09:10 | | 0 | | | | |
| 15:09:30 | | | | | | Whole pond dry |
| 15:19 | | | 3.14 | | | |
| 15:40 | | | 3.18 | | | CB=3.18; very low/no flow |
| 15:50 | | | | | | CB=3.18; very low/no flow |
| 15:57 | | | | Dry | | CB=3.18; end of test |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 48.1 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 74.1 |
| SG-1 Average Infiltration Rate (in/hr) during falling head (Logger): | 49.7 |

Waterfront Park Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)
Cell: Bioretention Swale #3

Assessed On:
July 13, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2010 and collects runoff from the adjacent roadway. The cell is constructed with 2" of mulch above 18" of bioretention soil in the cell base. Beneath the bioretention soil is 6" sand blanket followed by a 3" of pea gravel over 11" of drywell gravel backfill which contains the perforated underdrain pipe. We understand that beneath the underdrain is a PVC liner to prevent water from infiltrating into the subsurface.

BIORETENTION SOIL:

Thickness: 1-1.5'

The apparent thickness of the bioretention soil ranged from 1-1.5' with an average of 1.3'.

Composition: No soil specifications were received in the design plans. In comparison to the 2019 Ecology specification, the tested material met the specification for sand gradation and organic matter, but exceeded the specification for silt content.

Organic Matter Content (% by weight): 5.6

Percent passing #200 sieve: 6.4

Coefficient of Uniformity (Cu): 5.5

Coefficient of Curvature (Cc): 1.2

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: N/A

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand auger explorations within the cell. A temporary wellpoint was installed from 2.1-1.6' which did not respond to testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 66.5

Subgrade Soil Rate (in/hr): N/A

No subgrade soil rate can be measured due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|------------|---------------|------------------|
| Weather | Sunny, 80s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)
 Cell: Bioretention Swale #3

Assessed On:
 July 13, 2023



| | | |
|------------|-----------------|--------------------|
| Field Reps | Full Day: Ikeda | Half Day: Thompson |
|------------|-----------------|--------------------|

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230713-165836.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)

Cell: Bioretention Swale #3

Assessed On:

July 13, 2023



Cell Construction

| | |
|-----------------------------|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation located on the street side of cell |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: ' Full Width Width ' Underdrain surrounded by gravels. Encountered increased gravel content at 2' |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | The cell is constructed with 2" of mulch above 18" of bioretention soil in the cell base. Beneath the bioretention soil is 3" of pea gravel over 11" of drywell gravel backfill which contains the perforated underdrain pipe. We understand that beneath the underdrain is a PVC liner to prevent water from infiltrating into the subsurface. |

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)
Cell: Bioretention Swale #3

Assessed On:
July 13, 2023



Inlets

IN-1

- Curb cut Sheet Flow
 Dispersed Flow Pipe
 Other:

Pipe:

Material

- PVC Metal Concrete Other
Diameter: 0.5'

Energy Dissipation

- Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230713-191208.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 40% blocked

Types:

- Sediment Organic Rock
 Trash Vegetation

Additional Details: Inlet pipe blocked by vegetation and leaf litter.

Additional Details: no energy dissipation

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)
 Cell: Bioretention Swale #3

Assessed On:
 July 13, 2023



Design Overflow/Outlet

| | | |
|---|--|---|
| DO - 1 | |  |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.1' Width: 1.8' | |
| Additional Details: | | |
| Stickup (ft) From Ground: 0.3 Relative from staff gauge: 0.3 | | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |

FA_DOPhoto-20230713-191501.jpg

Cell Surface and Geotech Probe Observations

| | | |
|--|--|-----------------|
| Mulch: <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | Depth (ft): 0.2 |
| Cell Coverage | | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Natural mulch in the form of long fibrous grass. Some vegetation and small shrubs at either end of the cell near overflows | | |
| Pest Evidence | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Observed wasps/hornets entering burrows in the cell. No large animals seen | | |
| Vegetation Description | | |
| Natural mulch floating on surface of the water. Makes observation of ponded area difficult. | | |
| Additional Details | | |
| Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 1.7-2.3'. Probe depths were measured to be the shallowest at each end of the cell by the catch basins (1.7' and 1.8'). One shallow probe was collected directly outside the north catch basin with a depth of 0.4'. Probe depths estimate the thickness of the bioretention soil and sand blanket, not exclusively the bioretention soil. | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)
 Cell: Bioretention Swale #3

Assessed On:
 July 13, 2023



The underdrain trench was present throughout the length of the cell. No zones of excessive compaction or erosion were observed.

Hand Auger

| | |
|---|---|
| HA-1WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | 2 |
| Total Depth: | 2.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, grayish-brown fine-medium SAND, some silt, abundant organics, trace rootlets (SP-SM) Native Soil Texture: [Sand Blanket] Loose, slightly moist, brownish-gray, fine-medium SAND, trace gravel, trace silt, trace organics, (SP) | |
| Liner Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Plans call out liner present about 38" (3.15') below surface. Liner not encountered in HA | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): | |
| Additional Details Native = Sand Blanket 0-1.5\"BSM 1.5-2\"Sand Blanket 2-2.5\"Pea Gravel: loose, slightly moist, brownish-gray, gravelly f-m SAND, trace silt, trace organics | |

| | |
|---|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1 |
| to Import/Underdrain: | 1 |
| Total Depth: | 2 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist grayish-brown, fine-medium SAND, some silt, abundant organics, trace rootlets (SP-SM) | |

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)
Cell: Bioretention Swale #3

Assessed On:
July 13, 2023



| | |
|---|---|
| HA-2 | |
| Native Soil Texture: [Sand Blanket] loose, slightly moist, brownish-gray, fine-medium SAND, trace gravel, trace silt (SP) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Native = Sand Blanket 0-1': BSM 1-2': Sand Blanket | |

| | |
|--|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | 2 |
| Total Depth: | 2.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, grayish-brown, fine-medium SAND, some silt, abundant organics, trace rootlets (SP-SM) | |
| Native Soil Texture: [Sand Blanket] loose, slightly moist, brownish-gray, fine-medium SAND, trace coarse sand, trace silt, trace organics. | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Native = Sand Blanket 0-1.5': BSM 1.5-2': Sand Blanket 2-2.5': pea gravel: loose, dry, brownish-gray, (f-m) sandy GRAVEL, trace silt, trace organics (GP) | |

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 213 |
| Ponded Depth (ft) | 0.28 |
| Total Gallons | 53,706 |
| Steady State Flow Rate (GPM) | 180 |

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)

Cell: Bioretention Swale #3

Assessed On:

July 13, 2023



Additional Details:

11:00 removed AESI flow meter and switched to solely the city's hydrant meter for increased flow

14:08 water off for falling head #1

14:18 water back on for 1 hour held at constant head

15:26 water off for falling head #2



IMG_1702_1_.JPG

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: 185th Ave NE (Northern) (RD185N)

Cell: Bioretention Swale #3

Assessed On:

July 13, 2023



SITE: 185TH AVE NE (NORTHERN) (RD185N) CELL: BIORETENTION SWALE #3





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Well Point

RD185N-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/13/23

Logged By: APJ

20150387H008

Ending Date: 7/13/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.7

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.9

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered

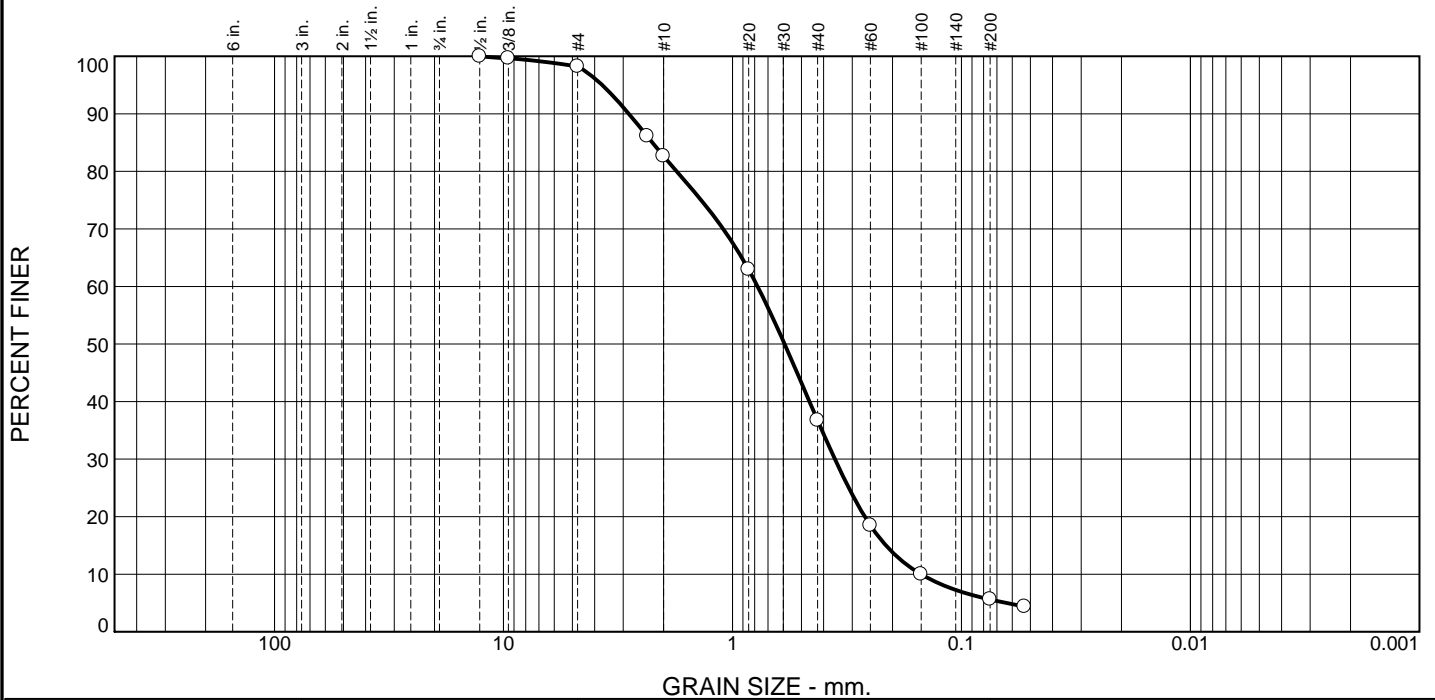
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----------|----------|----------|----------|---|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| 0 | Hand | 1 | | Bioretention Soil Mix Loose, slightly moist, brown to gray, fine to medium SAND, some coarse sand, some silt, trace gravel; abundant organics; trace rootlets (SP-SM). | | | | | | | <p>Stick up -4.9 to 0 feet Existing bioretention soil 0 to 1 feet 1.25-inch I.D. threaded galvanized steel casing 0.3 to 4.9 feet; duct tape covers screen 0.3 to 1.6 feet Bentonite chips 1 to 1.3 feet Medium grained silica sand 1.3 to 2.7 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.6 to 2.1 feet Cast iron end cap 2.1 to 2.4 feet Cast iron drive point 2.4 to 2.7 feet</p> |
| 1 | | | | | | | | | | | |
| 2 | Hand | 2 | | Import Sand Blanket Loose, slightly moist, brown to gray, fine to medium SAND, trace gravel, trace silt; trace organics (SP). | | | | | | | |
| 2 | Hand | 3 | | Loose, slightly moist, brownish gray, very gravelly, fine to medium SAND, trace silt; trace organics (SP). | | | | | | | |
| 3 | | | | No caving. No groundwater encountered. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.8 | 15.5 | 46.0 | 31.1 | 5.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 98.2 | | |
| #8 | 86.1 | | |
| #10 | 82.7 | | |
| #20 | 62.9 | | |
| #40 | 36.7 | | |
| #60 | 18.5 | | |
| #100 | 10.0 | | |
| #200 | 5.6 | | |
| #270 | 4.4 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 2.8353 D₈₅= 2.2361 D₆₀= 0.7766
D₅₀= 0.5921 D₃₀= 0.3571 D₁₅= 0.2139
D₁₀= 0.1501 C_u= 5.18 C_c= 1.09

Remarks

Date Received: 7/13/2023 Date Tested: 9/25/2023

Tested By: FEW

Checked By: APJ/JHS

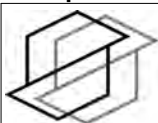
Title: _____

Location: Onsite - RD185

Sample Number: HA-1

Depth: 0-0.5'

Date Sampled: 7/13/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

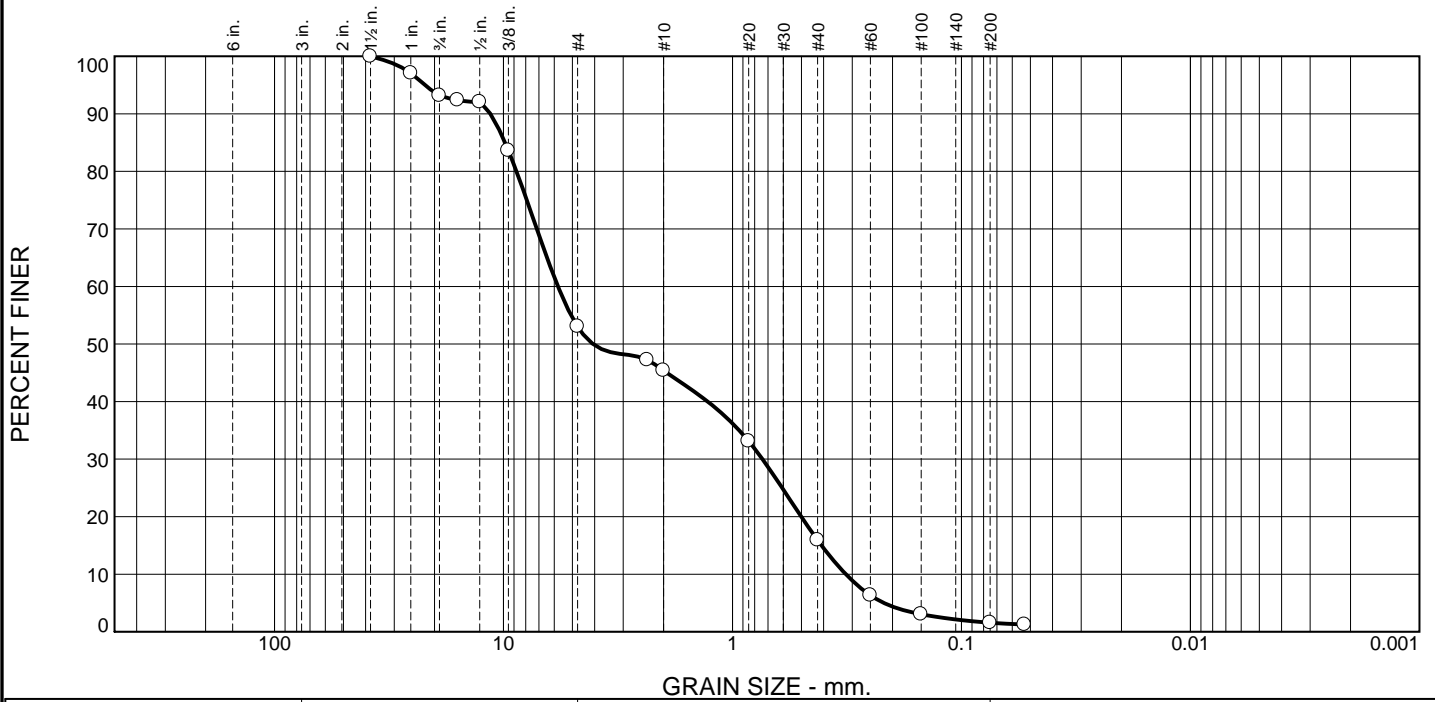
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 6.8 | 40.2 | 7.6 | 29.5 | 14.3 | 1.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 97.1 | | |
| 3/4" | 93.2 | | |
| 5/8" | 92.4 | | |
| 1/2" | 92.0 | | |
| 3/8" | 83.6 | | |
| #4 | 53.0 | | |
| #8 | 47.2 | | |
| #10 | 45.4 | | |
| #20 | 33.1 | | |
| #40 | 15.9 | | |
| #60 | 6.3 | | |
| #100 | 3.1 | | |
| #200 | 1.6 | | |
| #270 | 1.2 | | |

* (no specification provided)

Material Description

very gravelly SAND, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 11.4119 D₈₅= 9.8439 D₆₀= 5.7848
D₅₀= 4.0616 D₃₀= 0.7398 D₁₅= 0.4084
D₁₀= 0.3200 C_u= 18.08 C_c= 0.30

Remarks

Date Received: 7/13/2023 Date Tested: 9/25/2023

Tested By: FEW

Checked By: APJ/JHS

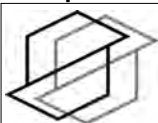
Title: _____

Location: Onsite - RD185

Sample Number: HA-1 and HA-3

Depth: 2-2.5'

Date Sampled: 7/13/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

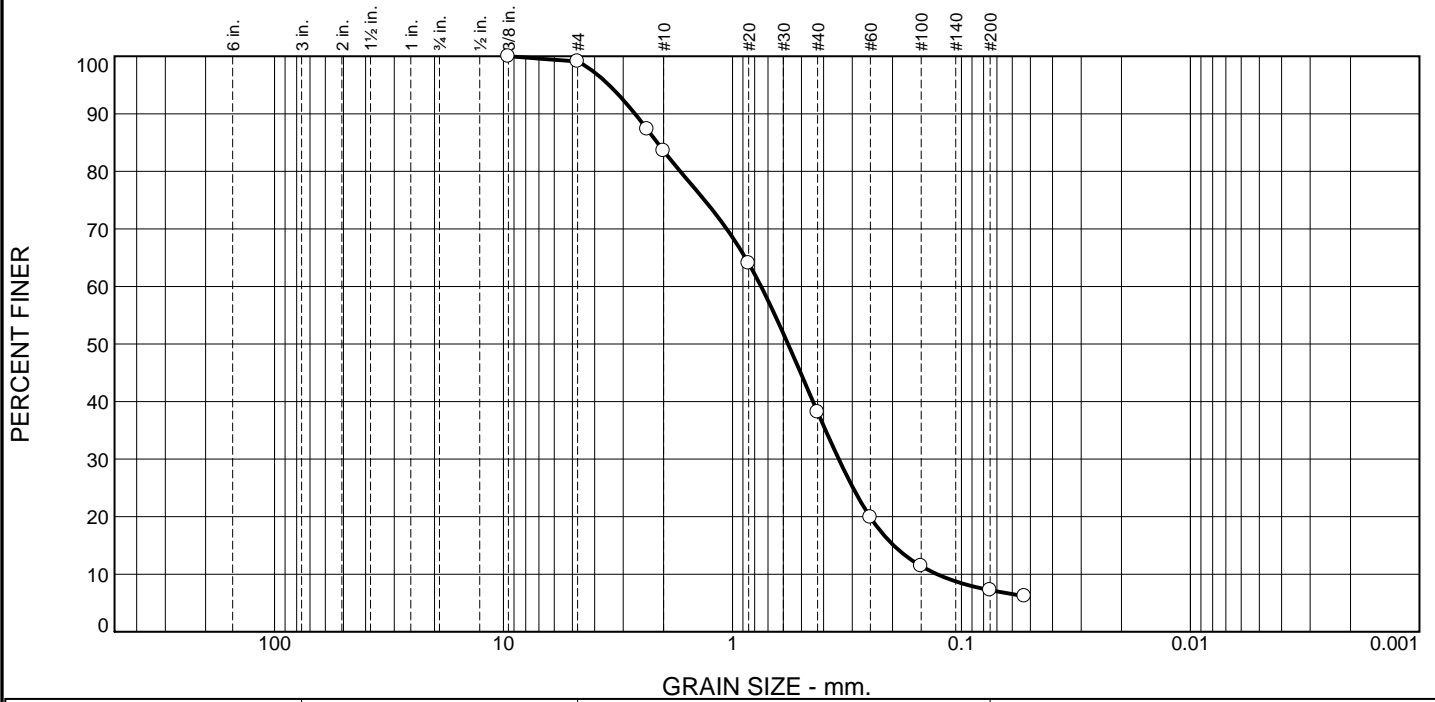
Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.9 | 15.5 | 45.4 | 31.0 | 7.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 99.1 | | |
| #8 | 87.3 | | |
| #10 | 83.6 | | |
| #20 | 64.0 | | |
| #40 | 38.2 | | |
| #60 | 19.9 | | |
| #100 | 11.4 | | |
| #200 | 7.2 | | |
| #270 | 6.2 | | |

* (no specification provided)

Material Description

BSM
SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 2.6642 | D ₈₅ = 2.1306 | D ₆₀ = 0.7498 |
| D ₅₀ = 0.5718 | D ₃₀ = 0.3435 | D ₁₅ = 0.1979 |
| D ₁₀ = 0.1278 | C _u = 5.87 | C _c = 1.23 |

Remarks

Date Received: 7/13/2023 Date Tested: 9/25/2023

Tested By: FEW

Checked By: APJ/JHS

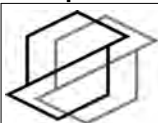
Title: _____

Location: Onsite - RD185

Sample Number: HA-2

Depth: 0.5'

Date Sampled: 7/13/2023



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Client: City of Olympia

Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 7/13/2023 | Project BHPS - Redmond 185th N | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Redmond, WA | EB/EP No. RD185N-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.5' | HA-2 @ 0.5' |
|--------------------|---------------|-------------|
| Wet Weight + Pan | 1293.2 | 952.8 |
| Dry Weight + Pan | 1259.8 | 922.1 |
| Weight of Pan | 391.9 | 247.1 |
| Weight of Moisture | 33.4 | 30.7 |
| Dry Weight of Soil | 867.9 | 675.0 |
| % Moisture | 3.8 | 4.6 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|-------|
| Dry Soil Before Burn + Pan | 1259.8 | 922.1 |
| Dry Soil After Burn + Pan | 1205.2 | 888.5 |
| Weight of Pan | 391.9 | 247.1 |
| Wt. Loss Due to Ignition | 54.6 | 33.6 |
| Actual Wt. Of Soil After Burn | 813.3 | 641.4 |
| % Organics | 6.3 | 5.0 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------|--------------------------------|------------------------|
| Project Name: | Redmond 185th | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 7/13/2023 | Wetted Area (sq. feet): | Steady State: 213 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Yes; with liner |
| Test No.: | IT-1 | Test Depth (feet): | 0.26 |
| Performed By: | CSI / SST | Receptor Soils: | Underdrain Gravels |

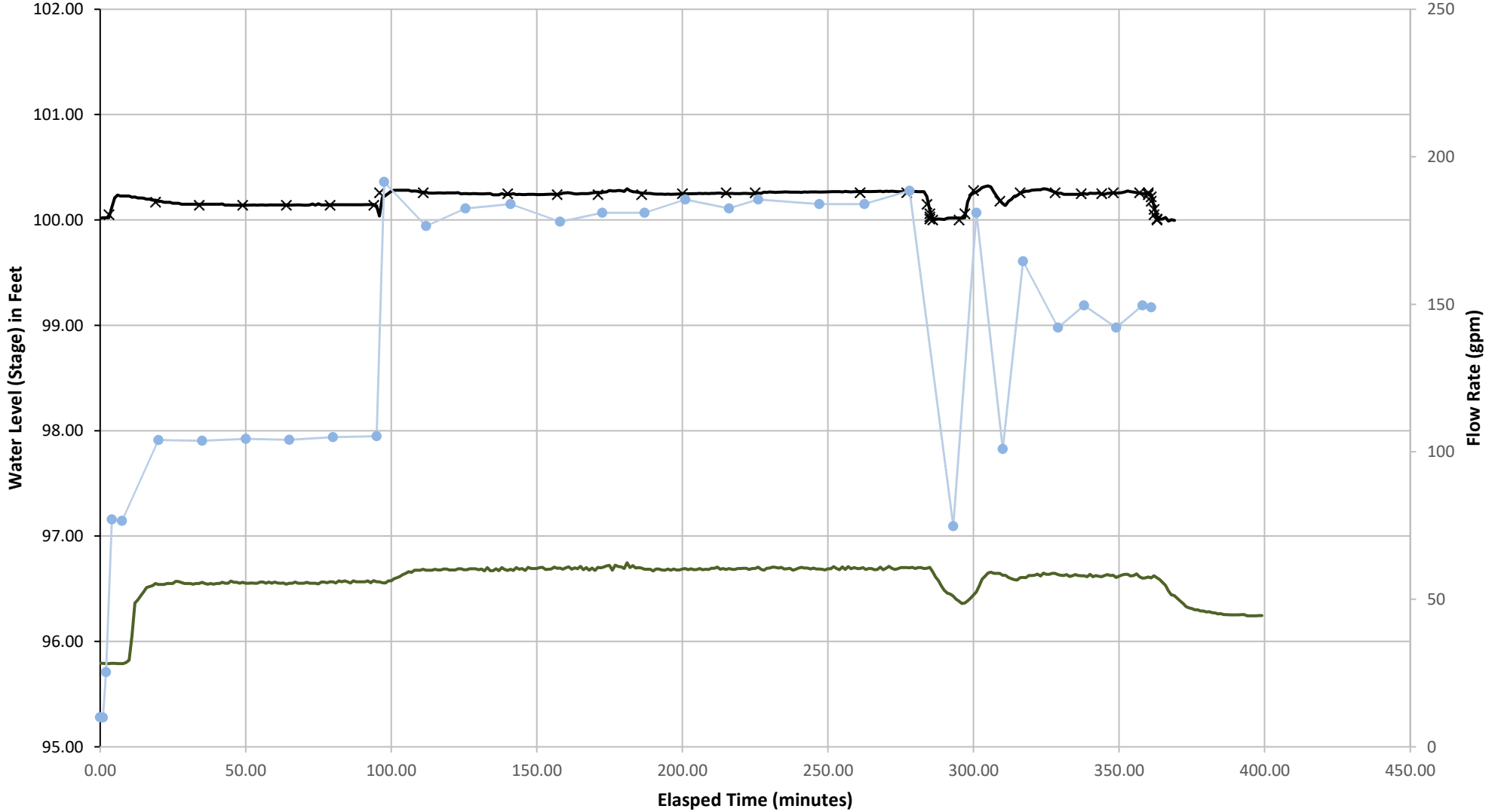
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin North (ft) | Catch Basin South (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------------|------------------------|----------------------|---------------------|---|
| 9:25 | 10.06 | | 3.56 | 4.21 | Dry | | Water on |
| 9:26 | 10 | | | | | 56 | Increase flow to 25 gpm |
| 9:27 | 25.31 | | | | | 73 | Increase flow to 75 gpm |
| 9:29 | 77.14 | 0.05 | | | | 162 | |
| 9:32 | 76.6 | | | | | 430 | Increase flow to 100 gpm |
| 9:45 | 104 | 0.17 | | | | 1,744 | Trickle into north CB |
| 10:00 | 103.8 | 0.14 | | | | 3,285 | |
| 10:15 | 104.4 | 0.14 | | | | 4,854 | |
| 10:30 | 104.1 | 0.14 | | | | 6,425 | |
| 10:45 | 105 | 0.14 | | | | 7,998 | Water flowing in underdrain |
| 11:00 | 105.28 | 0.14 | | | | 9,584 | Water off |
| 11:01 | | | | | | | Water on, removed FM - using hydrant meter only |
| 11:02 | 191.5 | 0.26 | | | | 10,062 | |
| 11:08 | | | | | | 11,042 | |
| 11:17 | 176.5 | 0.26 | | | | 12,688 | Inlet submerged |
| 11:30 | 182.5 | | | | | 15,216 | |
| 11:46 | 184 | 0.25 | | | | 17,969 | |
| 12:03 | 178 | 0.24 | | 3.31 | | 21,044 | |
| 12:17 | 181 | 0.24 | | 3.31 | | 23,685 | |
| 12:32 | 181 | 0.24 | | | | 26,318 | |
| 12:46 | 185.5 | 0.25 | | 3.31 | | 28,862 | |
| 13:01 | 182.5 | 0.26 | | | | 31,592 | |
| 13:11 | 185.5 | 0.26 | | | | 33,410 | |
| 13:32 | 184 | | 3.42 | | | 36,874 | |
| 13:47 | 184 | 0.26 | | | | 40,068 | Underdrain 35" below grate; grate SU = 4" |
| 14:03 | 188.5 | 0.26 | | 3.31 | | 42,904 | CB-S = 3.31' |
| 14:08 | | | | | | 43,816 | Water off |
| 14:10:30 | | 0.15 | | | | | |
| 14:10:45 | | 0.06 | | | | | |
| 14:11:00 | | 0.03 | | | | | |
| 14:11:15 | | 0.01 | | | | | |
| 14:12 | | 0 | | | | | |
| 14:14 | | | | 3.51 | | | |
| 14:18 | 74.81 | | | | | | Water on |
| 14:21 | | 0 | | | | 44,179 | |
| 14:23 | | 0.06 | | | | | |
| 14:26 | 181 | 0.28 | | 3.55 | | 44,908 | |

| | | | | | | | |
|----------|--------|------|------|------|--|--------|---------------------|
| 14:35 | 100.99 | 0.18 | | | | 46,270 | Adjusting flow rate |
| 14:42 | 164.6 | 0.26 | | | | 47,250 | |
| 14:54 | 142.1 | 0.26 | | 3.35 | | 49,098 | |
| 15:03 | 149.6 | 0.25 | 3.45 | 3.41 | | 50,437 | |
| 15:10 | | 0.25 | | | | | |
| 15:14 | 142.1 | 0.26 | | | | 52,015 | |
| 15:23 | 149.6 | 0.26 | | | | 53,227 | |
| 15:26:00 | 149 | 0.26 | | | | 53,706 | Water off |
| 15:26:30 | | 0.24 | | | | | |
| 15:27:00 | | 0.22 | | | | | |
| 15:27:30 | | 0.18 | | | | | |
| 15:28:00 | | 0.1 | | | | | |
| 15:28:30 | | 0.05 | | | | | |
| 15:29:00 | | 0.01 | | | | | |
| 15:29:30 | | 0 | | | | | Ponded area dry |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 66.5 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 60.0 |

Redmond 185th Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference.
Elevation 100 represents ground surface.

× Staff Gauge #1 Hand Data

— Staff Gauge #1 Logger

— Catch Basin South Logger

● Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
Cell: Cell 1

Assessed On:
July 20, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2013 and collects road runoff from the adjacent roadway. The cell is constructed with 1.5' of bioretention soil above a layer of geotextile filter fabric. Beneath the fabric is 1' of gravel drain rock which contains a perforated underdrain pipe. Beneath the underdrain gravels sits a PVC liner to prevent water from infiltrating into the subgrade.

BIORETENTION SOIL:

Thickness: 1.7'

The apparent thickness of the bioretention soil is 1.7', slightly more than the 1.5' specified by the plans.

Composition: No soil specifications were received in the design plans. In comparison to the 2019 Ecology specifications, the sand gradation and silt content met the specifications while the organic matter content fell below the standard.

Organic Matter Content (% by weight): 3.7

Percent passing #200 sieve: 3.2

Coefficient of Uniformity (Cu): 4.7

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Recent Alluvium

Soil Description: N/A

Hand auger explorations completed in the cell did not penetrate the underdrain gravels.

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was observed in the hand auger explorations conducted within the cell. No temporary wellpoint was installed due to the risk of penetrating the PVC liner.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 73.8

Subgrade Soil Rate (in/hr): N/A

No subgrade soil rate can be measured due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be in generally working condition.

Field Conditions

| | |
|---------|-------------|
| Weather | Clear, 70's |
|---------|-------------|

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
Cell: Cell 1

Assessed On:
July 20, 2023



| | | | |
|-----------------|-------------------------|---------------|-------------------------|
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Alex Johanson | | Half Day: Stan Thompson |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230720-185753.jpg



Site Photo: FA_SitePhotos-20230720-185827.jpg



Site Photo: FA_SitePhotos-20230720-185810.jpg



Site Photo: FA_SitePhotos-20230720-185854.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
 Cell: Cell 1

Assessed On:
 July 20, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation lines run down eastern and western edges of cell. Plants appear green and healthy |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Full Width Width 8.7' Full width underdrain trench. Contains an underdrain pipe with an accessible Cleanout in the southern edge of the cell. Underdrain pipe connects to the storm drain system. No design overflow. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments The cell collects runoff from the adjacent roadway. The cell is constructed with 1.5' of bioretention soil above a layer of geotextile filter fabric which sits above a gravel drain rock and a perforated underdrain pipe. | |

Cleanouts

| | |
|----------------------------------|--|
| CL-1 | |
| Condition | Accessible: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Distance from overflow/outlet: ' | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
Cell: Cell 1

Assessed On:
July 20, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.9'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Buried

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230720-222250.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 5% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Leaf litter blocking small portion of inlet.



FA_INBLPhoto-20230720-222227.jpg

Additional Details: Stream cobbles extend 2.5' from inlet. Buried with bioretention soil.

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
Cell: Cell 1

Assessed On:
July 20, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.9'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: Buried
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230720-194300.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Inlet is a curb cut which flows into .69' inlet pipe. Curb cut is filled with loose leaf debris, sediment, cigarettes. Trace sedimentation at base of inlet pipe.



FA_INBLPhoto-20230720-194158.jpg

Additional Details: Stream cobbles extend 3' beyond inlet.

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
 Cell: Cell 1

Assessed On:
 July 20, 2023



Cell Surface and Geotech Probe Observations

| | | |
|--|--|-----------------|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | Depth (ft): 0.1 |
| Cell Coverage | | |
| Mulch | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Other | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% | |
| Thin layer of fine mulch above bioretention base. Soil is uniform across cell. Hit filter fabric at 1.7' across the cell except for rockery near inlets. No change in bioretention soil composition with depth. Did not penetrate filter fabric, could not observe texture of gravels. Litter is present within the cell. Snack wrappers, straws, shoe insert, candy wrapper and other trash. . One large tree in the cell base whose roots made excavations difficult near HA-1. Soil especially loose, water was added to soil near excavation to limit slough. | | |
| Pest Evidence | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | | |
| Vegetation Description | | |
| Roots limited excavation depth for HA-1. Vegetation healthy, covers most of cell aerially. | | |
| Additional Details | | |
| Geotech Probe Observations: Geotech probes encountered a 1.7' of bioretention soil across the cell and terminated on gravel drain rock. | | |

Hand Auger

| | |
|--|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.7 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown f-m SAND, trace coarse sand, some silt, abundant organics (SP) | |
| Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Did not reach filter fabric. Encountered roots. | |
| Additional Details | |
| Terminated boring when tree roots were encountered. Moved to next HA due to time constraint. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
Cell: Cell 1

Assessed On:
July 20, 2023



| | |
|---|--|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | 1.7 |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, silty, m SAND, trace coarse sand, abundant organics and scattered rootlets (SP) | |
| Native Soil Texture: | |
| Liner Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Not encountered | Filter Fabric Present: <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Details Pre-soaked soil to aid with excavation 0-0.1: loose grasses and vegetative debris 0.1-1.7': BSM | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 1.7 |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, f-m SAND, trace coarse sand, some silt, abundant organics | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details Water added to sampling area to reduce slough. 0-1.7': BSM No groundwater encountered | |

Infiltration Test

| |
|--------------|
| IT-1 |
| Water Supply |

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)
Cell: Cell 1

Assessed On:
July 20, 2023



| | |
|--|----------|
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 126 |
| Ponded Depth (ft) | 0.43 |
| Total Gallons | 31,888.7 |
| Steady State Flow Rate (GPM) | 98 |

Additional Details:
Pond slowly expanded throughout course of test towards the southern end of cell.
Flow rate incrementally edged up throughout test without touching. Noticed the issue at 13:40 and slightly adjusted flow down to keep flow constant for last hour.



IT_Photo-20230720-205106.jpg



IT_Photo-20230720-205118.jpg



IT_Photo-20230720-205138.jpg

Additional Comments

- Terminated flow at 2:30 to comply with ROW asking for offsite at 3:00.
- Cleanout acted as WP for this test

BIORETENTION CELL FIELD ASSESSMENT

Site: Redmond Downtown Park (RDDP)

Cell: Cell 1

Assessed On:

July 20, 2023



SITE: REDMOND DOWNTOWN PARK (RDDP) CELL: CELL 1





associated
earth sciences
incorporated

Exploration Boring

RDDP-HA-2

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/20/2023

Logged By: APJ

20150387H008

Ending Date: 7/20/2023

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.7

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

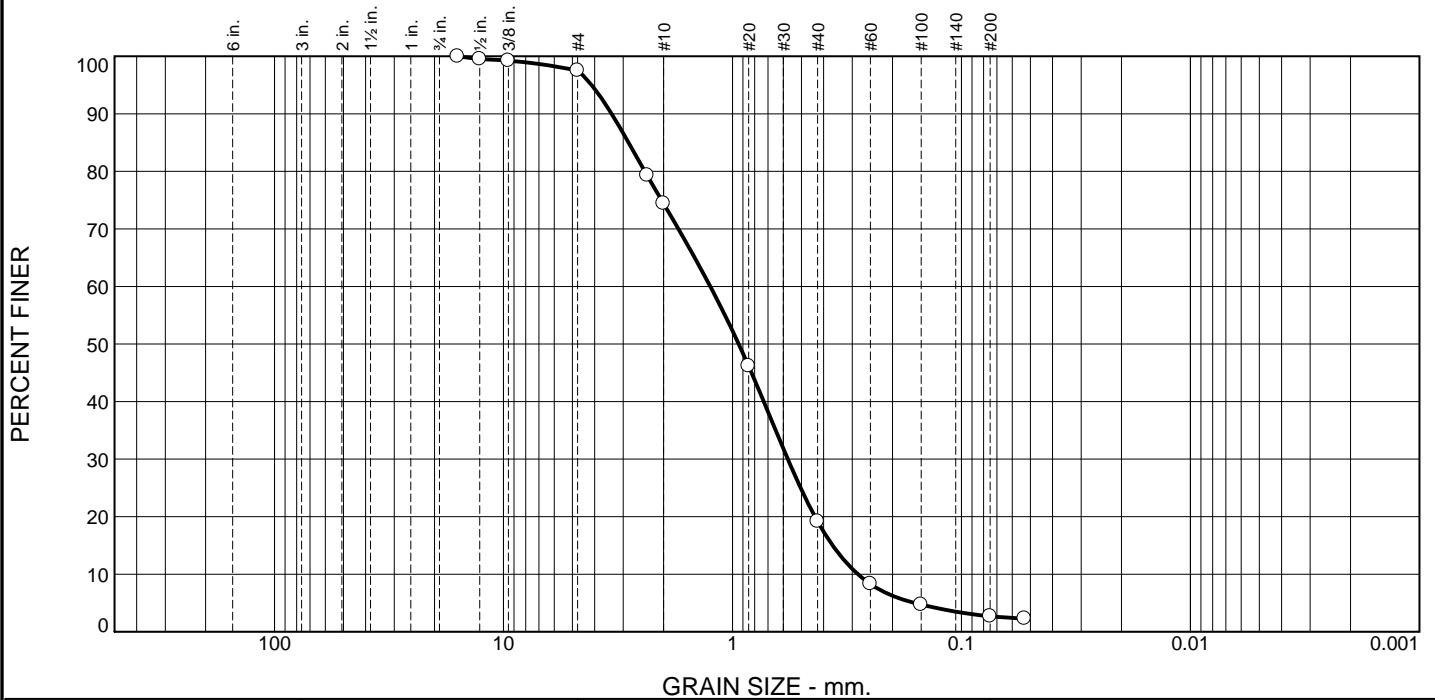
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | | <p>Mulch Loose grasses and vegetative debris.</p> | | | | | | | | |
| 0 - 1 | | | | | <p>Bioretention Soil Mix Loose, slightly moist, dark brown, medium SAND, some coarse sand, trace gravel, trace silt; abundant organics; scattered rootlets (SP).</p> | | | | | | | | |
| 1 - 2 | | | | | <p>No groundwater encountered. Caving within bioretention soil. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | | |
| 2 - 3 | | | | | | | | | | | | | |
| 3 - 4 | | | | | | | | | | | | | |
| 4 - 5 | | | | | | | | | | | | | |
| 5 - 6 | | | | | | | | | | | | | |
| 6 - 7 | | | | | | | | | | | | | |

12/15/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.5 | 23.1 | 55.2 | 16.5 | 2.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 99.5 | | |
| 3/8" | 99.2 | | |
| #4 | 97.5 | | |
| #8 | 79.3 | | |
| #10 | 74.4 | | |
| #20 | 46.2 | | |
| #40 | 19.2 | | |
| #60 | 8.3 | | |
| #100 | 4.7 | | |
| #200 | 2.7 | | |
| #270 | 2.3 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.3706 | D ₈₅ = 2.8438 | D ₆₀ = 1.2497 |
| D ₅₀ = 0.9390 | D ₃₀ = 0.5731 | D ₁₅ = 0.3654 |
| D ₁₀ = 0.2834 | C _u = 4.41 | C _c = 0.93 |

Remarks

Date Received: 7/20/2023 Date Tested: 9/28/2023

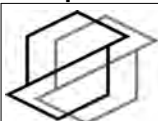
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Redmond Downtown Park
Sample Number: HA-2 **Depth:** 0-0.6'

Date Sampled: 7/20/2023



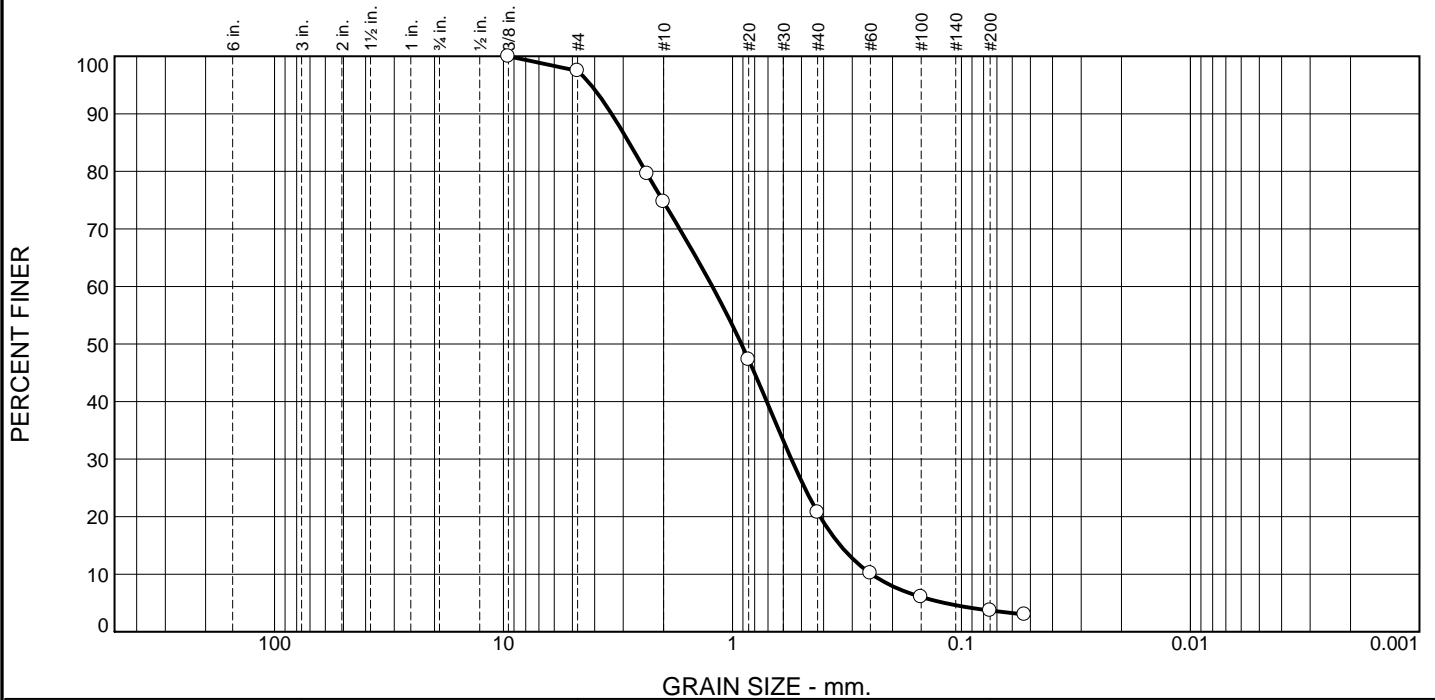
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.5 | 22.8 | 53.9 | 17.1 | 3.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 97.5 | | |
| #8 | 79.6 | | |
| #10 | 74.7 | | |
| #20 | 47.3 | | |
| #40 | 20.8 | | |
| #60 | 10.2 | | |
| #100 | 6.1 | | |
| #200 | 3.7 | | |
| #270 | 3.0 | | |

* (no specification provided)

Material Description

BSM
SAND, trace gravel, trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.3717 | D ₈₅ = 2.8296 | D ₆₀ = 1.2240 |
| D ₅₀ = 0.9138 | D ₃₀ = 0.5531 | D ₁₅ = 0.3380 |
| D ₁₀ = 0.2467 | C _u = 4.96 | C _c = 1.01 |

Remarks

Date Received: 7/20/2023 Date Tested: 9/28/2023

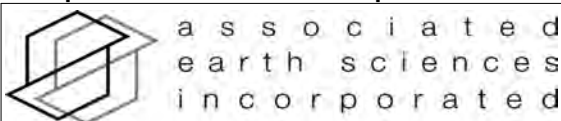
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Redmond Downtown Park
Sample Number: HA-3 **Depth:** 0-0.5'

Date Sampled: 7/20/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|---|-------------------------------------|-------------------------|--|
| Date Sampled 7/20/2023 | Project BHPS - Redmond Dwntwn | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By CSI | Location Redmond, WA | EB/EP No. RDDP-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0.6' | HA-3 @ 0.5' |
|--------------------|--------------------|--------------------|
| Wet Weight + Pan | 1368.4 | 945.8 |
| Dry Weight + Pan | 1256.6 | 818.4 |
| Weight of Pan | 358.0 | 247.5 |
| Weight of Moisture | 111.8 | 127.4 |
| Dry Weight of Soil | 898.6 | 570.9 |
| % Moisture | 12.4 | 22.3 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------------|--------------|
| Dry Soil Before Burn + Pan | 1256.6 | 818.4 |
| Dry Soil After Burn + Pan | 1228.6 | 794.4 |
| Weight of Pan | 358.0 | 247.5 |
| Wt. Loss Due to Ignition | 28.0 | 24.1 |
| Actual Wt. Of Soil After Burn | 870.6 | 546.9 |
| % Organics | 3.1 | 4.2 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------|--------------------------------|--|
| Project Name: | Downtown Park | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 7/20/2023 | Wetted Area (sq. feet): | 10:15: 70 ft^2 / 10:48: 113.7 ft^2 / 13:45: 126.9 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Yes, lined |
| Test No.: | IT-1 | Test Depth (feet): | 0.43 |
| Performed By: | APJ / SST | Receptor Soils: | Underdrain Gravels |

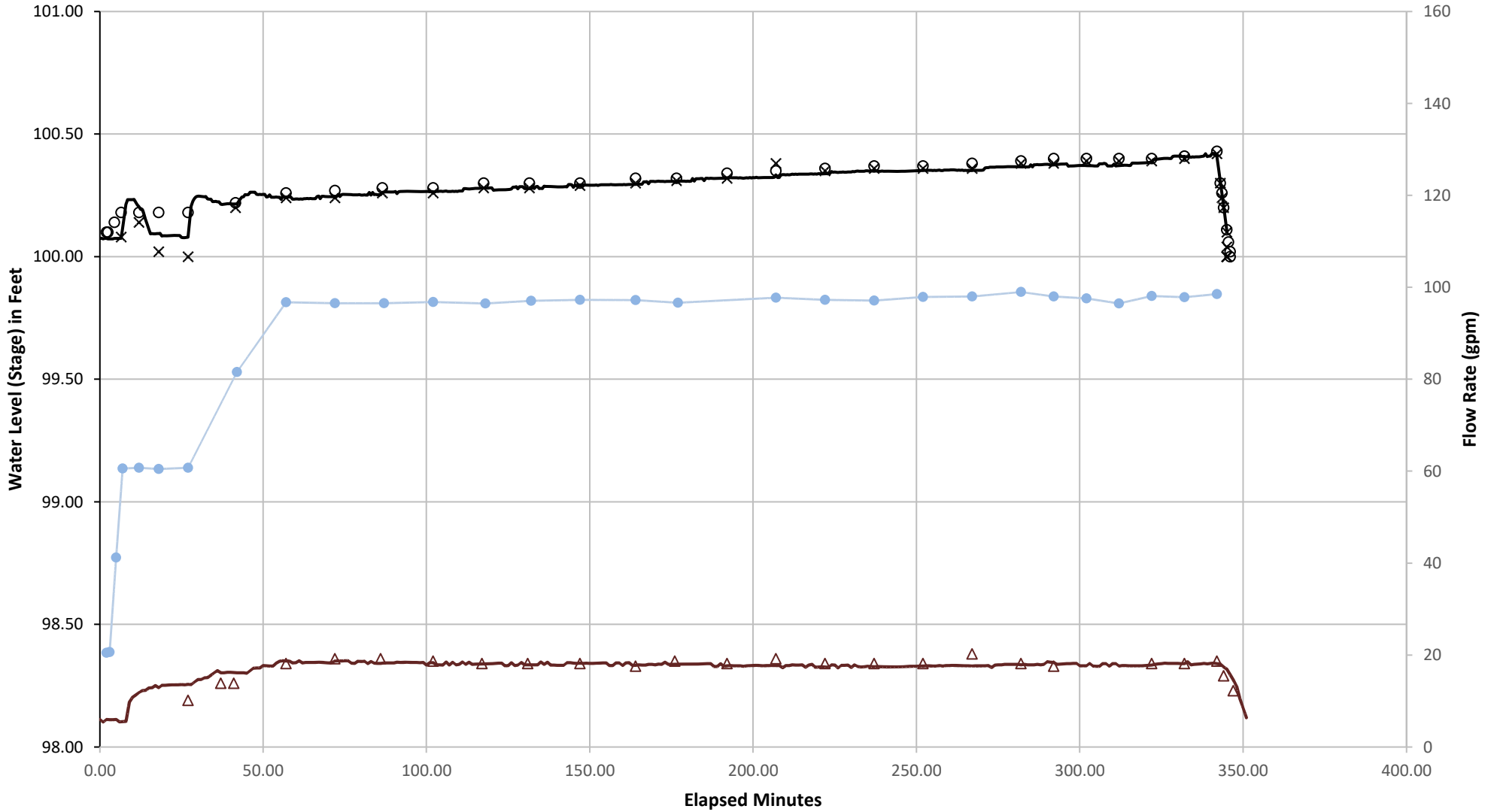
| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Cleanout Wellpoint (ft) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|-------------------------|---------------------|---|
| 8:48 | | | | | | Water on |
| 8:50 | 20.5 | | 0.1 | | 44 | |
| 8:51 | 20.66 | | 0.1 | | 67 | Increase flow to 40.52 gpm |
| 8:53 | 41.24 | | 0.14 | | 144 | Increase flow to 60.5 gpm |
| 8:55 | 60.6 | 0.08 | 0.18 | | 261 | Water observed at SG-1 |
| 9:00 | 60.78 | 0.14 | 0.18 | | 564 | |
| 9:06 | 60.49 | 0.02 | 0.18 | | 928 | |
| 9:15 | 60.78 | 0 | 0.18 | 2.81 | 1,471 | First WP measurement; increase flow to 81 gpm |
| 9:26 | | | | 2.74 | | Water audibly flowing into pipe |
| 9:30 | 81.61 | 0.2 | 0.22 | 2.74 | 2,698 | Increase flow to 96.37 gpm |
| 9:45 | 96.76 | 0.24 | 0.26 | 2.66 | 4,151 | |
| 10:00 | 96.54 | 0.24 | 0.27 | 2.64 | 5,592 | |
| 10:15 | 96.54 | 0.26 | 0.28 | 2.64 | 7,110 | Water observed flowing out CB at 161st/Redmond Way |
| 10:30 | 96.83 | 0.26 | 0.28 | 2.65 | 8,497 | |
| 10:46 | 96.48 | 0.28 | 0.3 | 2.66 | 10,042 | |
| 11:00 | 97.06 | 0.28 | 0.3 | 2.66 | 11,420 | |
| 11:15 | 97.29 | 0.29 | 0.3 | 2.66 | | Wrong totalizer reading recorded |
| 11:32 | 97.24 | 0.3 | 0.32 | 2.67 | 14,506 | |
| 11:45 | 96.65 | 0.31 | 0.32 | 2.65 | 15,757 | Pond growing/full to SE corner |
| 12:00 | | 0.32 | 0.34 | 2.66 | | |
| 12:15 | 97.74 | 0.38 | 0.35 | 2.64 | 18,671 | |
| 12:30 | 97.29 | 0.35 | 0.36 | 2.66 | 20,135 | Water approaching CB |
| 12:45 | 97.12 | 0.36 | 0.37 | 2.66 | 21,592 | |
| 13:00 | 97.9 | 0.36 | 0.37 | 2.66 | 23,050 | Water surrounds CB; pond full except area surrounding IN-1 |
| 13:15 | 98.03 | 0.36 | 0.38 | 2.62 | 24,544 | |
| 13:30 | 98.99 | 0.38 | 0.39 | 2.66 | 26,011 | |
| 13:40 | 98.03 | 0.38 | 0.4 | 2.67 | 27,045 | Flow has been steadily increasing - likely the cause of increase in pond and head; trying to keep it at 98 gpm for final hour |
| 13:50 | 97.58 | 0.39 | 0.4 | | 27,979 | |
| 14:00 | 96.48 | 0.39 | 0.4 | | 28,943 | |
| 14:10 | 98.14 | 0.39 | 0.4 | 2.66 | 29,945 | |
| 14:20 | 97.84 | 0.4 | 0.41 | 2.66 | 30,900 | |
| 14:30 | 98.54 | 0.42 | 0.43 | 2.65 | 31,889 | Water off |

| | | | | | | |
|----------|--|------|------|------|--|--|
| 14:31:00 | | 0.3 | 0.3 | | | |
| 14:31:30 | | 0.24 | 0.26 | | | |
| 14:32:00 | | 0.2 | 0.2 | 2.71 | | |
| 14:33:00 | | 0.1 | 0.11 | | | |
| 14:33:30 | | 0.04 | 0.06 | | | |
| 14:33:45 | | 0 | | | | |
| 14:34:00 | | 0 | 0.02 | | | |
| 14:34:15 | | 0 | 0 | | | |
| 14:35 | | | | 2.77 | | |
| 14:39 | | | | Dry | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 73.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 73.0 |
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 73.8 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 73.8 |
| CL Average Infiltration Rate (in/hr) during last hour of inflow: | 74.0 |
| CL Average Infiltration Rate (in/hr) during falling head: | - |

Downtown Park Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Cleanout Hand
- Cleanout Logger
- Staff Gauge #2 Hand Data
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)
Cell: Rain Garden #4

Assessed On:
September 7, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2010 and collects runoff from the adjacent school grounds and parking lot. No cross-sectional views of the cell were received. We understand the cell is constructed with bioretention soil above a partial width underdrain.

BIORETENTION SOIL:

Thickness: 0.3-2.3'

The apparent thickness of the bioretention soil ranged from 0.3-2.3' with an average of 1.3'. The soil was observed to be thinnest above the underdrain gravels.

Composition: No soil specifications were received in the design plans. In comparison to the 2019 Ecology specifications, the sand gradation and silt content exceeded the standard while the organic matter content fell within the specified range.

Organic Matter Content (% by weight): 3.8

Percent passing #200 sieve: 13.4

Coefficient of Uniformity (Cu): 6.1

Coefficient of Curvature (Cc): 1.6

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Till

Soil Description: Medium dense, moist to very moist, tannish gray, fine sandy, SILT, trace to some gravel (ML)

BUILT PER PLAN:

The cell was generally consistent with the understood design plan.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand augers within the cell. The temporary wellpoint was screened from 1.2-2.2' below ground surface outside of the underdrain. The wellpoint was screened across the contact between the underlying Vashon Till and the bioretention soil. The wellpoint responded to testing after 250 minutes and rose to the same elevation as the surface water after 100 minutes.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 21.8

Subgrade Soil Rate (in/hr): N/A

No subgrade soil rate can be measured due to the presence of the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be in generally working condition.

Field Conditions

| | |
|---------|----------------------|
| Weather | AM OC/60s, PM PC/60s |
|---------|----------------------|

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)
 Cell: Rain Garden #4

Assessed On:
 September 7, 2023



| | | | |
|-----------------|-------------------------|---------------------------------|------------------|
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Stan Thompson | Half Day: Forest Gheen-Regouski | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | School |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230907-191545.jpg



Site Photo: FA_SitePhotos-20230907-191612.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)
 Cell: Rain Garden #4

Assessed On:
 September 7, 2023




Cell Construction

| | |
|---|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Sprinkler heads present in rain garden floor. |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 0.5' Width ' Underdrain pipe is .5 foot diameter, based on cleanout. Underdrain trench is a partial width of the cell base. |
| Cleanouts | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Comments The cell is constructed with a partial width underdrain above bioretention soil. | |

Cleanouts

| | |
|------------------------------------|--|
| CL-1 | |
| Condition | Accessible: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Standing Water: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Sediment Accumulation: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Vegetation or Rooting: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Distance from overflow/outlet: 65' | |

Inlets

| | |
|---|--|
| IN-1 | |
| <input type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input checked="" type="checkbox"/> Pipe <input type="checkbox"/> Other: Pipe: Material <input type="checkbox"/> PVC <input type="checkbox"/> Metal <input type="checkbox"/> Concrete <input type="checkbox"/> Other Diameter: 1' Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230907-194645.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)
 Cell: Rain Garden #4

Assessed On:
 September 7, 2023



Design Overflow/Outlet

DO - 1

| | | |
|---|--|--|
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2' Width: 2' | |
| Additional Details: Stickup (ft) From Ground: 0.5 Relative from staff gauge: 0 | | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | |
| | | |

FA_DOPhoto-20230907-194910.jpg

Cell Surface and Geotech Probe Observations

S1A Mulch: None Shredded Mulch Fine Mulch Coarse Mulch Depth(ft): 0.3
 S1B Mulch: None Shredded Mulch Fine Mulch Coarse Mulch Depth(ft):
 S1C Mulch: None Shredded Mulch Fine Mulch Coarse Mulch Depth(ft):
 S2 Mulch: None Shredded Mulch Fine Mulch Coarse Mulch Depth(ft):
 S3 Mulch: None Shredded Mulch Fine Mulch Coarse Mulch Depth(ft):

Cell Coverage

| | | | | | |
|-------------|--|--------------------------------|--|-----------------------------------|------------------------------------|
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |

Very little of cell bottom is visible due to abundant irrigated vegetation. In 2 of the 3 hand auger borings, typical dark colored, organic-rich bioretention soils were not encountered.

Pest Evidence

| | |
|---------------------------|---|
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Additional Details:

Vegetation Description
 Cell heavily vegetated with sedge, small bushes and trees, minor blackberry vines. Vegetation does not significantly limit our work.

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)
 Cell: Rain Garden #4

Assessed On:
 September 7, 2023



Additional Details

Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 1.2 to 3'+. The shallowest depth (1.2') was located just outside the rip rap pad on the northwestern end of the cell. The deepest depth (3'+) was encountered in the center of the cell approximately 20' from the NW inlet. Underdrain gravels were only encountered in HA-1.

Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | 0.3 |
| Total Depth: | 0.5 |
| Rain/Garden Mix Soil Texture: Loose, dark brown, moist silty fine sand with abundant organics (SM) | |
| Native Soil Texture: 1-inch gravel drain rock | |
| Liner Present: <input type="checkbox"/> Yes <input type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Black, non-woven fabric at ~0.3 feet |
| Additional Details 0-0.3': BSM 0.3': filter fabric 0.3-0.5': 1" round drain rock encountered beneath the filter fabric. No groundwater encountered. | |

| | |
|---|---|
| HA-2 | |
| <input type="checkbox"/> Zone 1 <input checked="" type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 2.3 |
| to Import/Underdrain: | 2.3 |
| Total Depth: | 2.6 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, light brown, f-m SAND, some silt, scattered organics (SP-SM) | |
| Native Soil Texture: Medium dense, moist-very moist, tannish-gray, fine sandy SILT, trace gravel (ML) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)
 Cell: Rain Garden #4

Assessed On:
 September 7, 2023




| |
|--|
| HA-2 |
| 0-2.3': loose, slightly moist, light brown, fine sand, some silt to silty, scattered organics (SM) 2.3-2.6: the hand boring encountered m. dense, moist to very moist, tannish gray, fine sandy silt, tr gvl. No groundwater |

| | |
|---|---|
| HA-3/WP-1 | |
| <input type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input checked="" type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.8 |
| to Import/Underdrain: | 1.8 |
| Total Depth: | 2.2 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, light brown, silty fine SAND, trace gravel, scattered rootlets (SM) | |
| Native Soil Texture: Medium dense, moist-very moist, tannish-gray, fine sandy SILT, trace gravel (ML) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details | |
| 0-1.8': Loose, slightly moist, lt brown, silty fine sand, scattered organics (SM). | |
| 1.8-2.2': M. dense, tan-gray, moist to v moist, f sandy silt, tr gravel (ML) | |

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6, 10-100gpm | |
| Wetted Pond Area (sq. ft) | 450 |
| Ponded Depth (ft) | 0.09 |
| Total Gallons | 35,474 |
| Steady State Flow Rate (GPM) | 102 |
| Additional Details: | |



BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)

Cell: Rain Garden #4

Assessed On:
September 7, 2023



IT_Photo-20230907-221245.jpg



IT_Photo-20230907-221320.jpg



IT_Photo-20230907-221357.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Creekside Elementary (SACR)

Cell: Rain Garden #4

Assessed On:

September 7, 2023



SITE: CREEKSIDE ELEMENTARY (SACR) CELL: RAIN GARDEN #4





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Well Point

SACR-HA-1

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/7/23

Logged By: SST

20150387H008

Ending Date: 9/7/23

Approved By: JHS

Driller/Equipment: Hand Auger
 Hammer Weight/Drop: N/A
 Hole Diameter (in): 4
 Ground Surface Elevation (ft): 100
 Water Level Elevation (ft):
 ▽ Groundwater Depth ATD (ft): N/A

Total Depth (ft): 0.5
 Well Completion Depth (ft):
 Well Tag No.:
 Top of Well Casing Elevation (ft):
 Datum: Project Datum
 ▽ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Well Construction |
|------------|-------------|------------|----------------|--|-------------|-------------------|
| 0 | | | | <p>Bioretention Soil Mix Loose, moist, dark brown, silty, fine SAND, some gravel; abundant organics (SM). Black; geotextile filter fabric.</p> | | |
| 0.5 | | | | <p>Underdrain Gravel Loose, moist, gray, GRAVEL (1 inch diameter; rounded) (SP). No seepage. No caving</p> | | |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |
| 7 | | | | | | |

1/26/2024

20150387H008



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Exploration Boring

SACR-HA-2

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/7/23

Logged By: SST

20150387H008

Ending Date: 9/7/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.6

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Other Tests |
|------------|-------------|--------|------------|----------------|--|-------------|----------|----|----|----|-----|-------------|
| | | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | | Grass Grass and sedge ground coverage. | | | | | | | |
| 0.5 | | | | | Bioretention Soil Mix Loose, slightly moist, light brown, fine SAND, some silt, trace gravel; scattered organics (SP-SM). | | | | | | | |
| 1.0 | | | | | As above; increase in organics. | | | | | | | |
| 1.5 | | | | | As above, trace fine gravel. | | | | | | | |
| 2.0 | | | | | | | | | | | | |
| 2.5 | | | | | Vashon Lodgement Till Medium dense, moist to very moist, tannish gray, fine sandy, SILT, trace to some gravel (ML). No seepage. No caving | | | | | | | |
| 3.0 | | | | | | | | | | | | |
| 4.0 | | | | | | | | | | | | |
| 5.0 | | | | | | | | | | | | |
| 6.0 | | | | | | | | | | | | |
| 7.0 | | | | | | | | | | | | |

12/15/2023

20150387H008



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Well Point

SACR-HA-3-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/7/23

Logged By: APJ

20150387H008

Ending Date: 9/7/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.2

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 103.6

Water Level Elevation (ft): N/A

Datum: Project Datum

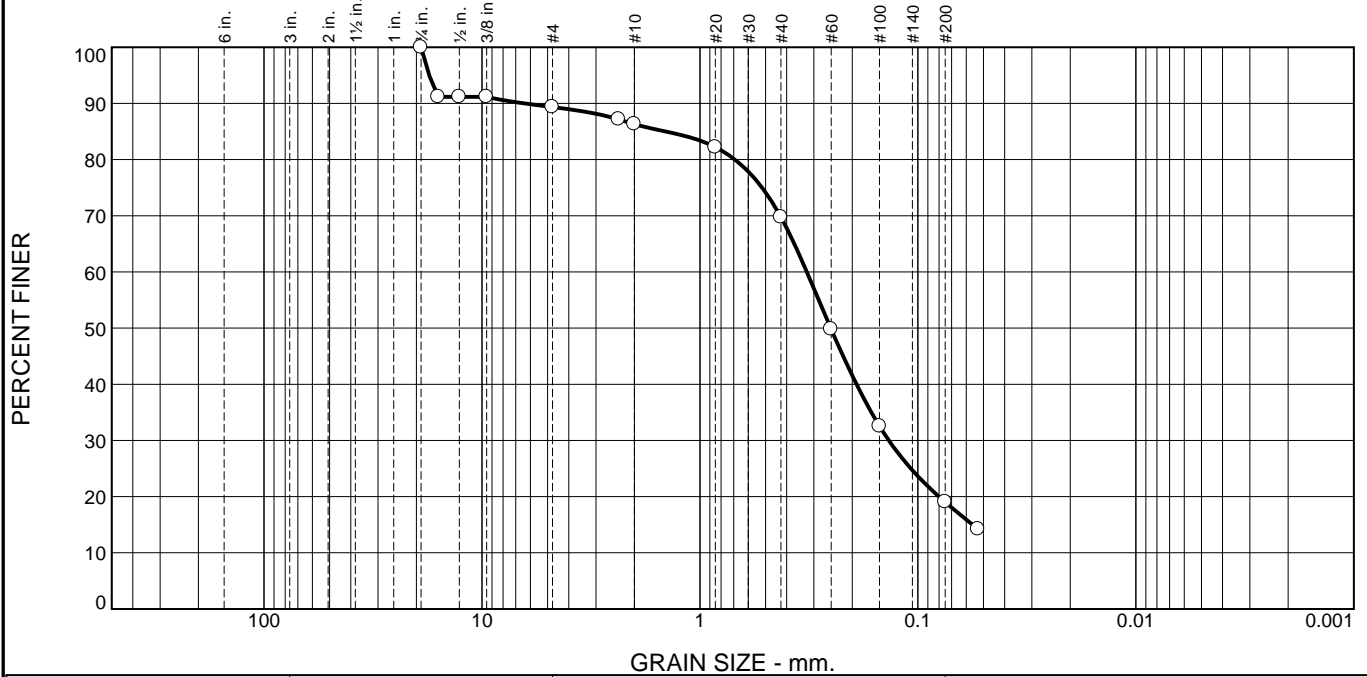
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | <p>Mulch Loose grasses.</p> | | | | | | | <p>Stickup -3.6 to 0 feet Existing Bioretention Soil 0 to 0.3 feet 3/8 inch Bentonite chips 0.3 to 1 foot</p> |
| 0.3 | | | | <p>Bioretention Soil Mix Loose, slightly moist, light brown, fine SAND, some silt; scattered organics (SP-SM). Becomes moist.</p> | | | | | | | |
| 2 | | | | <p>Vashon Till Medium stiff, moist to very moist, tannish gray, fine sandy, SILT, trace gravel (ML). No seepage. No caving.</p> | | | | | | | <p>Medium grain silica sand 1.25 inch I.D. threaded galvanized steel casing +3.6 to 0.5 feet; duct tape covers screen 0.5 to 1.2 feet 1.25 inch I.D. Stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.2 to 2.2 feet Cast iron endcap 2.2 to 2.5 feet Cast iron drivepoint 2.5 to 2.8 feet</p> |
| 2.2 | | | | | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/15/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 0.0 | 10.7 | 3.0 | 16.6 | 50.7 | 19.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 91.2 | | |
| 1/2" | 91.2 | | |
| 3/8" | 91.2 | | |
| #4 | 89.3 | | |
| #8 | 87.2 | | |
| #10 | 86.3 | | |
| #20 | 82.2 | | |
| #40 | 69.7 | | |
| #60 | 49.8 | | |
| #100 | 32.5 | | |
| #200 | 19.0 | | |
| #270 | 14.2 | | |

Material Description

silty SAND some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 6.3844 D₈₅= 1.4334 D₆₀= 0.3233
D₅₀= 0.2512 D₃₀= 0.1359 D₁₅= 0.0561
D₁₀= C_u= C_c=

Remarks

Date Received: 9-07-2023 Date Tested: 11-9-2023

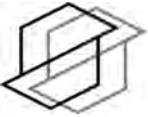
Tested By: RW

Checked By: SNCF/APJ/JS

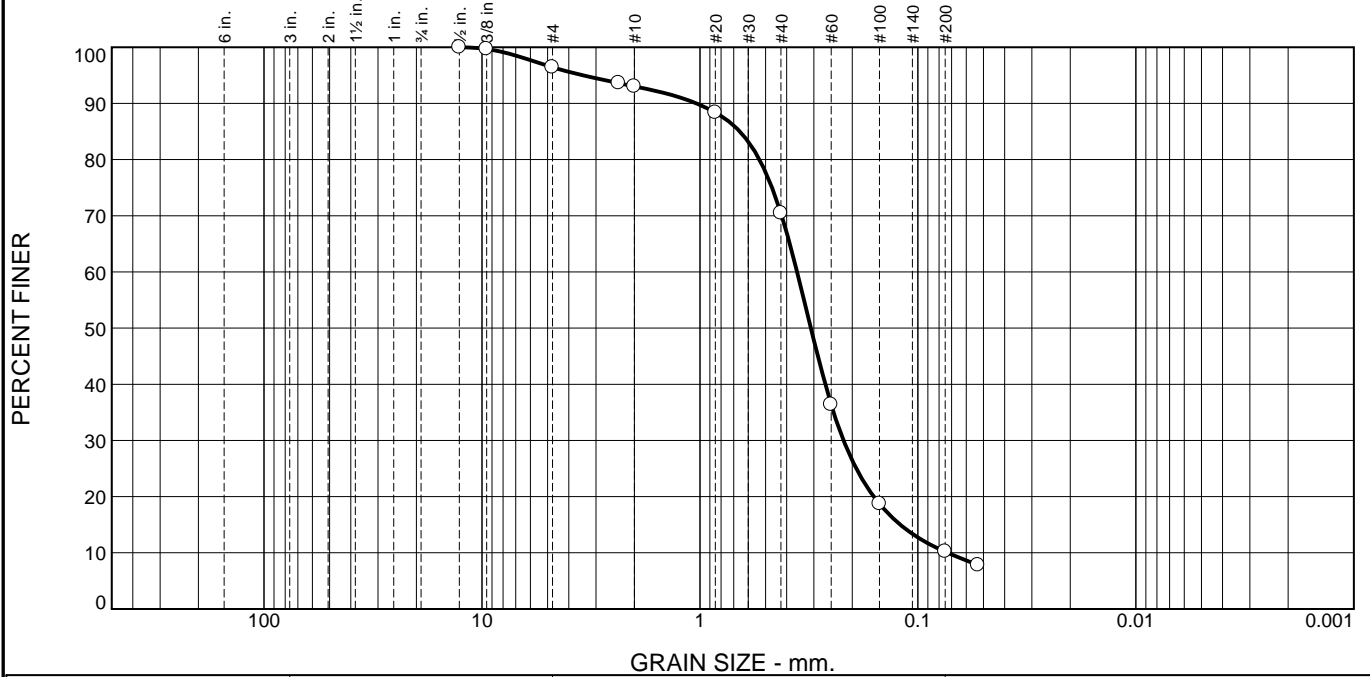
Title: _____

* (no specification provided)

Location: Onsite - SACR Date Sampled: 9-07-2023
Sample Number: HA-1 Depth: 0-0.35'

| | | |
|---|---|--------|
|  | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 | Figure |
|---|---|--------|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 3.6 | 3.4 | 22.5 | 60.3 | 10.2 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.7 | | |
| #4 | 96.4 | | |
| #8 | 93.6 | | |
| #10 | 93.0 | | |
| #20 | 88.4 | | |
| #40 | 70.5 | | |
| #60 | 36.4 | | |
| #100 | 18.7 | | |
| #200 | 10.2 | | |
| #270 | 7.8 | | |

Material Description

SAND some silt trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-3

Coefficients

D₉₀= 1.0381 D₈₅= 0.6554 D₆₀= 0.3583
 D₅₀= 0.3097 D₃₀= 0.2194 D₁₅= 0.1205
 D₁₀= 0.0729 C_u= 4.91 C_c= 1.84

Remarks

Date Received: 9-7-2023 Date Tested: 10-30-2023

Tested By: FEW

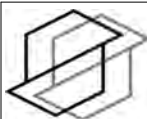
Checked By: APJ/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Creekside ES
Sample Number: HA-2 **Depth:** 0-0.5'

Date Sampled: 9-7-2023



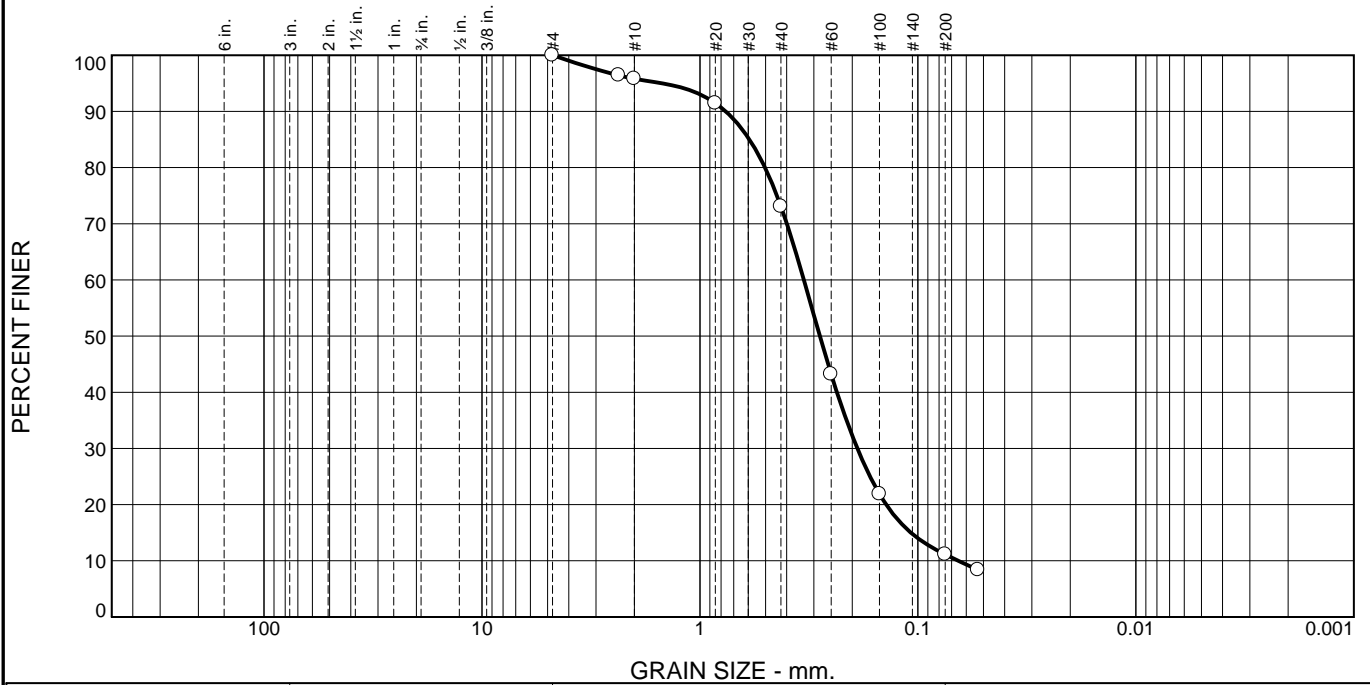
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incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.0 | 4.2 | 22.7 | 62.0 | 11.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #4 | 100.0 | | |
| #8 | 96.4 | | |
| #10 | 95.8 | | |
| #20 | 91.5 | | |
| #40 | 73.1 | | |
| #60 | 43.2 | | |
| #100 | 21.9 | | |
| #200 | 11.1 | | |
| #270 | 8.4 | | |

* (no specification provided)

Material Description

SAND some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-2-4(0)

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 0.7611 | D ₈₅ = 0.5928 | D ₆₀ = 0.3335 |
| D ₅₀ = 0.2816 | D ₃₀ = 0.1896 | D ₁₅ = 0.1077 |
| D ₁₀ = 0.0653 | C _u = 5.11 | C _c = 1.65 |

Remarks

Date Received: 9-07-2023 Date Tested: 11-8-2023

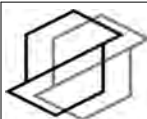
Tested By: FEW

Checked By: APJ/JS

Title: _____

Location: Onsite - BHPS Creekside ES
Sample Number: HA-3 **Depth:** 0.5-1'

Date Sampled: 9-07-2023



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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|---------------------------------|-----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/7/2023 | Project BHPS-SACR | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Sammamish, Wa. | EB/EP No. SACR-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.35' | HA-2 @ 0-0.5' | HA-3 @ 0.5-1' |
|--------------------|----------------|---------------|---------------|
| Wet Weight + Pan | 768.8 | 814.3 | 504.1 |
| Dry Weight + Pan | 663.2 | 773.3 | 483.7 |
| Weight of Pan | 392.0 | 247.5 | 257.8 |
| Weight of Moisture | 105.6 | 41.0 | 20.4 |
| Dry Weight of Soil | 271.2 | 525.8 | 225.9 |
| % Moisture | 39.0 | 7.8 | 9.0 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|-------|-------|-------|
| Dry Soil Before Burn + Pan | 663.2 | 773.3 | 483.7 |
| Dry Soil After Burn + Pan | 619.3 | 752.3 | 475.5 |
| Weight of Pan | 392.0 | 247.5 | 257.8 |
| Wt. Loss Due to Ignition | 43.8 | 21.0 | 8.2 |
| Actual Wt. Of Soil After Burn | 227.3 | 504.8 | 217.7 |
| % Organics | 16.2 | 4.0 | 3.6 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--------------------------------------|--------------------------------|--------------------|
| Project Name: | Creekside Elementary (Raingarden #4) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 9/27/2023 | Wetted Area (sq. feet): | 15:00: 451 ft^2 |
| Weather: | Clear, 70's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.09 |
| Performed By: | SST / FGR | Receptor Soils: | Underdrain Gravels |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Catch Basin (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|------------------|----------------------|---------------------|------------------------------|
| 10:08 | 23.3 | 0 | 3.78 | | 0 | Water on |
| 10:15 | 23.36 | 0 | | | 190 | |
| 10:20 | 23.3 | 0 | | | 307 | Increase flow rate to 55.56 |
| 10:30 | 55.4 | 0 | 3.63 | | 855 | |
| 10:37 | 55.4 | 0 | | | 1,245 | Increase flow rate to 102.94 |
| 10:52 | 102.6 | 0.04 | 3.53 | | 2,768 | |
| 11:15 | 102.6 | 0.04 | 3.53 | | 5,126 | |
| 11:30 | 2:38 | 0.05 | | | 6,672 | |
| 11:45 | 102.78 | 0.05 | | | 8,210 | |
| 12:00 | 102.38 | 0.05 | | | 9,750 | |
| 12:15 | 102.83 | 0.05 | 3.5 | | 11,291 | |
| 12:30 | 102.6 | 0.05 | 3.5 | | 12,833 | |
| 12:45 | 103 | 0.06 | | | 14,374 | |
| 13:00 | 102.6 | 0.06 | | | 15,917 | |
| 13:15 | 102.6 | 0.06 | | | 17,456 | |
| 13:30 | 102.22 | 0.08 | | | 19,010 | |
| 13:45 | 103.44 | 0.08 | | | 20,552 | |
| 14:03 | 103.22 | 0.08 | | | 22,402 | |
| 14:16 | 103.06 | 0.08 | | | 23,738 | |
| 14:30 | 102.83 | 0.09 | | 4.95 | 25,185 | |
| 14:46 | 102.94 | 0.09 | 3.5 | 4.73 | 26,841 | |
| 15:00 | 103.06 | 0.09 | | 4.52 | 28,277 | |
| 15:10 | 102.71 | 0.09 | | 4.25 | 29,304 | |
| 15:20 | 102.88 | 0.09 | | 4.02 | 30,333 | |
| 15:30 | 102.72 | 0.09 | 3.5 | 3.85 | 31,362 | |
| 15:40 | 102.88 | 0.09 | | 3.7 | 32,389 | |
| 15:50 | 102.94 | 0.09 | | 3.61 | 33,417 | |
| 16:00 | 103.06 | 0.09 | | 3.57 | 34,440 | |
| 16:10 | 102.88 | 0.09 | | 3.53 | 35,424 | Water off |
| 16:11 | | 0.06 | | 3.53 | | |
| 16:12 | | 0.03 | | 3.54 | | |
| 16:13 | | 0 | | 3.55 | | |
| 16:21 | | | | 3.97 | | |
| 16:36 | | | | 4.31 | | Remove wellpoint |

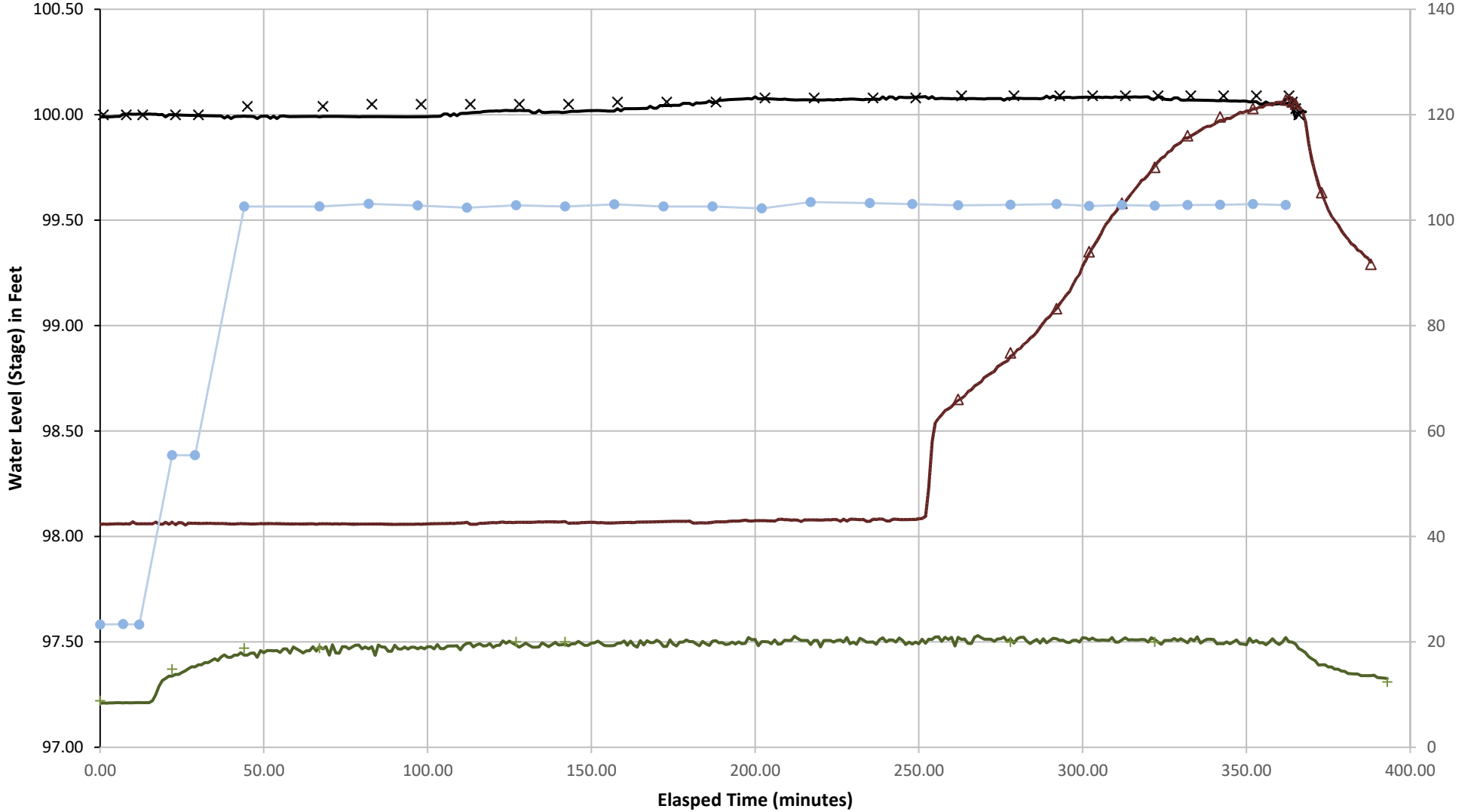
| | | | | | | |
|-------|--|--|------|--|--|--|
| 16:41 | | | 3.69 | | | |
|-------|--|--|------|--|--|--|

| | |
|--|------|
| SG Average Infiltration Rate (in/hr) during last hour of inflow: | 21.8 |
| SG Average Infiltration Rate (in/hr) during falling head: | 21.6 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 30.4 |
| WP Average Infiltration Rate (in/hr) during falling head: | 21.6 |

Creekside Elementary Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 1 (18824)

Assessed On:
September 27, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The 2011 Priority Sidewalk Project constructed a series of bioretention cells along Ashworth Avenue in 2011. The cells are designed to collect run off from Ashworth Avenue and sidewalk. The cell is constructed with 1.5 ft of bioretention soil above 1 ft of compost amended soil, above native soil. This study chose three of the cells to test, cell 1 is on the north end of Ashworth Avenue and of average cell length.

BIORETENTION SOIL:

Thickness: 0.5'-2.7'

The apparent thickness of the bioretention soil ranged from 0.5-2.7 feet, with an average of 1.8'. Plans call for 2.5' bioretention soil mix above compost amended soil. The shallowest depths were at the cell walls at the top of the facility. Probe depths deepened towards the center of the cell. Differentiation between bioretention soil and compost amended soil with the probe was difficult, probe depths assumed total combined thickness.

Composition:

The design plans call out bioretention soil, but do not reference soil specifications. Based on the 2019 Ecology bioretention soil specifications, the tested soil met the gradation for sands, though had a higher gravel and silt content than meets the specifications. The organic content percentage by weight was within the 2019 Ecology specifications.

Organic Matter Content (% by weight): 7.3

Percent passing #200 sieve: 10.3

Coefficient of Uniformity (Cu): 10.8

Coefficient of Curvature (Cc): 1.5

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense, moist, tannish-brown fine to medium SAND, some coarse sand, some gravel, trace silt (SP)

The site is mapped as Vashon Till by Booth, Troost and Schimel (2009). AESI interprets the subgrade material as Vashon Advance Outwash.

BUILT PER PLAN:

The bioretention soil and amended soil were a little thinner than called for in the design plans. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

The temporary wellpoint we installed screened 1.5-2 ft below ground surface did not encounter groundwater. The wellpoint responded to infiltration testing with the minimum measured water level above the ground surface.

INFILTRATION TEST RESULTS:

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 1 (18824)

Assessed On:
 September 27, 2023



Bioretention Soil Rate (in/hr): 20.5
 Subgrade Soil Rate (in/hr): 8.8

The bioretention soil rate was calculated using the ponded area before storage was filled. The subgrade rate is calculated from the constant head portion of the test. There was a variance in flow rate at times during the test due to flow splitter as the infiltration test for cell 2 was being conducted simultaneously.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Bioretention soil and amended soil not placed to full 2.5' depth. Otherwise, the cell is in good condition.

Field Conditions

| | | | |
|-----------------|-------------------------|------------------|-------------------------|
| Weather | Morning showers, 60s | | |
| Recent Rainfall | Today: 1.22" | Yesterday: 0.29" | Two Days Ago: 0.93" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Alex Johanson |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 3 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230927-201021.jpg



Site Photo: FA_SitePhotos-20230927-201054.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 1 (18824)

Assessed On:
September 27, 2023



Site Photo: FA_SitePhotos-20230927-201135.jpg

Cell Construction

| | |
|---|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 90% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Cell 1 collects road runoff from Ashworth Ave via sheet flow. There is one curb cut located near the adjacent parking pull off which is likely a minor contributor as inlet is slightly uphill from neighboring parking space cell which would collect majority of runoff. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 1 (18824)

Assessed On:
September 27, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 48'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230927-202345.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: No energy dissipation.

IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 9'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: Buried
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230927-202601.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: 1x1 pad of stream cobbles in SE corner of cell

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 1 (18824)

Assessed On:
September 27, 2023



IN-3

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 1.1'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: Buried
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20230927-205424.jpg

Erosion Present? Yes No

Blockage Present? Yes No
Approximately 50% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Inlet base filled in with organics and surface cover plants, room for water to enter available.



FA_INBLPhoto-20230927-205412.jpg

Additional Details: Buried stream cobbles adjacent inlet.

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 1 (18824)

Assessed On:
 September 27, 2023



HA-1-WP

0-0.1: Grass
 0.1-1.7: BSM
 1.7-2.2: [Amended Soil] medium dense, very moist, tannish-brown, gravelly fine to medium SAND, some silt, trace organics, angular gravel (SP)
 2.2-2.65: Qva
 Shallowest depth to water measured was above ground surface.


HA-2

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|-----|
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.8 |
| to Import/Underdrain: | 1.8 |
| Total Depth: | 2.1 |

Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM)
 Native Soil Texture: Vashon Advance Outwash: Medium dense, moist, tannish-brown fine to medium SAND, some coarse sand, some gravel, trace silt (SP)

| | |
|---|---|
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |



SHAS-1_HA-2.jpg

Additional Details

0-0.1: Grass
 0.1-1.8: BSM
 1.8-2.1: [Amended Soil] medium dense, very moist, tannish-brown, gravelly fine to medium SAND, some silt, trace organics, angular gravel (SP)

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

| | |
|-----------------------|------|
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.75 |
| to Import/Underdrain: | 1.35 |
| Total Depth: | 1.75 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 1 (18824)

Assessed On:
 September 27, 2023



HA-3

Rain/Garden Mix Soil Texture: Loose, slightly moist-moist, dark brown, f-m SAND, some gravel, abundant organics (SP)

Native Soil Texture: Medium dense, moist, tannish-brown with orange-brown oxidation fine to medium SAND, some coarse sand, some gravel, trace silt (SP)

Liner Present:

Yes No

Filter Fabric Present:

Yes No



SHAS-1_HA-3.jpg

Additional Details

0-0.1': Mulch, bark chips

0.1-1.35': BSM

1.35-1.75': [Amended Soil] medium dense, very moist, tannish-brown, gravelly fine to medium SAND, some silt, trace organics, angular gravel (SP)

1.75': Qva

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-6 (10-100)

Wetted Pond Area (sq. ft) 165

Ponded Depth (ft) 0.56

Total Gallons 8,578

Steady State Flow Rate (GPM) 20

Additional Details:

Additional infiltration test details available in executive summary.



BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 1 (18824)

Assessed On:
September 27, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)

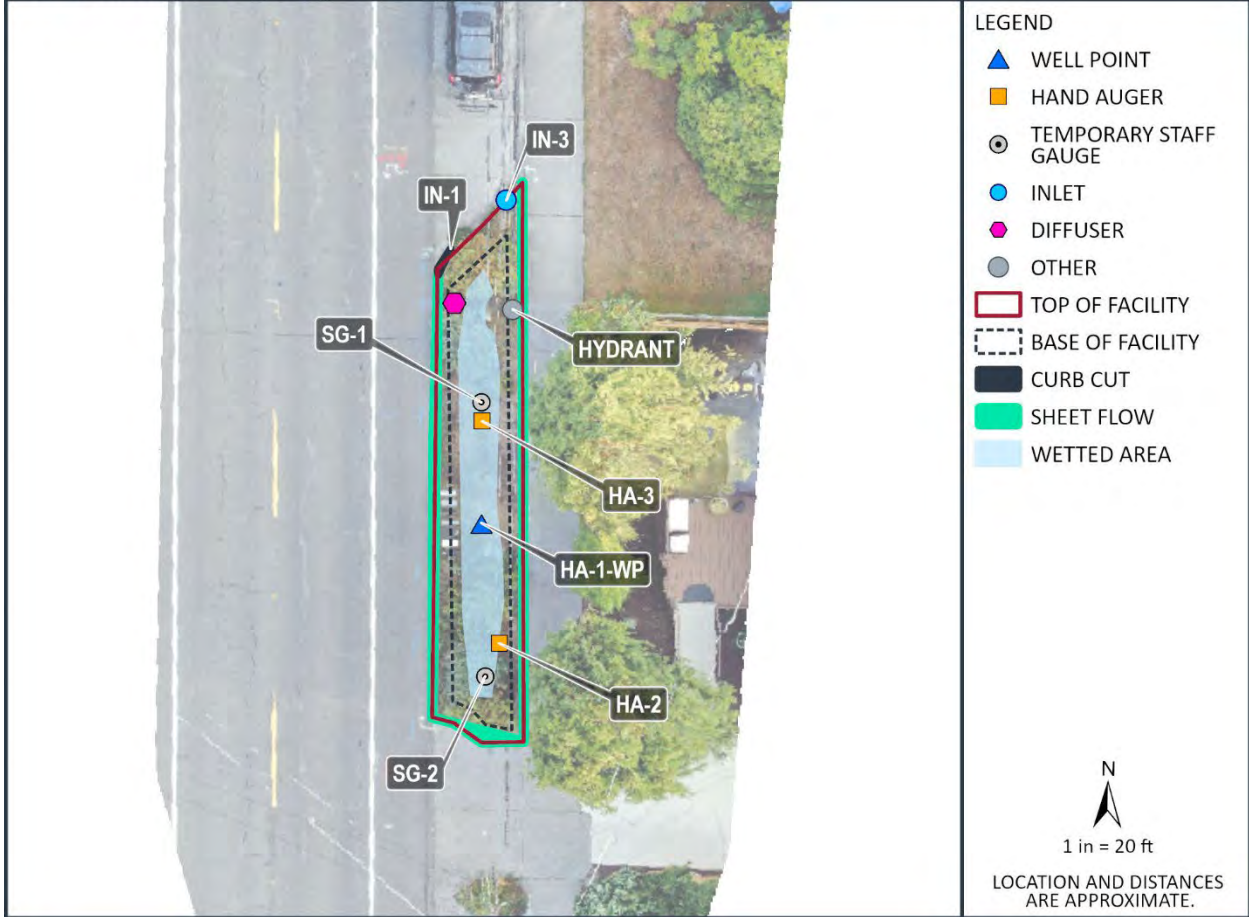
Cell: Cell 1 (18824)

Assessed On:

September 27, 2023



SITE: ASHWORTH AVE (SHAS) CELL: CELL 1 (18824)





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Well Point

SHAS-1-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/26/23

Logged By: CSI

20150387H008

Ending Date: 9/26/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.7

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.7

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 103.5

Water Level Elevation (ft): N/A

Datum: Project Datum

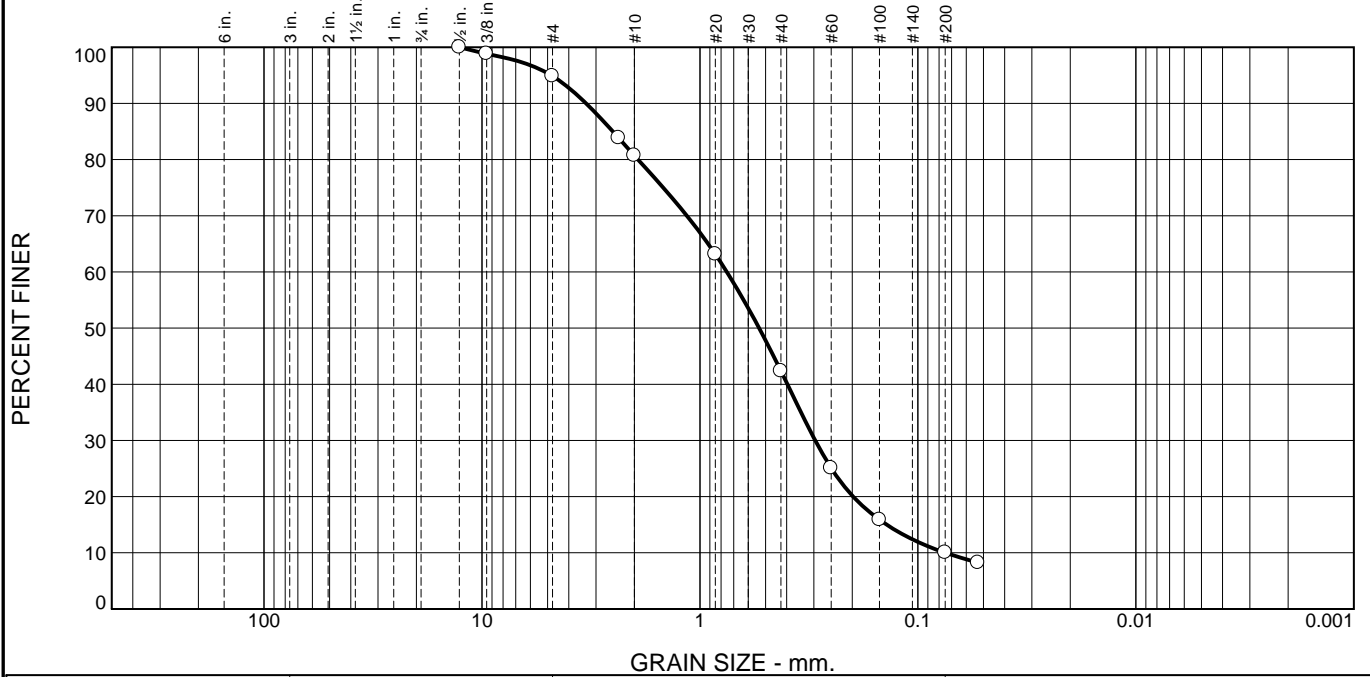
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----------|----------|----------|----------|---|
| | | | | | | Blows/6" | Blows/6" | Blows/6" | Blows/6" | Blows/6" | |
| 0 | | | | <p>Grass</p> <p>Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, some silt; abundant organics (SW-SM).</p> <p>Loose, very moist, dark brown, fine to medium SAND, some gravel, some silt, some coarse sand; abundant organics (SW-SM).</p> <p>Loose, very moist, dark brown, fine to medium SAND, some silt, some gravel; some organics (SW-SM).</p> | | | | | | | <p>Stickup -3.5 to 0 feet Existing Bioretention Soil 0 to 0.3 feet Medium grain silica sand 0.3 to 1.2 feet</p> <p>3/8 inch Bentonite chips 1.2 to 1.6 feet 1.25-inch I.D. threaded galvanized steel casing +3.5 to 0.5 feet; duct tape covers screen +0.5 to 1.5 feet 1.25 inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.5 to 2 feet Medium grain silica sand 1.6 to 2.6 feet Cast iron endcap 2 to 2.3 feet Cast iron drivepoint 2.3 to 2.6 feet</p> |
| 1 | | | | <p>Amended Soil Medium dense, very moist, tan to brown, gravelly, fine to medium SAND, some silt, trace organics; angular gravel (SP).</p> <p>Vashon Advance Outwash Loose to medium dense, tan to brown, medium SAND, some gravel, trace silt (SP).</p> | | | | | | | |
| 2 | | | | | | | | | | | |
| 3 | | | | <p>No seepage. No caving. Refusal due to gravel and no returns. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.1 | 14.2 | 38.3 | 32.4 | 10.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 98.8 | | |
| #4 | 94.9 | | |
| #8 | 83.8 | | |
| #10 | 80.7 | | |
| #20 | 63.2 | | |
| #40 | 42.4 | | |
| #60 | 25.1 | | |
| #100 | 15.9 | | |
| #200 | 10.0 | | |
| #270 | 8.2 | | |

* (no specification provided)

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.3302 | D ₈₅ = 2.5103 | D ₆₀ = 0.7527 |
| D ₅₀ = 0.5353 | D ₃₀ = 0.2959 | D ₁₅ = 0.1390 |
| D ₁₀ = 0.0748 | C _u = 10.06 | C _c = 1.55 |

Remarks

Date Received: 9-27-2023 Date Tested: 11-16-2023

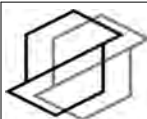
Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - BHPS-SHAS Cell 1 (18824)
Sample Number: HA-1 **Depth:** 0.1-0.75'

Date Sampled: 9-27-2023



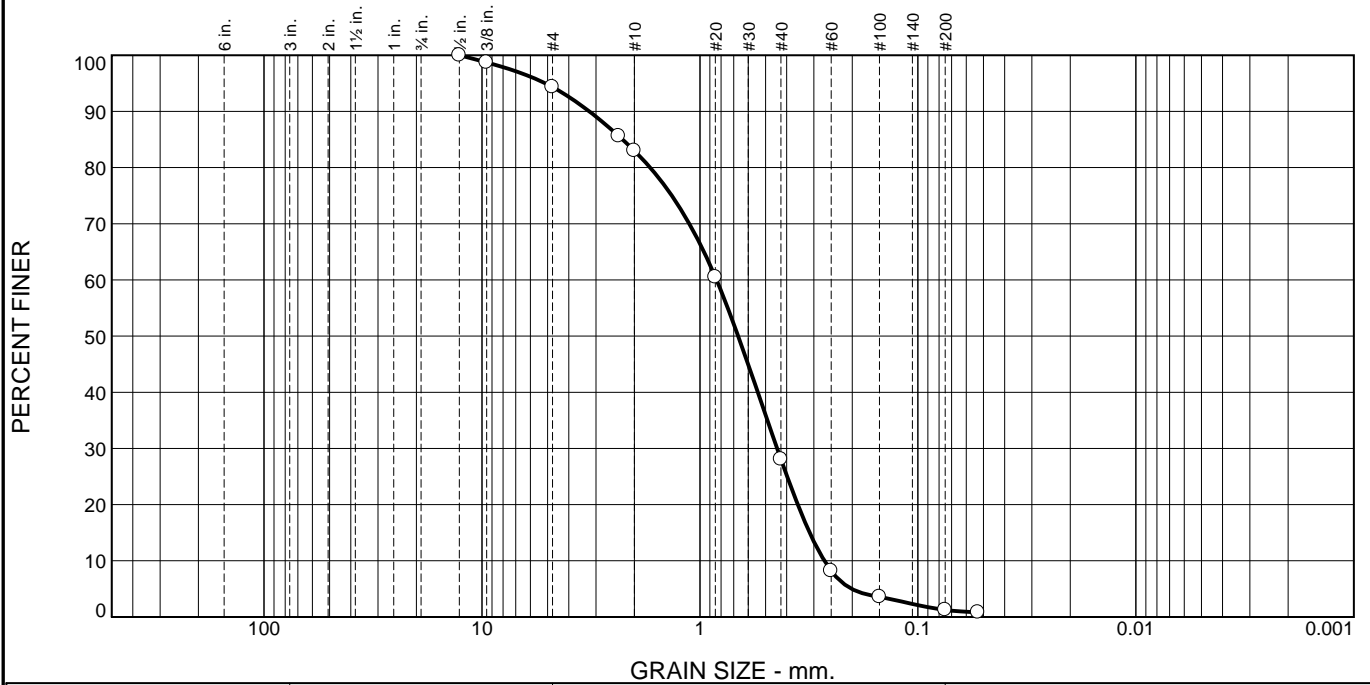
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

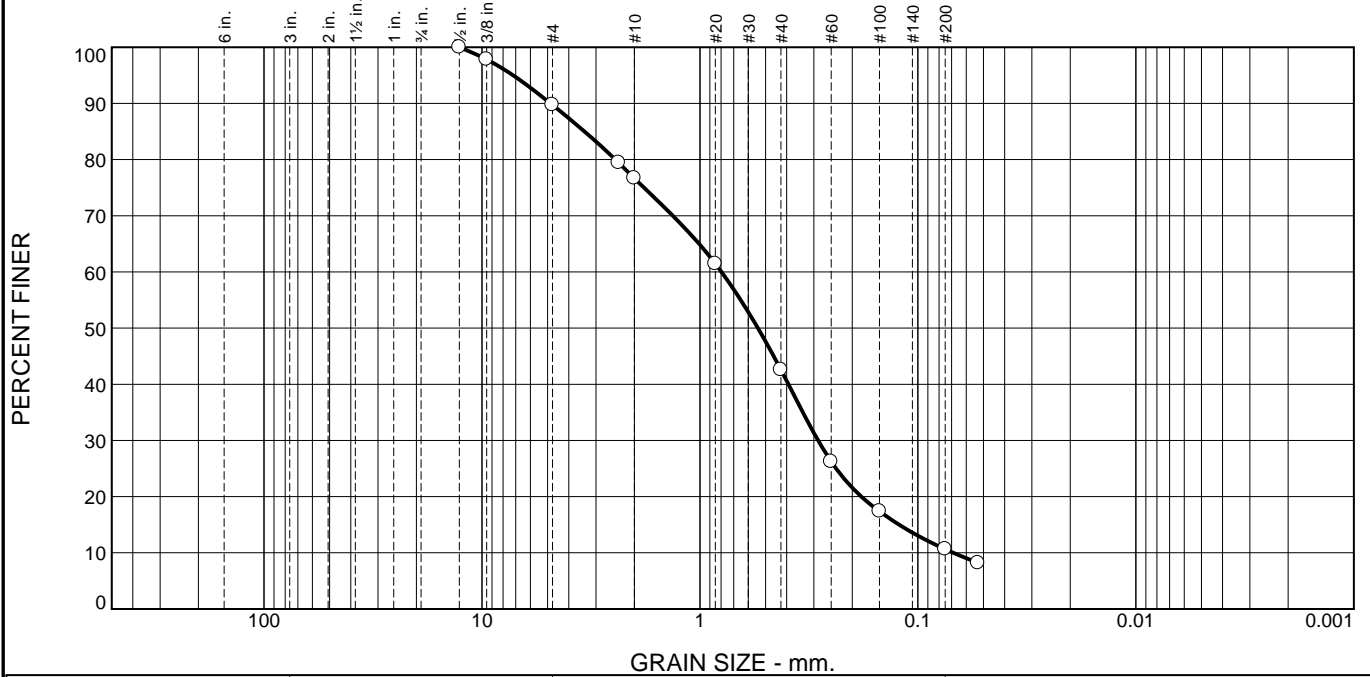
Project No: 20150387 H008

Figure

Particle Size Distribution Report



Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 10.3 | 13.0 | 34.1 | 32.0 | 10.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 97.8 | | |
| #4 | 89.7 | | |
| #8 | 79.4 | | |
| #10 | 76.7 | | |
| #20 | 61.5 | | |
| #40 | 42.6 | | |
| #60 | 26.2 | | |
| #100 | 17.4 | | |
| #200 | 10.6 | | |
| #270 | 8.2 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 4.8482 | D ₈₅ = 3.3858 | D ₆₀ = 0.7963 |
| D ₅₀ = 0.5421 | D ₃₀ = 0.2869 | D ₁₅ = 0.1219 |
| D ₁₀ = 0.0688 | C _u = 11.57 | C _c = 1.50 |

Remarks

Date Received: 9-27-2023 Date Tested: 11-16-2023

Tested By: FEW

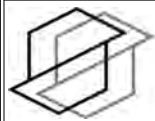
Checked By: CSI/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-SHAS Cell 1 (18824)
Sample Number: HA-3 **Depth:** 0.1-0.5'

Date Sampled: 9-27-2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|-----------------------------------|--|-------------------------------------|-------------------------|--|
| Date Sampled 10/27/2023 | Project BHPS-SHAS Cell1(18824) | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Bellevue, WA | EB/EP No. SHAS-1-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.1-0.75' | HA-3 @ 0.1-0.5' |
|--------------------|------------------|-----------------|
| Wet Weight + Pan | 534.72 | 514.25 |
| Dry Weight + Pan | 495.86 | 473.68 |
| Weight of Pan | 262.05 | 263.62 |
| Weight of Moisture | 38.86 | 40.57 |
| Dry Weight of Soil | 233.81 | 210.06 |
| % Moisture | 16.62 | 19.31 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 495.86 | 473.68 |
| Dry Soil After Burn + Pan | 483.30 | 454.26 |
| Weight of Pan | 262.05 | 263.62 |
| Wt. Loss Due to Ignition | 12.56 | 19.42 |
| Actual Wt. Of Soil After Burn | 221.25 | 190.64 |
| % Organics | 5.37 | 9.24 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------------------|--------------------------------|--|
| Project Name: | Ashworth Ave Cell 1 18824 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 9/27/2023 | Wetted Area (sq. feet): | 11:15: 102 ft ² / 12:30 165 ft ² / 15:25 162 ft ² |
| Weather: | Scattered Showers, 60s | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.56 |
| Performed By: | APJ / SNCF | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|---|
| 8:50 | 10.94 | | | | | Water on, light rain showers |
| 8:52 | 11.48 | | | | | |
| 8:54 | 30.08 | | | | 69 | |
| 8:58 | 20.72 | | | | 144 | Ponding near hydrant between shrubs |
| 9:01 | 20.9 | | | | 205 | Wetted area moved past shrubs |
| 9:05 | 20.88 | | | | 292 | |
| 9:10 | 20.88 | 0.15 | | | 396 | |
| 9:16 | 20.88 | 0.19 | | | 522 | H2O at HA-2 at 9:18 |
| 9:30 | 21.02 | 0.25 | | | 815 | |
| 9:35 | 16.6 | | | | | Flow down |
| 9:45 | 16.76 | 0.3 | | | 1,072 | |
| 9:54 | 23.6 | | | | | Flow up |
| 10:00 | 23.6 | 0.37 | | | 1,371 | |
| 10:15 | 22.1 | 0.38 | | 4.88 | 1,718 | |
| 10:30 | 21.8 | 0.38 | | 4.68 | 2,042 | |
| 10:45 | 21.71 | 0.38 | | 3.55 | 2,370 | Alex begins measurements |
| 11:00 | 21.6 | 0.39 | | 3.51 | 2,695 | Flow up slightly |
| 11:03 | 22.26 | | | | 2,767 | |
| 11:15 | 22.2 | 0.4 | | 3.47 | 3,027 | Rain stopped |
| 11:30 | 21.66 | 0.4 | | 3.44 | 3,356 | Flow up to 35 gpm to fill pond |
| 11:46 | 35.41 | 0.44 | | 3.34 | 3,901 | Pond base full |
| 12:00 | 35.3 | 0.44 | | 3.29 | 4,397 | Flow down to 25 gpm |
| 12:15 | 20.61 | 0.4 | | | 4,743 | |
| 12:30 | 20.39 | 0.4 | | | 5,048 | |
| 12:45 | 20.28 | 0.4 | | | 5,348 | |
| 13:01 | 20.44 | 0.4 | | | 5,681 | |
| 13:15 | 20.44 | 0.41 | 0.46 | | 5,970 | SG-2 added |
| 13:32 | 20.22 | 0.42 | 0.48 | 3.24 | 6,311 | |
| 13:45 | 20.22 | 0.44 | 0.52 | 3.23 | 6,577 | |
| 14:03 | 20.12 | 0.44 | 0.52 | 3.2 | 6,940 | |
| 14:15 | 21.49 | 0.46 | 0.54 | 3.19 | 7,183 | |
| 14:30 | 19.34 | 0.48 | 0.56 | 3.17 | 7,485 | Flow rate lowered for fear of overtopping cell, pond shrunk significantly |
| 14:46 | 10.2 | 0.41 | 0.48 | 3.17 | 7,702 | |
| 14:50 | 9.07 | 0.36 | 0.44 | 3.24 | 7,833 | |
| 15:10 | 15.14 | 0.38 | 0.42 | 3.3 | 7,972 | Flow rate increased for final hour |
| 15:20 | 15.24 | 0.38 | 0.42 | 3.3 | 8,122 | Showers begin |
| 15:30 | 15.19 | 0.38 | 0.42 | 3.3 | 8,274 | |
| 15:40 | 15.24 | 0.39 | 0.44 | 3.28 | 8,440 | |

| | | | | | | |
|----------|-------|------|------|------|-------|---------------------------|
| 15:50 | 14.97 | 0.39 | 0.44 | 3.28 | 8,578 | Water off |
| 15:51 | | 0.38 | 0.44 | 3.3 | | |
| 15:52 | | 0.36 | 0.43 | | | |
| 15:54 | | 0.33 | 0.42 | | | |
| 15:56 | | 0.31 | 0.39 | | | |
| 15:58 | | 0.3 | 0.36 | | | |
| 16:00 | | 0.28 | 0.34 | 3.39 | | |
| 16:02 | | 0.26 | 0.32 | 3.45 | | |
| 16:05 | | 0.24 | 0.25 | | | |
| 16:07 | | 0.23 | 0.24 | | | |
| 16:08 | | | | 3.51 | | |
| 16:10 | | 0.2 | 0.19 | | | Rain intensifies slightly |
| 16:12 | | 0.18 | | 3.58 | | |
| 13:13 | | | 0.15 | | | |
| 16:15 | | 0.15 | 0.12 | | | |
| 16:19 | | 0.1 | 0.08 | | | |
| 16:20 | | | | 3.66 | | |
| 16:22 | | 0.04 | 0 | | | |
| 16:24 | | 0.02 | | | | |
| 16:24:30 | | | | | | |
| 16:26 | | | | 3.78 | | |
| 16:29 | | | | 3.85 | | |
| 16:34 | | | | 3.93 | | |
| 16:38 | | | | 4 | | |
| 16:46 | | | | 4.1 | | |
| 17:50 | | | | 4.15 | | |

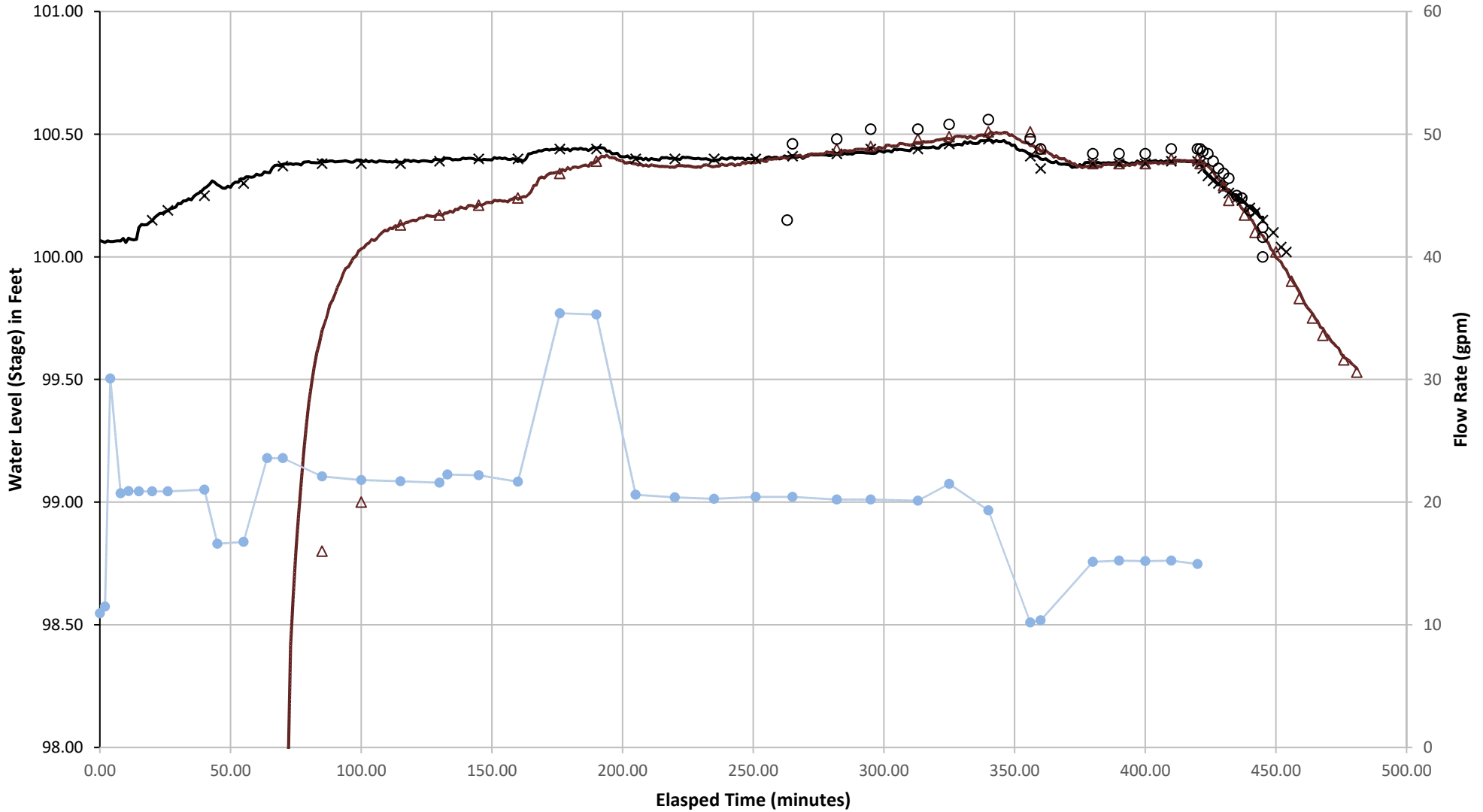
| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 8.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 7.8 |

| | |
|--|-----|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 8.6 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 8.9 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 9.4 |
| WP Average Infiltration Rate (in/hr) during falling head: | 5.0 |

| | |
|---|------|
| SG-1 Average Infiltration Rate (in/hr) during inflow from 10:00-11:15 | 20.5 |
|---|------|

Ashworth Avenue Cell 1 (18824) Infiltration Test Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Staff Gauge #2 Hand Data
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 2 (18834)

Assessed On:
September 27, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The 2011 Priority Sidewalk Project constructed a series of bioretention cells along Ashworth Avenue in 2011. The cells are designed to collect run off from Ashworth Avenue and sidewalk. The cell is constructed with 1.5 ft of bioretention soil above 1 ft of compost amended soil, above native soil. This study chose three of the cells to test, cell 2 is the farthest north cell tested in this series, and the smallest cell.

BIORETENTION SOIL:

Thickness: 0.1'-2.1'

The apparent thickness of the bioretention soil ranged from 0.1-2.1 feet, plans call for 2.5' bioretention soil mix above compost amended soil. The shallowest depths were at the cell walls at the top of the facility. Probe depths deepened towards the center of the cell. Differentiation between bioretention soil and compost amended soil with the probe was difficult, probe depths assumed total combined thickness.

Composition:

The design plans call out bioretention soil, but do not reference soil specifications. Based on the 2019 Ecology bioretention soil specifications, the tested soil was low in organic content and had a higher percentage of fines and fine gravels.

Organic Matter Content (% by weight): 4.9

Percent passing #200 sieve: 10.0

Coefficient of Uniformity (Cu): 9.9

Coefficient of Curvature (Cc): 1.5

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: Medium dense, moist, grey/oxidized orange, fine to medium SAND, some coarse sand, some gravel, trace silt (SP)

The site is mapped as Vashon Till by Booth, Troost and Schimel (2009). AESI interprets the subgrade material as Vashon Advance Outwash.

BUILT PER PLAN:

The bioretention soil and amended soil were a little thinner than called for in the design plans. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

The temporary wellpoint we installed, screened 1.5-2 ft below ground surface, did not encounter groundwater. The wellpoint responded to infiltration testing with the minimum measured water level above the ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >25.6

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 2 (18834)

Assessed On:
 September 27, 2023



Subgrade Soil Rate (in/hr): 25.6

The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils. There was a variance in flow rate due to flow splitter as the infiltration test for cell 1 was being conducted simultaneously.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Bioretention soil and amended soil was not placed to full 2.5' depth. Otherwise, the cell is in good condition.

Field Conditions

| | | | |
|-----------------|-------------------------|------------------|--|
| Weather | RAIN | | |
| Recent Rainfall | Today: 1.22" | Yesterday: 0.29" | Two Days Ago: 0.93" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Catherine Ikeda/ Alex Johanson |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 2 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230927-190853.jpg



Site Photo: FA_SitePhotos-20230927-190910.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 2 (18834)

Assessed On:
September 27, 2023



Site Photo: FA_SitePhotos-20230927-190930.jpg

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 75% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | |
| Water is conveyed to the cell from the adjacent road and sidewalk via sheet flow and one curb cut inlet. Water is designed to infiltrate through the bioretention soil, then infiltrate through the amended soil, before reaching the underlying native soil. There is no designed overflow. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 2 (18834)

Assessed On:
September 27, 2023



Inlets

| | |
|---|--|
| <p>IN-1</p> <p><input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 31'</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230927-190958.jpg</p> |
| <p>Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> | <p>Blockage Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 35% blocked</p> <p>Types: <input type="checkbox"/> Sediment <input type="checkbox"/> Organic <input type="checkbox"/> Rock <input type="checkbox"/> Trash <input checked="" type="checkbox"/> Vegetation</p> <p>Additional Details: Thick sedges border the edge of the pavement, but will allow water through.</p> |
| <p>Additional Details: No energy dissipation features were observed, if present they would be significantly buried.</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 2 (18834)

Assessed On:
September 27, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230927-191028.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 2 (18834)

Assessed On:
 September 27, 2023



Large Deposition of Feces Yes No

Additional Details:

Vegetation Description

Small cell, some limitation to edges

Additional Details

Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 0.1-2.1 feet (plans call for 2.5' BSM/Amended soil). The shallowest depths were at the cell walls at the top of the facility (0.1'). Probe depths deepened towards the center of the cell (2.1'). The width of the cell was measured to be approximately 9' and the length was measured to be approximately 15'. No zones of excessive compaction or erosion were observed.

Hand Auger

HA-1WP

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.3

to Native Soil: 1.9

to Import/Underdrain:

Total Depth: 2.5

Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM)

Native Soil Texture: Medium dense, moist, grey/oxidized orange, fine to medium SAND, some coarse sand, some gravel, trace silt (SP)

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Well Point Detail

Is the well point dry? Yes No

Depth to water from TOC (ft):

Respond to Testing: Yes No

Shallowest Depth to water during testing from Ground Surface (ft): 0



HA-1.JPG

Additional Details

Amended soil layer at 1.6-1.9' consisted of loose, moist, dark brown, fine to medium SAND, some coarse sand, some fine gravel, trace silt, abundant organics (SW-SM)

Shallowest depth to water during the test was above the ground surface.

HA-2

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.1

to Native Soil:

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 2 (18834)

Assessed On:
 September 27, 2023



| | |
|---|---|
| HA-2 | |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics (SW-SM) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
| Additional Details | |



HA-2.JPG

Infiltration Test

| | |
|---|-------|
| IT-1 | |
| Water Supply <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-9 (3-50) | |
| Wetted Pond Area (sq. ft) | 27 |
| Ponded Depth (ft) | 0.74 |
| Total Gallons | 3,410 |
| Steady State Flow Rate (GPM) | 7.4 |
| Additional Details: This cell was tested at the same time as Cell #1, adjustments to flow rate had to be coordinated between the two cells. Additional test details can be found in the executive summary. | |



BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)

Cell: Cell 2 (18834)

Assessed On:

September 27, 2023



Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)

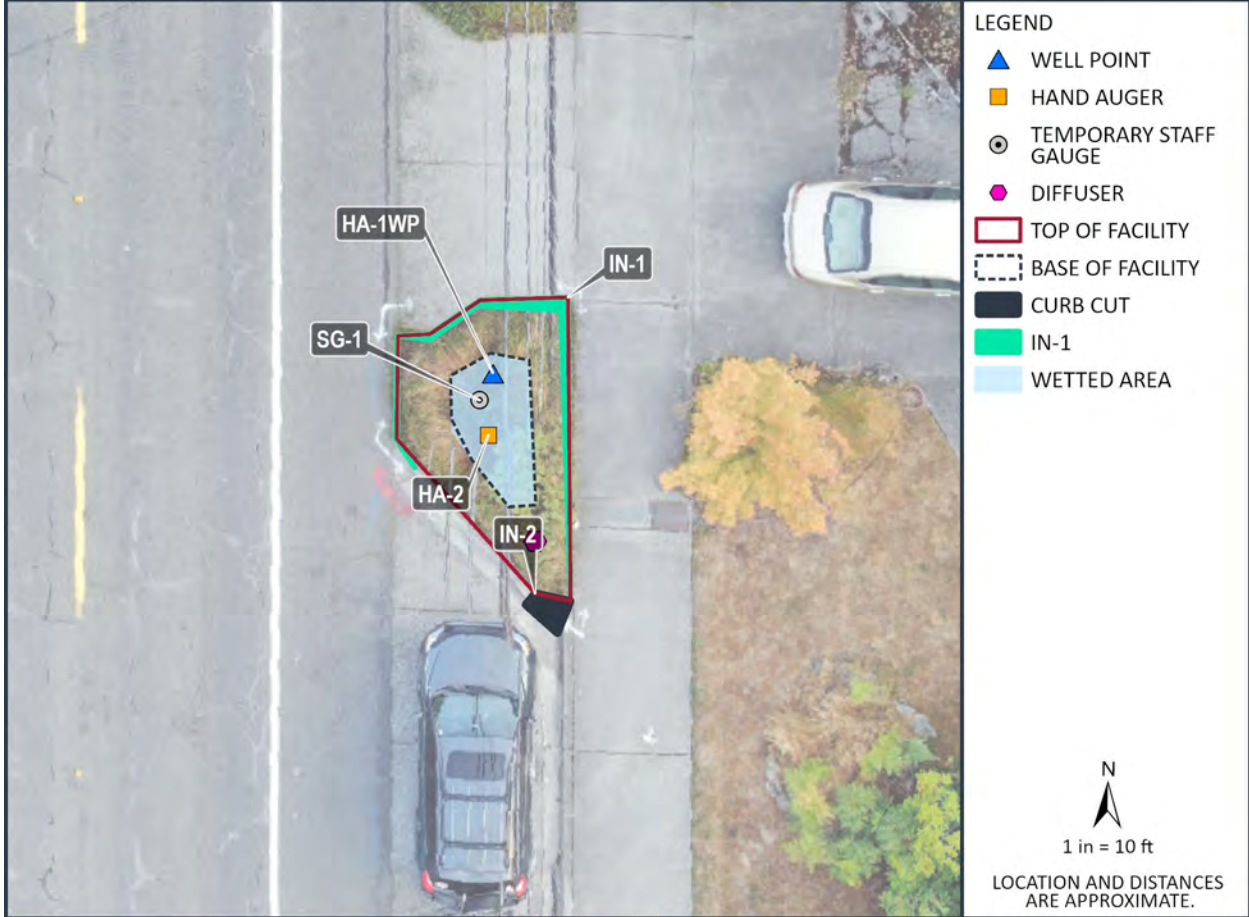
Cell: Cell 2 (18834)

Assessed On:

September 27, 2023



SITE: ASHWORTH AVE (SHAS) CELL: CELL 2 (18834)





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Well Point

SHAS-2-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/26/23

Logged By: SNCF

20150387H008

Ending Date: 9/26/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.5

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.6

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.1

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | █ | Natural Mulch Bark mulch mix with natural mulch grasses. | | | | | | | Stickup -5.1 to 0 feet Medium grain silica sand 0 to 1 feet 1.25-inch I.D. threaded galvanized steel casing -5.1 to -0.5 feet; duct tape covers screen from -0.5 to 1.5 feet 3/8-inch bentonite chips 1 to 1.3 feet Medium grain silica sand 1.3 to 2.5 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.5 to 2 feet Cast iron endcap 2 to 2.3 feet Cast iron drivepoint 2.3 to 2.6 feet |
| | Hand | 2 | █ | Bioretention Soil Mix Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt; abundant organics (SW-SM). | | | | | | | |
| | Hand | 3 | █ | | | | | | | | |
| 1 | Hand | 4 | █ | Loose, moist, dark brown, medium to coarse SAND, some fine sand, some silt, trace fine gravel; abundant organics (SW-SM). | | | | | | | |
| | Hand | 5 | █ | | | | | | | | |
| 2 | Hand | 6 | █ | Vashon Advance Outwash Medium dense, moist, gray to orange, fine SAND, some gravel, trace silt (SP). | | | | | | | |
| | | | | No seepage. Moderate caving 0 to 1.9 feet. Refusal at rock. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/15/2023

20150387H008



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Exploration Boring

SHAS-HA-2

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/26/23

Logged By: SNCF

20150387H008

Ending Date: 9/26/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.5

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

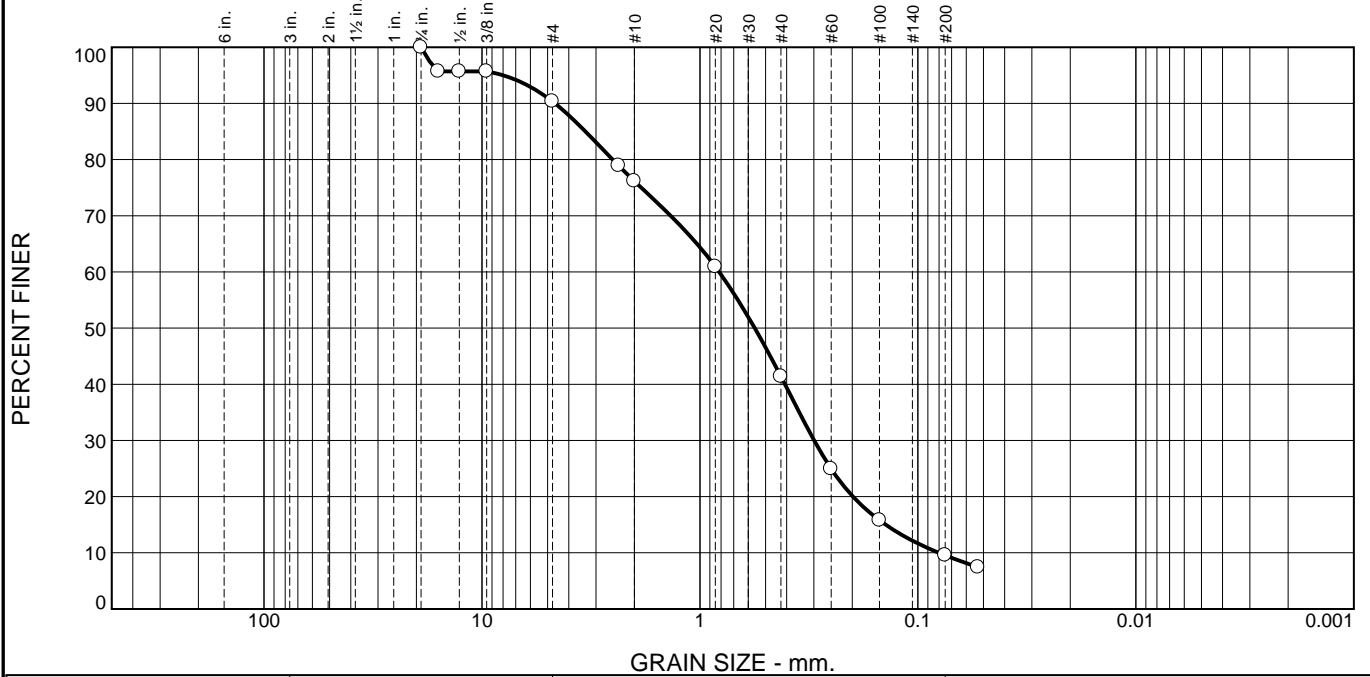
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|---|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | | | | Natural Mulch | | | | | | | | | |
| | | 1 | | | Bioretention Soil Mix | | | | | | | | | |
| | | 2 | | | Loose, slightly moist, dark brown, fine to medium SAND, some coarse sand, trace silt; abundant organics (___). As above. | | | | | | | | | |
| 1 | | 3 | | | As above; trace gravel. | | | | | | | | | |
| 2 | | | | | No seepage. Moderate caving. Refusal at rock. Base of cell. | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

12/5/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 9.6 | 14.2 | 34.8 | 31.8 | 9.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 95.7 | | |
| 1/2" | 95.7 | | |
| 3/8" | 95.7 | | |
| #4 | 90.4 | | |
| #8 | 78.9 | | |
| #10 | 76.2 | | |
| #20 | 60.9 | | |
| #40 | 41.4 | | |
| #60 | 24.9 | | |
| #100 | 15.8 | | |
| #200 | 9.6 | | |
| #270 | 7.4 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 4.6241 D₈₅= 3.3530 D₆₀= 0.8165
D₅₀= 0.5607 D₃₀= 0.2991 D₁₅= 0.1405
D₁₀= 0.0801 C_u= 10.20 C_c= 1.37

Remarks

Date Received: 9-27-2023 Date Tested: 11-7-2023

Tested By: FEW

Checked By: SNCF/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-SHAS-2
Sample Number: SHAS-2-HA-1WP

Depth: 0.5-1.0'

Date Sampled: 9-27-2023



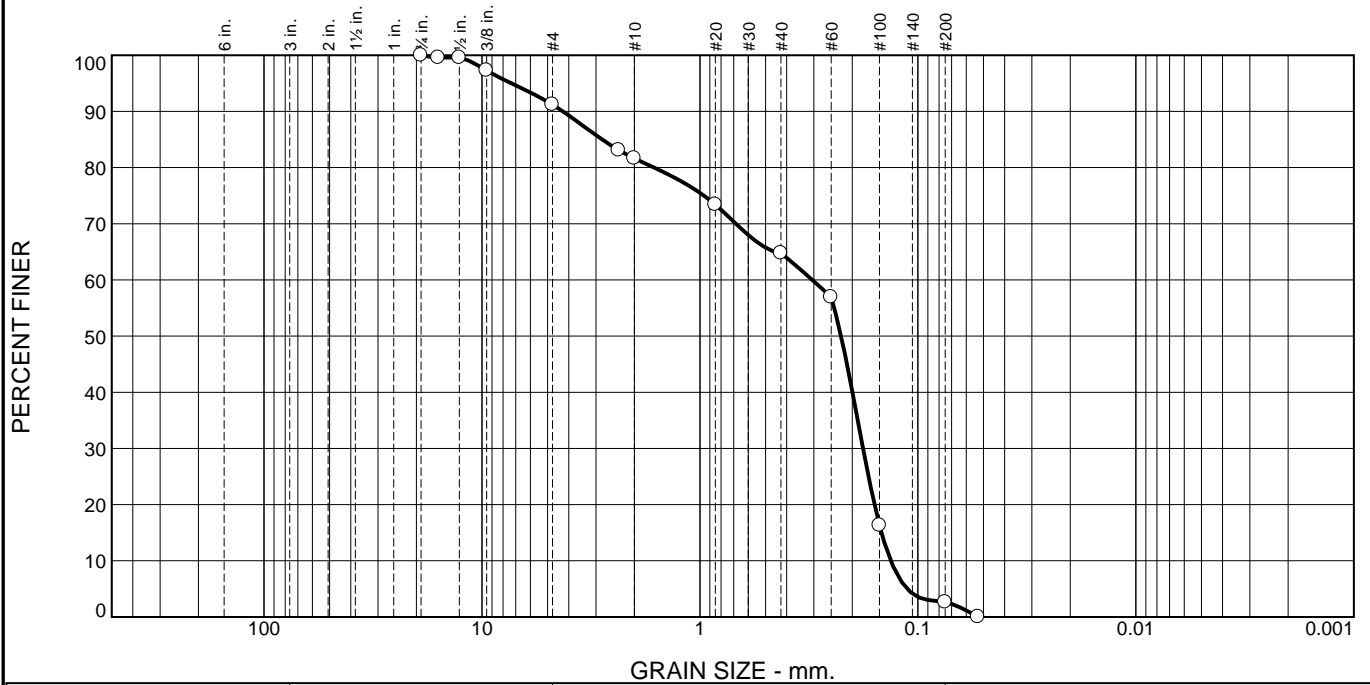
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 8.8 | 9.5 | 16.9 | 62.2 | 2.6 | 0.0 |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 99.6 | | |
| 1/2" | 99.6 | | |
| 3/8" | 97.3 | | |
| #4 | 91.2 | | |
| #8 | 83.1 | | |
| #10 | 81.7 | | |
| #20 | 73.4 | | |
| #40 | 64.8 | | |
| #60 | 56.9 | | |
| #100 | 16.3 | | |
| #200 | 2.6 | | |
| #270 | 0.0 | | |

* (no specification provided)

Material Description

SAND some gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

D₉₀= 4.2539 D₈₅= 2.8104 D₆₀= 0.3051
D₅₀= 0.2251 D₃₀= 0.1785 D₁₅= 0.1469
D₁₀= 0.1331 C_u= 2.29 C_c= 0.78

Remarks

Date Received: 9-27-2023 Date Tested: 10-26-2023

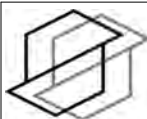
Tested By: FEW

Checked By: SNCF/JS

Title: _____

Location: Onsite - BHPS-SHAS-2 **Depth:** 1.9-2.5'

Date Sampled: 9-27-2023



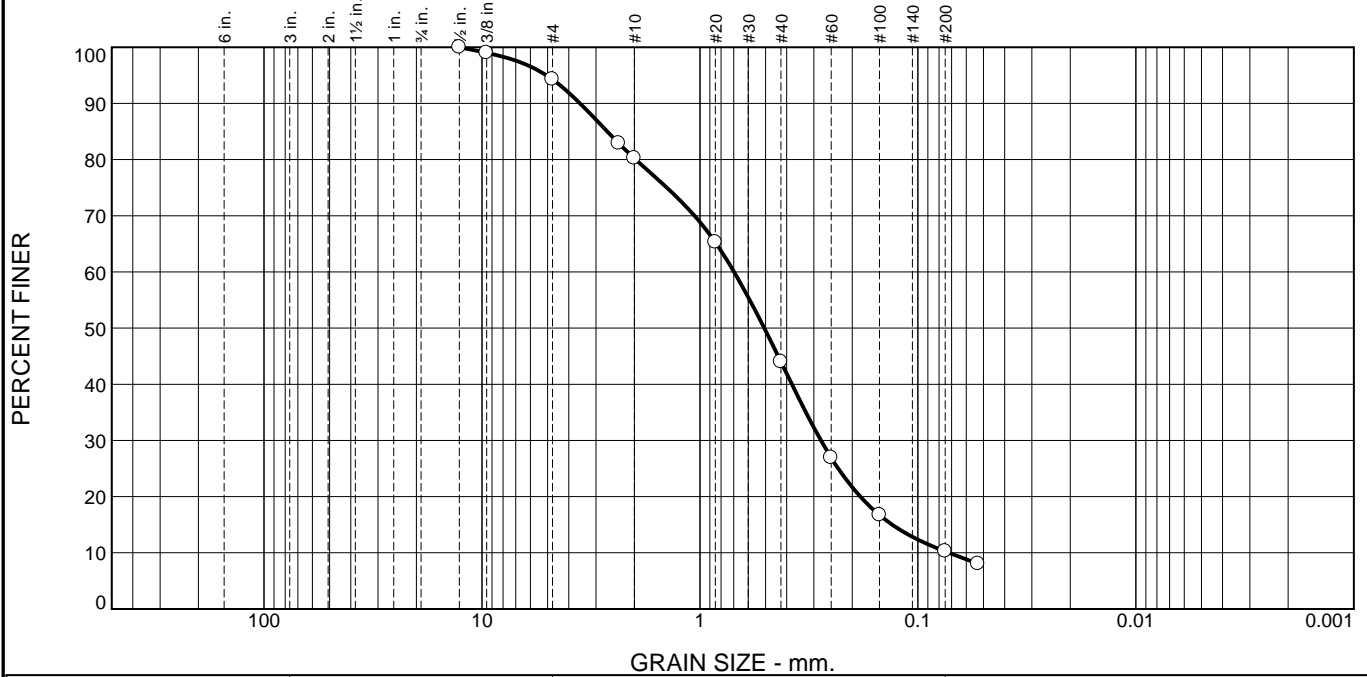
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 5.7 | 14.1 | 36.2 | 33.7 | 10.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.0 | | |
| #4 | 94.3 | | |
| #8 | 82.9 | | |
| #10 | 80.2 | | |
| #20 | 65.3 | | |
| #40 | 44.0 | | |
| #60 | 26.9 | | |
| #100 | 16.7 | | |
| #200 | 10.3 | | |
| #270 | 8.1 | | |

Material Description

SAND some gravel some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 3.5489 | D ₈₅ = 2.6621 | D ₆₀ = 0.6971 |
| D ₅₀ = 0.5069 | D ₃₀ = 0.2786 | D ₁₅ = 0.1312 |
| D ₁₀ = 0.0721 | C _u = 9.66 | C _c = 1.54 |

Remarks

Date Received: 9-27-2023 Date Tested: 11-7-2023

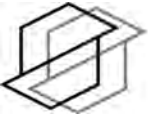
Tested By: FEW

Checked By: SNCF/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-SHAS-2 Date Sampled: 9-27-2023
 Sample Number: SHAS-2-HA-2 Depth: 0.5'-1.0'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 |
| | | Figure |



| | | | | |
|----------------------------------|-----------------------------------|-------------------------------------|--------------------------|--|
| Date Sampled 9/26/2023 | Project BHPA-SHAS-2 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Shoreline, Wa. | EB/EP No. SHAS-2-HA | Depth 0.1-0.8' | |

Moisture Content

| Sample ID | HA-1-WP @ 0.1-0.8 | HA-2 @ 0.5-1' |
|--------------------|-------------------|---------------|
| Wet Weight + Pan | 523.6 | 515.2 |
| Dry Weight + Pan | 497.2 | 491.2 |
| Weight of Pan | 257.1 | 259.5 |
| Weight of Moisture | 26.4 | 24.0 |
| Dry Weight of Soil | 240.1 | 231.6 |
| % Moisture | 11.0 | 10.4 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 497.2 | 491.2 |
| Dry Soil After Burn + Pan | 485.4 | 480.0 |
| Weight of Pan | 257.1 | 259.5 |
| Wt. Loss Due to Ignition | 11.8 | 11.2 |
| Actual Wt. Of Soil After Burn | 228.4 | 220.5 |
| % Organics | 4.9 | 4.8 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-----------------------------------|--------------------------------|---------------------------------|
| Project Name: | Shoreline Ashworth-Cell 2 (18834) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-9 (3-50) |
| Date: | 10/10/2023 | Wetted Area (sq. feet): | 10:45: 26 ft^2 / 11:45: 27 ft^2 |
| Weather: | Scattered Showers | Underdrain: | No |
| Test No.: | IT-2 | Test Depth (feet): | 0.55 |
| Performed By: | SNCF/APJ | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|---|
| 8:50 | | | | | Water on |
| 8:58 | 17 | 0.14 | | 85 | Leaky filter and non-collapse hose - duct taped |
| 9:03 | 17.5 | 0.2 | 5.63 | 120 | |
| 9:10 | 17.4 | 0.36 | 4.94 | 287 | Leak at 0.5 gpm out of filter - flow eventually gets to cell through curb cut |
| 9:15 | 17.4 | 0.54 | 4.68 | 380 | |
| 9:30 | 17.4 | 0.74 | 4.45 | 642 | |
| 9:35 | 4.8 | | | 715 | Decrease flow to 5 gpm |
| 9:47 | 4.9 | 0.44 | | 772 | WL battery dead |
| 9:53 | | 0.4 | 4.75 | | Increase flow to 8 gpm |
| 10:00 | 8.75 | 0.44 | 4.73 | 857 | |
| 10:15 | 6.9 | 0.46 | 4.68 | 981 | |
| 10:30 | 7.2 | 0.46 | 4.68 | 1,090 | |
| 10:45 | 7.6 | 0.48 | 4.68 | 1,203 | Rain started |
| 11:00 | 7.7 | 0.5 | 4.67 | 1,318 | Decrease flow slightly to 7 gpm |
| 11:15 | 6.98 | 0.48 | 4.69 | 1,425 | Stopped raining |
| 11:30 | 7.3 | 0.48 | 4.67 | 1,536 | Rainwater contributing ~0.85 gpm |
| 11:45 | 7.43 | 0.5 | 4.66 | 1,659 | Adjusting flow in other cell |
| 12:00 | 7 | 0.5 | 4.67 | 1,759 | Flow fiddling, leaking decreased |
| 12:15 | 7.5 | 0.49 | 4.67 | 1,860 | |
| 12:30 | 7.4 | 0.5 | 4.66 | 1,973 | |
| 12:45 | 7.4 | 0.52 | 4.65 | 2,084 | |
| 13:00 | 7.2 | 0.51 | 4.65 | 2,196 | |
| 13:15 | 7.2 | 0.51 | 4.65 | 2,301 | |
| 13:31 | 7.16 | 0.51 | 4.65 | 2,417 | |
| 13:45 | 7.18 | 0.51 | 4.65 | 2,516 | Rainwater ~0.18 gpm - flows to cell |
| 14:00 | 7.12 | 0.51 | 4.65 | 2,623 | |
| 14:15 | 7.9 | 0.53 | 4.64 | 2,732 | |
| 14:30 | 6.97 | 0.5 | 4.65 | 2,838 | Adjusting flow in other cell |
| 14:46 | 7.51 | 0.48 | 4.67 | 2,937 | |
| 15:00 | 7.5 | 0.52 | 4.65 | 3,040 | Adjusting flow in other cell |
| 15:10 | 7.3 | 0.53 | 4.64 | 3,112 | |
| 15:20 | 7.3 | 0.54 | 4.63 | 3,185 | Rain started |
| 15:30 | 7.3 | 0.54 | 4.62 | 3,259 | |
| 15:40 | 7.5 | 0.54 | 4.62 | 3,340 | |
| 15:50 | 7.5 | 0.55 | | 3,410 | Water off |

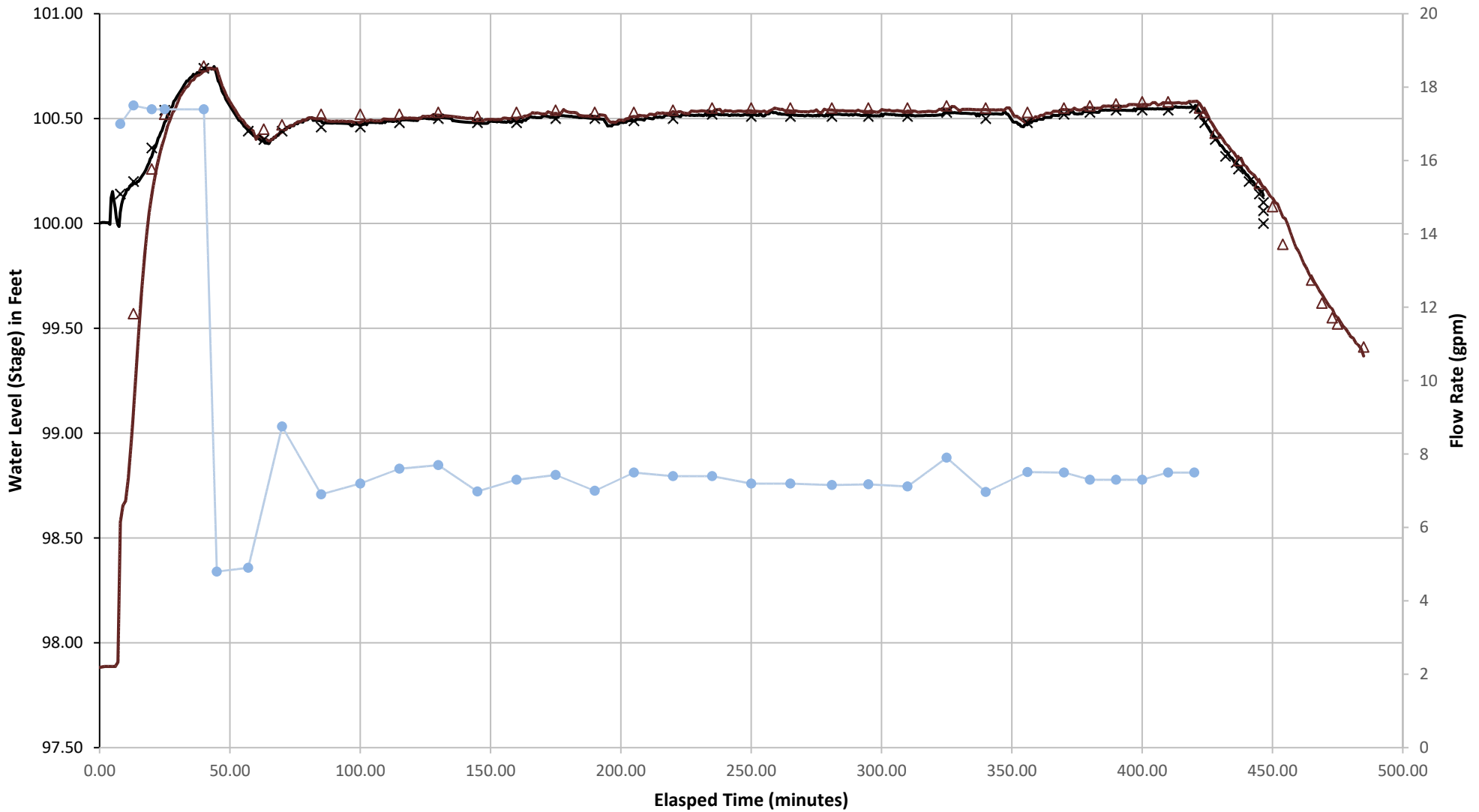
| | | | | | |
|-------|--|------|------|--|--|
| 15:52 | | 0.52 | 4.65 | | |
| 15:54 | | 0.48 | 4.67 | | |
| 15:58 | | 0.4 | 4.77 | | |
| 16:02 | | 0.32 | | | |
| 16:06 | | 0.29 | | | |
| 16:07 | | 0.26 | 4.9 | | |
| 16:11 | | 0.2 | | | |
| 16:15 | | 0.14 | 5.01 | | |
| 16:18 | | 0.1 | | | |
| 16:20 | | 0.06 | 5.12 | | |
| 16:24 | | 0 | 5.3 | | |
| 16:35 | | | 5.47 | | |
| 16:39 | | | 5.58 | | |
| 16:43 | | | 5.65 | | |
| 16:45 | | | 5.68 | | |
| 17:01 | | | 5.79 | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 25.6 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 11.8 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 25.9 |
| WP Average Infiltration Rate (in/hr) during falling head: | 16.1 |

Ashworth Avenue Cell 2 (18834) Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 3 (18538)

Assessed On:
October 10, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The 2011 Priority Sidewalk Project constructed a series of bioretention cells along Ashworth Avenue in 2011. The cells are designed to collect run off from Ashworth Avenue and sidewalk. The cell is constructed with 1.5 ft of bioretention soil above 1 ft of compost amended soil, above native soil. This study chose three of the cells to test, cell 3 is the farthest south cell tested in this series, and the largest cell.

BIORETENTION SOIL:

Thickness: 1.0-2.0 ft

The apparent thickness of the bioretention soil ranged from 1.0 -2.0 ft, plans call for 2.5' bioretention soil mix above compost amended soil. Probe depths deepen towards the center of the cell. Differentiation between bioretention soil and compost amended soil with the probe was difficult, probe depths assumed total combined thickness.

Composition:

The design plans call out bioretention soil, but do not reference soil specifications. Based on the 2019 Ecology bioretention soil specifications, the tested soil was slightly high in organic matter and had a higher percentage of fines and fine gravels.

Organic Matter Content (% by weight): 8.3

Percent passing #200 sieve: 12.8

Coefficient of Uniformity (Cu): 16.4

Coefficient of Curvature (Cc): 2.4

SUBGRADE CONDITIONS:

Geologic Unit: Fill/ Qvt

Soil Description: Wet, medium dense, light brown, sandy GRAVEL, some silt (GP) (reworked Vashon Till)

The site is mapped as Vashon Till by Booth, Troost and Schimel (2009). The layer beneath the bioretention soil on the side wall of the cell, where no amended soil is shown, appears to be fill made up of re-worked Vashon Till due to chunks of gravel sized pieces of till.

BUILT PER PLAN:

The bioretention soil and amended soil were a little thinner than called for in the design plans. An existing sump pump outlet pipe was grandfathered into the cell construction, originating from the 18542 Ashworth Ave. residence. Otherwise, the cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

The temporary Wellpoint we installed, screened 1.4-2 ft below ground surface, encountered groundwater at 0.95 ft below ground surface. The Wellpoint responded to infiltration testing with the minimum measured water level above the ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >4.1

Subgrade Soil Rate (in/hr): 4.1

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 3 (18538)

Assessed On:
 October 10, 2023



The infiltration test consisted of one ponded area covering two segments with a low check dam that was overtopped between the two segments, the diffuser was kept in the same location after the 10-100 gpm flowmeter was changed to a low flow (3-50gpm) flowmeter mid-way through the test. The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying soils infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Abundant trash was observed in the cell beneath dense vegetation.

Field Conditions

| | | | |
|-----------------|-------------------------|------------------|--------------------------|
| Weather | Rain, 50's | | |
| Recent Rainfall | Today: 0.25" | Yesterday: 0.05" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Colin Marshall |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 4 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20231010-213900.jpg



Site Photo: FA_SitePhotos-20231010-213932.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 3 (18538)

Assessed On:
 October 10, 2023



Site Photo: FA_SitePhotos-20231010-213948.jpg



Site Photo: FA_SitePhotos-20231010-214008.jpg

Cell Construction

| | |
|---|--|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 80% |
| Standing Water | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth: 0.25' Possible Cause: <input type="checkbox"/> Recent Rain <input type="checkbox"/> Clogged bottom <input type="checkbox"/> Blocked Underdrain <input checked="" type="checkbox"/> Unknown A roughly 4' by 4' pond of water near the base of the telephone pole. As the pond is partially located under dense woody shrubs it is difficult to observe the entirety of the standing water. |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed to the cell from sheet flow runoff from the adjacent roadway and sidewalk, in addition to an inlet from the sump pump associated with the northeastern adjacent house. Water is designed to infiltrate through the bioretention soil before reaching the native soil. There is no designed overflow feature, but there are check dams described in the plans as placed every 10 feet to reduce lateral flow down gradient. The standing water in the cell is from the sump pump associated with house #18542. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 3 (18538)

Assessed On:
October 10, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 156'

Energy Dissipation
Angular Rock: n/a
Stream Cobble: n/a
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20231010-213734.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: No energy dissipation features were observed.

IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Energy Dissipation
Angular Rock: n/a
Stream Cobble: Functioning
Water Wheel: n/a
Splash Block: n/a
Concrete Apron: n/a



FA_INphoto-20231010-213815.jpg

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details: Pipe is below stream cobble, comes from under sidewalk

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
 Cell: Cell 3 (18538)

Assessed On:
 October 10, 2023




Cell Surface and Geotech Probe Observations

| | | | | | |
|---|---|--------------------------------|--|-----------------------------------|------------------------------------|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): | | | | | |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Some natural dead grass mulch was observed around the fire hydrant and HA-1WP. A large amount of garbage was observed under the thick vegetation of the cell. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | | | | |
| Additional Details: | | | | | |
| Vegetation Description | | | | | |
| The north end of cell is thick with thorny wild rose bushes, thick shrubs hinder access to 75% of cell. | | | | | |
| Additional Details | | | | | |
| Geotech Probe Observations: At the cell base, probe measurements found 1.0-2.0' of bioretention soil, with an average probe depth of 1.6', before encountering the amended /native soils. This is slightly more than the 1.5' of bioretention soil specified by the plans, however there is a 1.0' of amended soil shown in the plans below the bioretention soil that may be difficult to discern the boundary. On the cell edges, 0.4-1.9 feet of soil, with an average of 0.9' of soil, was encountered above the amended soils. This is inconsistent with the cell design which shows 3:1 and 2:1 sloped sides with only 4" of bark mulch above the existing native subgrade. No zones of compaction were observed. Some areas of the cell could not be probed due to thick, thorny vegetation. | | | | | |

Hand Auger

| | |
|---|---|
| HA-1WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.6 |
| to Import/Underdrain: | |
| Total Depth: | 2.4 |
| Rain/Garden Mix Soil Texture: Very moist to wet, loose, dark brown, fine to medium SAND, some coarse sand, some gravel, some silt, abundant organics. (SW-SM) | |
| Native Soil Texture: Amended Native Soil: Wet, medium dense, light brown, gravelly fine to medium SAND, some coarse sand, trace silt (SP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Depth to water from TOC (ft): 5.99 | |



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BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 3 (18538)

Assessed On:
October 10, 2023



| | |
|---|--|
| HA-1WP | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details | |
| Amended native soil sample is made of broken up chunks of till, possibly broken up when construction amended and placed the 12" of amended native soil per design plans below the bioretention soil. Groundwater was encountered at 0.95' below ground surface. | |

| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Very moist to wet, loose, dark brown, fine to medium SAND, some coarse sand, some fine gravel, some silt, abundant organics. (SM) | |
| Native Soil Texture: Amended Native Soil: Wet, medium dense, light brown, gravelly fine to medium SAND, some coarse sand, trace silt (SP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |
| Amended native soil sample is made of broken up chunks of till, possibly broken up when construction amended and placed the 12" of amended native soil per design plans below the bioretention soil. Groundwater was encountered at 0.9' below ground surface. | |



FA_FPhoto-20231010-213008.jpg

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.7 |
| to Import/Underdrain: | |
| Total Depth: | 2 |
| Rain/Garden Mix Soil Texture: Very moist to wet, loose, dark brown, fine to medium SAND, some coarse sand, some fine gravel, some silt, abundant organics. (SM) | |
| Native Soil Texture: Amended Native Soil: Wet, medium dense, light brown, gravelly fine to medium SAND, some coarse sand, trace silt (SP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 3 (18538)

Assessed On:
October 10, 2023



| | |
|---|--|
| HA-3 | |
| Additional Details | |
| Amended native soil sample is made of broken up chunks of till, possibly broken up when construction amended and placed the 12" of amended native soil per design plans below the bioretention soil. Groundwater was encountered at 0.88' below ground surface. | |

| | |
|---|--|
| HA-4 | |
| <input type="checkbox"/> Zone 1 <input checked="" type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 0.6 |
| to Import/Underdrain: | |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Very moist to wet, loose, dark brown, fine to medium SAND, some coarse sand, some fine gravel, some silt, abundant organics. (SM) Native Soil Texture: Fill: Wet, medium dense, light brown, sandy GRAVEL, some silt (GP) (reworked Vashon Till) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input type="checkbox"/> No | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| Additional Details | |
| Fill is made of broken up chunks of till, possibly broken chunks of the native sediment when construction scarified the native soil during construction of the road and bioretention cell. Groundwater was encountered at 0.9' below ground surface. | |

Infiltration Test

| | |
|---|-------|
| IT-1 | |
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 10-100 | |
| Wetted Pond Area (sq. ft) | 147 |
| Ponded Depth (ft) | 0.78 |
| Total Gallons | 3,904 |
| Steady State Flow Rate (GPM) | 7 |
| Additional Details: | |
| The infiltration test consisted of one ponded area covering two segments with a low check dam that was overtopped between the two segments, the diffuser was kept in the same location after the flowmeter was changed to a low flowmeter mid way through the test. Shallowest depth to water during the test was at the ground surface. Additional test details can be found in the executive summary. | |
| | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)

Cell: Cell 3 (18538)

Assessed On:
October 10, 2023



Additional Comments

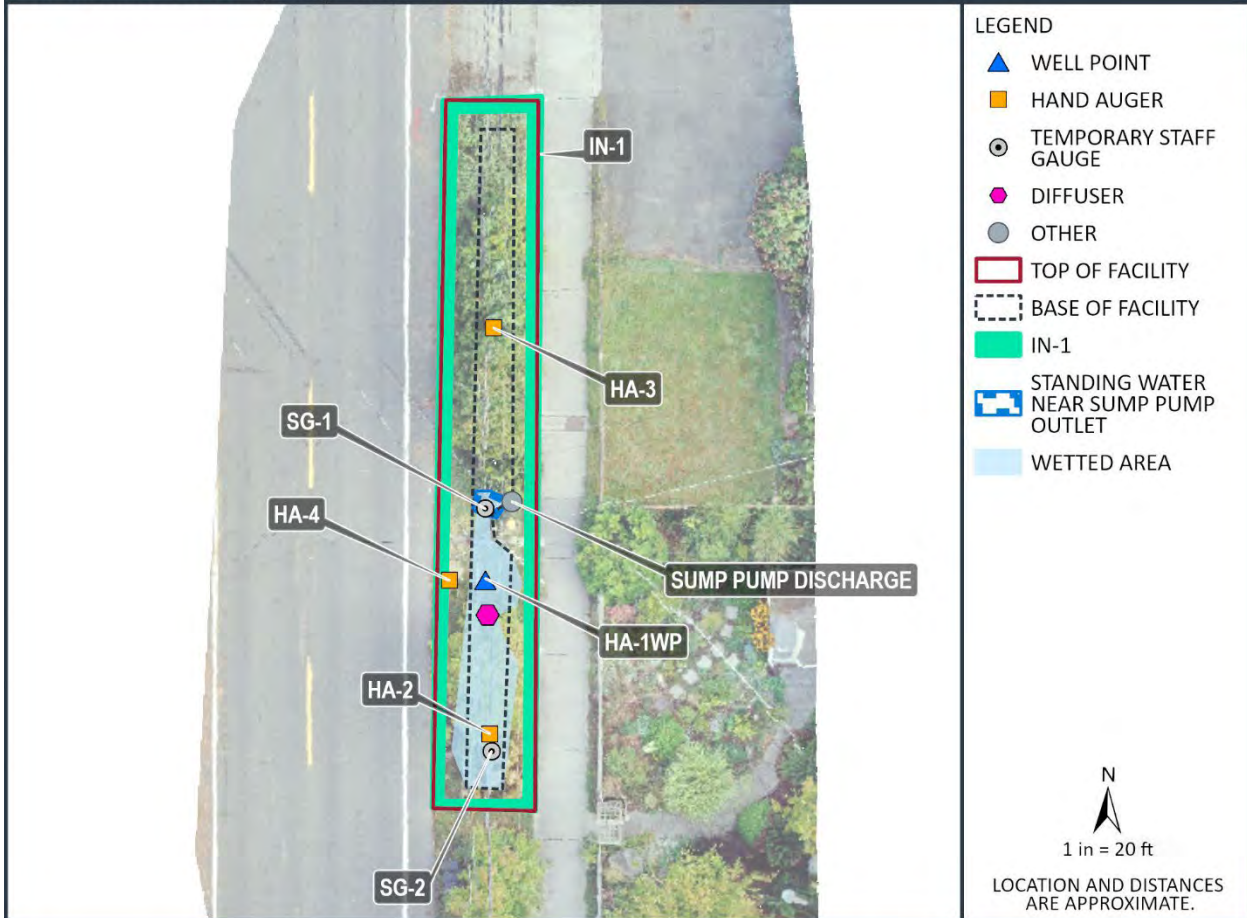
BIORETENTION CELL FIELD ASSESSMENT

Site: Ashworth Ave (SHAS)
Cell: Cell 3 (18538)

Assessed On:
October 10, 2023



SITE: ASHWORTH AVE (SHAS) CELL: CELL 3 (18538)





associated
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Well Point

SHAS-3-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/26/23

Logged By: SNCF

20150387H008

Ending Date: 9/26/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.4

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.7

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.1

Water Level Elevation (ft): 99.05

Datum: Project Datum

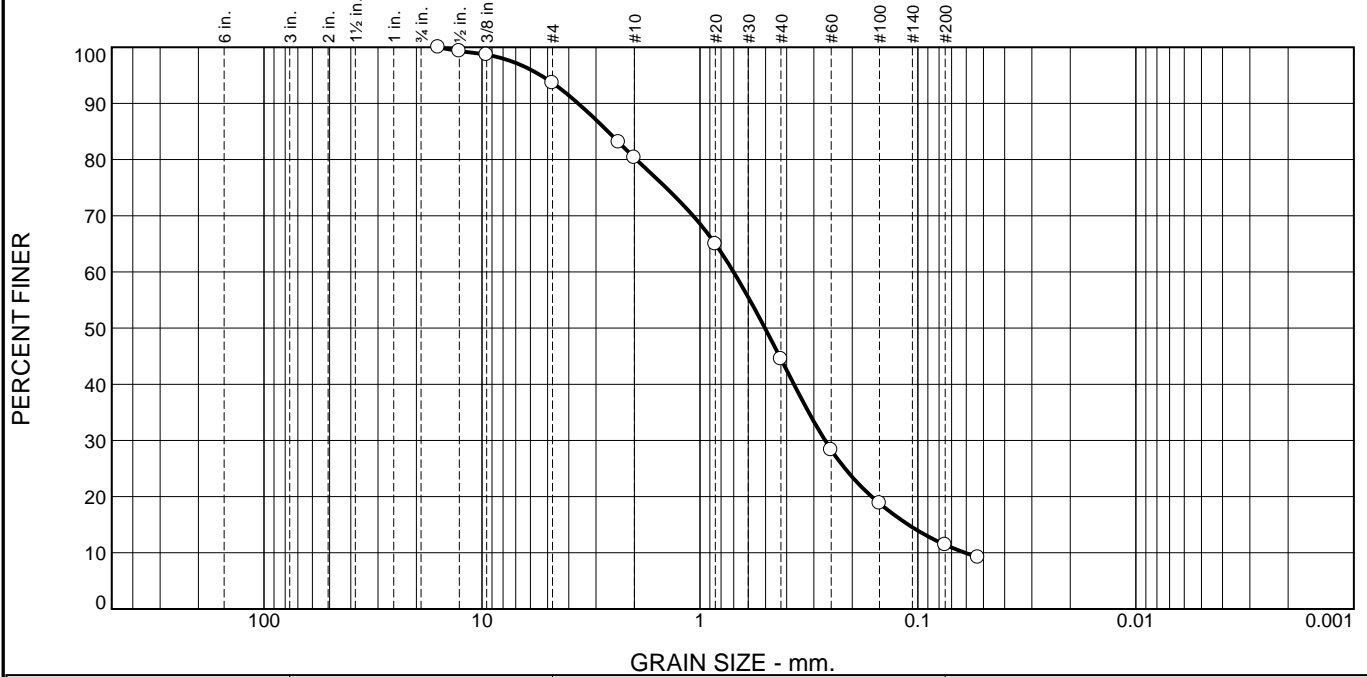
▼ Groundwater Depth ATD (ft): 0.95

▼ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|---|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | Hand | 1 | | Natural Mulch Loose grasses, vegetative debris. | ▼ | | | | | | <p>Stickup -5.1 to 0 feet Existing Bioretention Soil 0 to 0.2 feet Medium Grain Silica Sand 0.2 to 2.4 feet 1.25-inch I.D. threaded galvanized steel casing -5.1 to 0.6 feet; duct tape covers screen 0.6 to 1.4 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.4 to 2 feet Cast iron endcap 2 to 2.3 feet Cast iron drivepoint 2.3 to 2.6 feet</p> |
| | | | Bioretention Soil Loose, very moist, dark brown, fine to medium SAND, trace gravel, trace silt; abundant organics (SP). | | | | | | | | |
| 1 | | 2 | | Same as above; becomes wet; some gravel. | | | | | | | |
| 2 | | 3 | | Fill Medium dense, wet, light brown, very sandy, GRAVEL, trace silt (GP). | | | | | | | |
| 2 | 4 | | | | | | | | | | |
| 3 | | | | Groundwater encountered at 0.95 feet. Minimum caving. More caving below saturated zone. Refusal at rocks. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

20150387H008
1/24/2024

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 6.3 | 13.4 | 35.8 | 33.1 | 11.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 99.3 | | |
| 3/8" | 98.7 | | |
| #4 | 93.7 | | |
| #8 | 83.1 | | |
| #10 | 80.3 | | |
| #20 | 65.0 | | |
| #40 | 44.5 | | |
| #60 | 28.3 | | |
| #100 | 18.8 | | |
| #200 | 11.4 | | |
| #270 | 9.2 | | |

Material Description

SAND some gravel some sand

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SW-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.6190 D₈₅= 2.6427 D₆₀= 0.7012
D₅₀= 0.5034 D₃₀= 0.2666 D₁₅= 0.1106
D₁₀= 0.0607 C_u= 11.55 C_c= 1.67

Remarks

Date Received: 10-10-2023 Date Tested: 10-30-2023

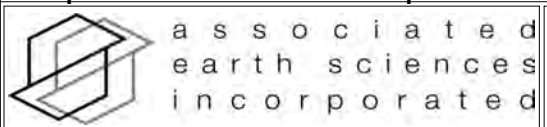
Tested By: FEW

Checked By: CSI/JHS

Title: _____

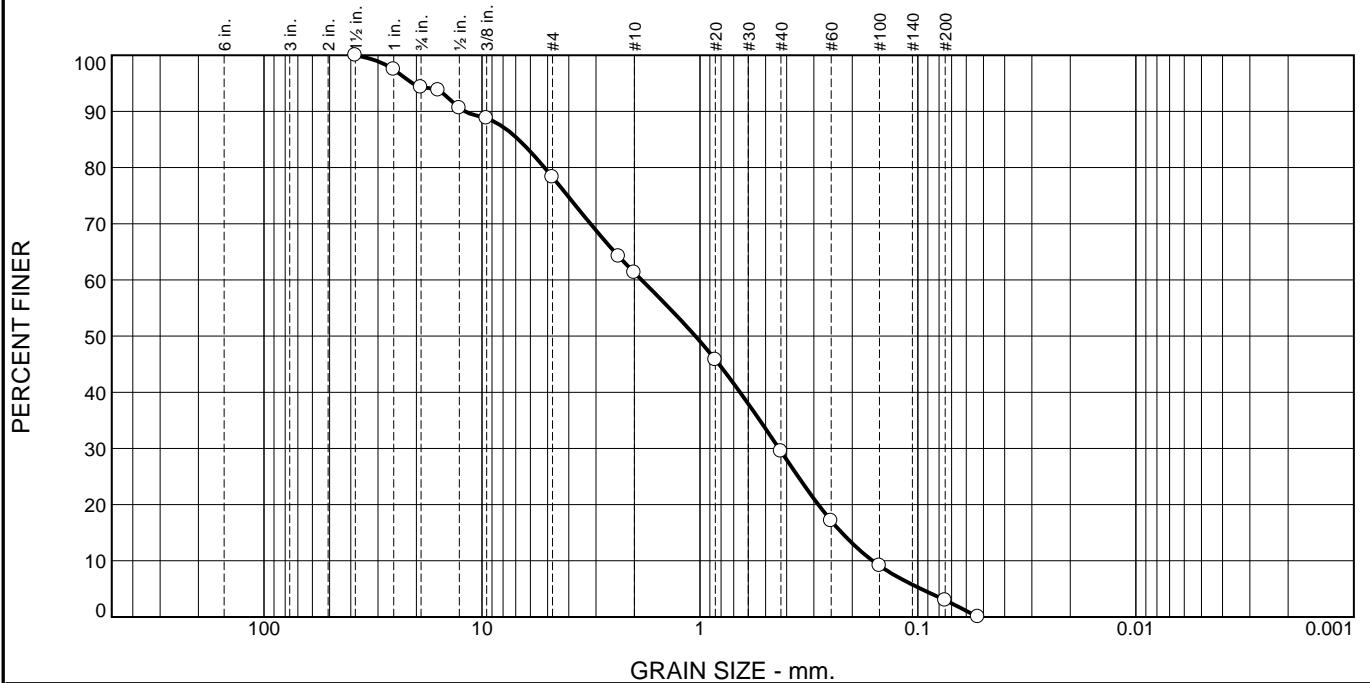
* (no specification provided)

Location: Onsite - BHPS-SHAS-3 Date Sampled: 10-10-2023
Sample Number: HA-1WP Depth: 0.1-0.9'



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.7 | 16.0 | 17.0 | 31.8 | 26.5 | 3.0 | 0.0 |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.50" | 100.0 | | |
| 1" | 97.5 | | |
| 3/4" | 94.3 | | |
| 5/8" | 93.8 | | |
| 1/2" | 90.6 | | |
| 3/8" | 88.8 | | |
| #4 | 78.3 | | |
| #8 | 64.2 | | |
| #10 | 61.3 | | |
| #20 | 45.8 | | |
| #40 | 29.5 | | |
| #60 | 17.1 | | |
| #100 | 9.1 | | |
| #200 | 3.0 | | |
| #270 | 0.0 | | |

* (no specification provided)

Material Description

gravelly SAND trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|---------------------------|--------------------------|--------------------------|
| D ₉₀ = 12.0129 | D ₈₅ = 6.8043 | D ₆₀ = 1.8521 |
| D ₅₀ = 1.0492 | D ₃₀ = 0.4339 | D ₁₅ = 0.2236 |
| D ₁₀ = 0.1612 | C _u = 11.49 | C _c = 0.63 |

Remarks

Date Received: 10-10-2023 Date Tested: 10-26-2023

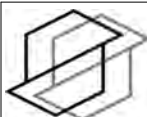
Tested By: FEW

Checked By: SNCF/CEM/JS

Title: _____

Location: Onsite - BHPS-Ashworth-Cell3
Sample Number: HA-1WP **Depth:** 2.0-2.4'

Date Sampled: 10-10-2023



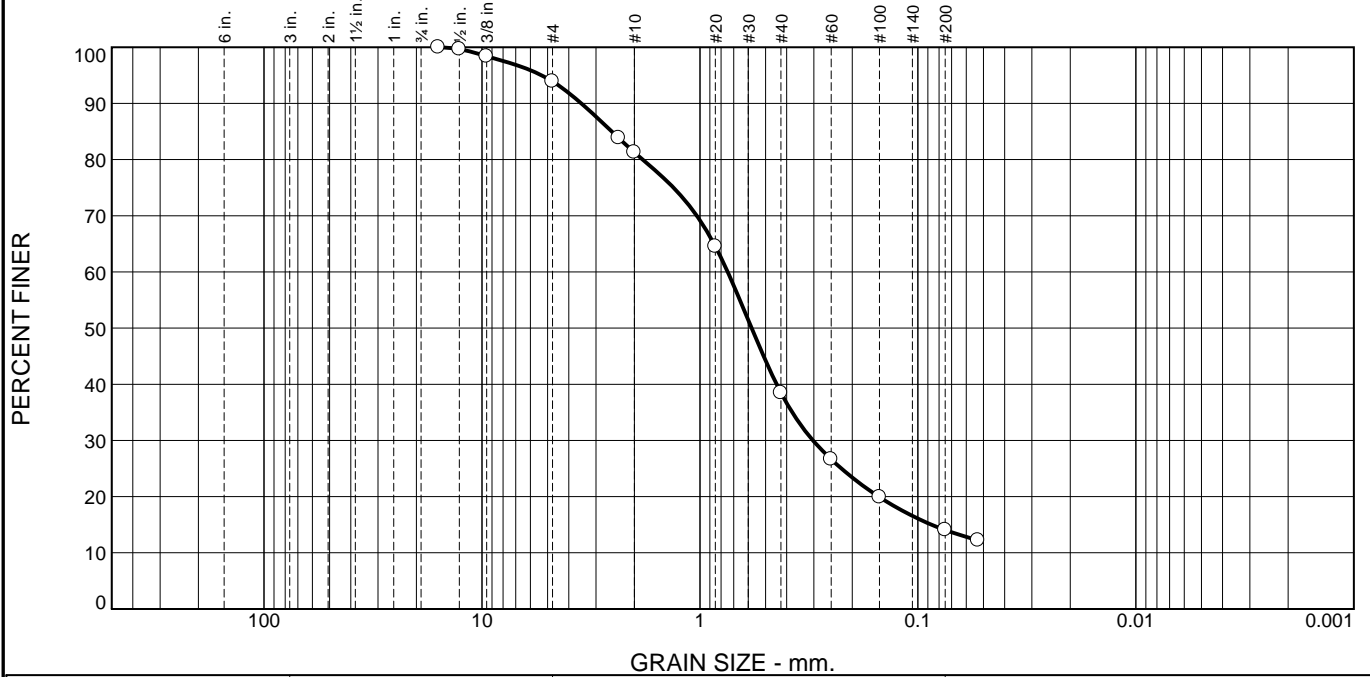
associated
earth sciences
incorporated

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 6.1 | 12.6 | 42.8 | 24.4 | 14.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 99.7 | | |
| 3/8" | 98.4 | | |
| #4 | 93.9 | | |
| #8 | 83.8 | | |
| #10 | 81.3 | | |
| #20 | 64.5 | | |
| #40 | 38.5 | | |
| #60 | 26.6 | | |
| #100 | 19.9 | | |
| #200 | 14.1 | | |
| #270 | 12.2 | | |

Material Description

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.4989 D₈₅= 2.5392 D₆₀= 0.7460
D₅₀= 0.5791 D₃₀= 0.3030 D₁₅= 0.0866
D₁₀= C_u= C_c=

Remarks

Date Received: 10-10-2023 Date Tested: 10-30-2023

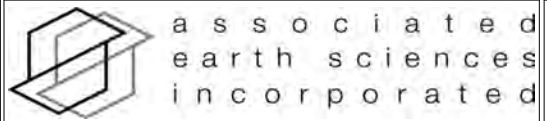
Tested By: FEW

Checked By: CSI/JS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-SHAS-3 Date Sampled: 10-10-2023
Sample Number: HA-2 Depth: 0-0.8'



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study
Project No: 20150387 H008 Figure



| | | | | |
|-----------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 10/10/2023 | Project BHPS-SHAS-3 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Shoreline, WA | EB/EP No. SHAS-3-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.1-0.9' | HA-2 @ 0-0.8' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 1024.14 | 1465.53 |
| Dry Weight + Pan | 798.95 | 1206.78 |
| Weight of Pan | 247.08 | 357.99 |
| Weight of Moisture | 225.19 | 258.75 |
| Dry Weight of Soil | 551.87 | 848.79 |
| % Moisture | 40.80 | 30.48 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|---------|
| Dry Soil Before Burn + Pan | 798.95 | 1206.78 |
| Dry Soil After Burn + Pan | 743.12 | 1151.25 |
| Weight of Pan | 247.08 | 357.99 |
| Wt. Loss Due to Ignition | 55.83 | 55.53 |
| Actual Wt. Of Soil After Burn | 496.04 | 793.26 |
| % Organics | 10.12 | 6.54 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|------------------------------------|--------------------------------|---------------------------------|
| Project Name: | Shoreline Ashworth- 18535 (Cell 3) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 10/10/2023 | Wetted Area (sq. feet): | 11:05 143 ft^2 / 12:30 147 ft^2 |
| Weather: | Scattered Showers | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.74 |
| Performed By: | SNCF/CEM | Receptor Soils: | Fill |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|--------------------------------|
| 10:00 | | 0.28 | | 5.99 | | Water on |
| 10:02 | 27.9 | 0.28 | | 5.99 | 28 | |
| 10:05 | 27.7 | 0.28 | | 5.75 | 115 | |
| 10:15 | 27.8 | 0.3 | | 5.12 | 379 | Water approaching overflow |
| 10:22 | 27.5 | | | | 579 | Decrease flow |
| 10:25 | | 0.34 | 0.64 | | | Placed SG-2 |
| 10:30 | 15.8 | 0.34 | 0.66 | 5.15 | 717 | |
| 10:40 | 15.9 | 0.34 | 0.7 | 5.14 | 862 | Decrease flow |
| 10:45 | 10.22 | 0.34 | 0.7 | 5.15 | 926 | |
| 11:00 | 10.06 | 0.35 | 0.7 | 5.15 | 1,087 | |
| 11:20 | 10.1 | 0.36 | 0.7 | 5.14 | 1,288 | Sump pump < 1 gal every 90 sec |
| 11:30 | 10.1 | 0.38 | 0.7 | 5.13 | 1,384 | |
| 11:45 | 10.1 | 0.37 | 0.72 | 5.13 | 1,535 | |
| 12:00 | 10 | 0.38 | 0.72 | 5.12 | 1,685 | |
| 12:15 | 10 | 0.38 | 0.74 | 5.12 | 1,836 | |
| 12:29 | 9.99 | 0.4 | 0.74 | 5.1 | 1,982 | |
| 12:30 | | 0.4 | 0.74 | | 1,986 | Water off |
| 12:35 | | 0.38 | 0.71 | 5.14 | | |
| 12:40 | | 0.34 | 0.68 | 5.18 | | |
| 13:05 | | 0.3 | 0.48 | 5.28 | | |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 6.3 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 2.1 |

| | |
|--|-----|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 6.1 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 4.3 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 7.0 |
| WP Average Infiltration Rate (in/hr) during falling head: | 3.6 |

| | | | |
|------------------------|------------------------------------|--------------------------------|---|
| Project Name: | Shoreline Ashworth- 18535 (Cell 3) | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) |
| Date: | 10/10/2023 | Wetted Area (sq. feet): | 14:30 147 ft ² / 15:45 157 ft ² |
| Weather: | Scattered Showers | Underdrain: | No |
| Test No.: | IT-2 | Test Depth (feet): | 0.78 |
| Performed By: | SNCF/CEM | Receptor Soils: | Fill |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|--|
| 13:05 | | 0.3 | 0.48 | 5.28 | | Water on |
| 13:08 | 8.3 | 0.3 | 0.46 | | 16 | |
| 13:10 | 12 | 0.3 | 0.48 | 5.23 | | |
| 13:15 | 13.6 | 0.32 | 0.5 | | 104 | |
| 13:30 | 13.4 | 0.33 | 0.69 | 5.16 | 305 | Decrease flow to 8.5 gpm |
| 13:45 | 8.4 | 0.36 | 0.7 | 5.15 | 438 | Rain intensifies |
| 14:00 | 8.3 | 0.37 | 0.71 | 5.14 | 569 | |
| 14:15 | 8.3 | 0.38 | 0.73 | 5.13 | 690 | Increase flow to account for rain (RG=0.25') |
| 14:30 | 8 | 0.39 | 0.74 | 5.11 | 813 | Ponded area hit marker flag from IT-1 |
| 14:45 | 8.6 | 0.4 | 0.75 | 5.09 | 938 | Loud sound from backflow device |
| 15:06 | 7.56 | 0.41 | | | 1,106 | |
| 15:16 | 7.74 | 0.42 | 0.76 | 5.08 | 1,186 | |
| 15:30 | 7.8 | 0.42 | 0.76 | 5.08 | 1,293 | Decrease flow; sun's out |
| 15:35 | 6.9 | 0.42 | 0.76 | | 1,337 | Con't troubleshooting backflow |
| 15:44 | | | | | | Sound from backflow stopped |
| 15:45 | 6.8 | 0.42 | 0.76 | 5.08 | 1,397 | Hose leak ~1 gpm |
| 16:00 | 6.8 | 0.42 | 0.76 | 5.07 | 1,498 | |
| 16:10 | 6.9 | 0.42 | 0.76 | 5.07 | 1,567 | Rain started |
| 16:30 | 6.9 | 0.43 | 0.77 | 5.06 | 1,705 | |
| 16:40 | 6.9 | 0.43 | 0.78 | 5.06 | 1,774 | Heavy rain |
| 16:50 | 6.9 | 0.43 | 0.78 | 5.06 | 1,843 | |
| 17:00 | 0 | 0.44 | 0.78 | 5.05 | 1,918 | Water off; rain stopped |
| 17:07 | | 0.43 | 0.76 | 5.06 | | |
| 17:10 | | 0.42 | 0.75 | 5.08 | | |
| 17:15 | | 0.42 | 0.74 | 5.09 | | |
| 17:21 | | 0.4 | 0.73 | 5.12 | | |
| 17:25 | | 0.4 | 0.71 | 5.13 | | |
| 17:30 | | 0.38 | 0.7 | 5.15 | | |
| 17:35 | | 0.36 | 0.68 | | | |

| | | | | | | |
|-------|--|------|------|------|--|--|
| 17:37 | | | | 5.16 | | |
| 17:41 | | 0.35 | 0.66 | 5.18 | | |
| 17:45 | | 0.35 | 0.64 | 5.19 | | |
| 17:50 | | 0.34 | 0.62 | 5.19 | | |
| 17:55 | | 0.34 | 0.6 | 5.21 | | |
| 18:00 | | 0.33 | 0.58 | 5.21 | | Pulled loggers at 18:08; put WP and baro back in overnight |

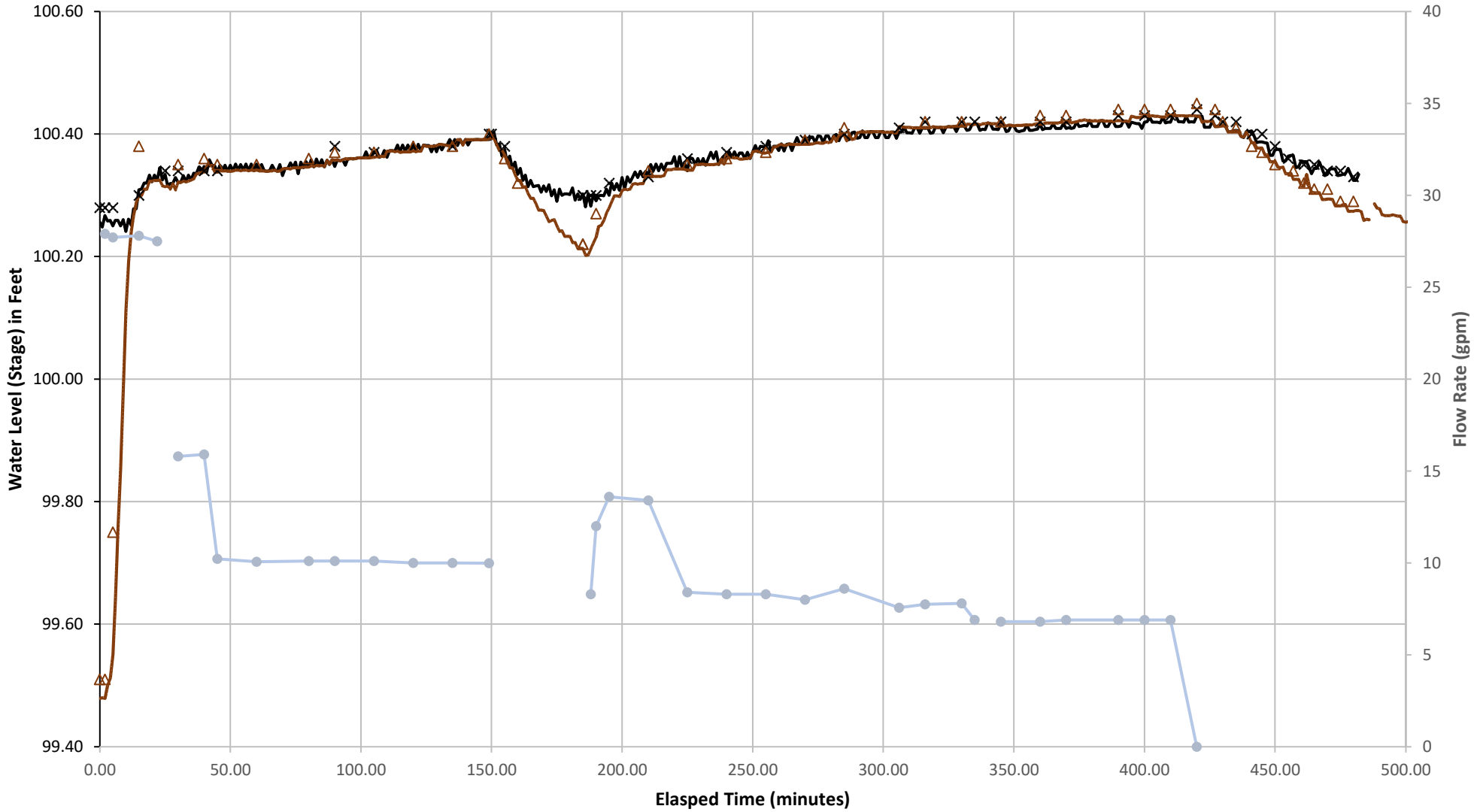
| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 4.1 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 1.3 |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 4.1 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 2.4 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 4.5 |
| WP Average Infiltration Rate (in/hr) during falling head: | 1.9 |

Ashworth Avenue Cell 3 (18538) Infiltration Test

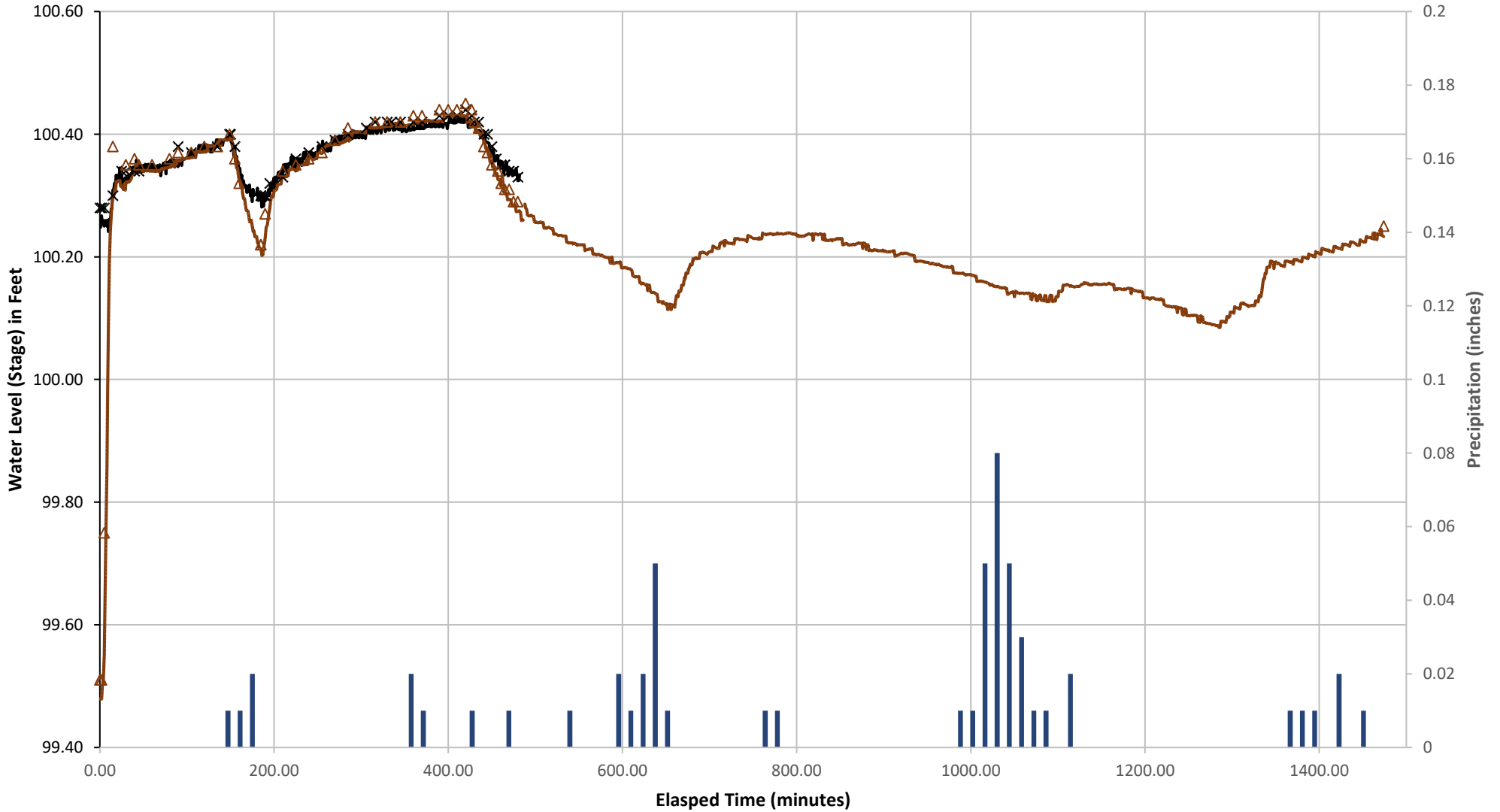
Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
 - △ Wellpoint Hand
 - Flow Rate (gpm)
- Staff Gauge #1 Logger
 - Wellpoint Logger

Ashworth Avenue Cell 3 (18538) Infiltration Test; Precipitation Response Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface. Precipitation data from King County gauge #04u

- Precipitation
- Staff Gauge #1 Logger
- Wellpoint Hand
- Staff Gauge #1 Hand Data
- Wellpoint Logger

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2009 and collects stormwater runoff from the adjacent roadway through curb cut inlets. The cell is constructed with 2' of bioretention soil placed above native sediments. There is an overflow structure located in the southern corner of the cell which is designed to allow for 1.5' of ponding. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 1-2.5'

The apparent thickness of the bioretention soil ranged from 1-2.5' with an average thickness of 1.9'. The soil profile was observed to be thinnest in the center of the cell.

Composition: No soil specifications were received in the design plans. In comparison to the 2019 Ecology specifications, the sand gradation exceeded the standard while the organic matter content and fines content was within the specifications. Soil samples from HA-2 measured a fines content exceeding the standard (9.2%). This portion of the cell was observed to drain much more slowly during falling head.

Organic Matter Content (% by weight): 5.2

Percent passing #200 sieve: 6.5

Coefficient of Uniformity (Cu): 13.1

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Advance Outwash

Soil Description: Dense, moist, brown, fine to medium SAND, some silt, some gravel (SP-SM).

BUILT PER PLAN:

Water was observed entering the catch basin through leaky joints in the cement concrete structure. The flow rate was turned down to limit the water lost to leaks. Otherwise, the observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

Perched water was observed in HA-1 at 2.2' below ground surface. This location is closest to the inlet which receives most of the inflow and the water encountered is most likely a result of heavy rains in the days prior to the infiltration test. The temporary wellpoint was screened from 2.4-2.9' below ground surface and responded to testing after approximately 45 minutes and slowly rose to the same elevation as the surface water throughout the test.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): >8.4

Subgrade Soil Rate (in/hr): 8.4

The falling head rate was measured to be 10.9 in/hr at SG-1. The area surrounding HA-2 was observed to drain much more slowly than the rest of the cell though was not measured by a staff gauge. This slower rate is likely due to the elevated fines content in the bioretention soil measured from HA-2. The constant

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



head rate of 8.4 in/hr is presented as a composite average of the entire cell's infiltration capacity. The infiltration rate of the bioretention soil cannot be determined from our test results because the underlying deposits infiltrate water more slowly than the overlying bioretention soil. Therefore, the measured rate represents the infiltration rate of the native subgrade soils.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Other than the leaky catch basin, the cell was observed to be in generally working condition.

Field Conditions

| | | | |
|-----------------|---------------|------------------|---------------------|
| Weather | Cloudy | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.05" | Two Days Ago: 1.22" |
| Field Reps | Full Day: PEL | Half Day: CSI | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Arterial Road |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
 Cell: Rain Garden Swale DR10-9

Assessed On:
 September 29, 2023



Site Photo: IMG_6085.JPG



Site Photo: IMG_6094.JPG

Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 40% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments | |
| The cell has an overflow catch basin structure located on the south end. The overflow drains to a catch basin in the street and is dispersed through piles along the road. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



Inlets

| | |
|--|--|
| <p>IN-1</p> <p><input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 2'</p> <p>Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>IMG_6096.JPG</p> |
| <p>Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Minimal erosion and fines deposition around stream cobbles near inlet.</p> | <p>Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> |
| <p>Additional Details:</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



IN-2

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Width: 2'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



IMG_6097.JPG

Erosion Present? Yes No

Blockage Present? Yes No

Additional Details:


BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
 Cell: Rain Garden Swale DR10-9

Assessed On:
 September 29, 2023



Design Overflow/Outlet

| | |
|---|--|
| DO - 1 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 2.1' Width: 1.6' |
| Additional Details: | |
| Stickup (ft) From Ground: 1 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
|  | |
| IMG_6105.JPG | |

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|--------------------------------|--|--|------------------------------------|--|
| Cell Coverage | | | | | | |
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input checked="" type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input checked="" type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Cell is covered in grass and a thin layer of bark mulch | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | | <input checked="" type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | | <input checked="" type="checkbox"/> No | | | |
| Additional Details: | | | | | | |
| Vegetation Description | | | | | | |
| Leaf litter on the ground makes observing ponded area difficult. | | | | | | |
| Additional Details | | | | | | |
| Geotechnical Probe Observations: The probe depths from the center of the cell range from 1-2.5 feet. The shallowest probe depths were recorded in the center of the cell (1.0-1.6') near HA-2. The cell was measured to be approximately 15-18' wide and 115' long. Power lines located on the street side of the cell restricted probe measurements. | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
 Cell: Rain Garden Swale DR10-9

Assessed On:
 September 29, 2023



Hand Auger

| | |
|---|---|
| HA-3-WP | |
| <input type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input checked="" type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 2.2 |
| to Import/Underdrain: | |
| Total Depth: | 2.9 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, f-m SAND, some silt, trace gravel, fine organics and rootlets (SP-SM) Native Soil Texture: Dense, moist, brown, f-m SAND, some silt, some gravel (SP-SM); less-no organics | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details 0-0.2': Mulch/topsoil 0.2-2.2': BSM 2.2-2.9': Vashon Advance Outwash: probed an additional 2-3 inches after refusal No groundwater | |



SHAU_HA-3-WP.jpg

| | |
|---|---|
| HA-2 | |
| <input type="checkbox"/> Zone 1 <input checked="" type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.4 |
| to Import/Underdrain: | |
| Total Depth: | 1.4 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, f-m SAND, some silt, trace gravel, fine organics and rootlets (SP-SM) Native Soil Texture: Dense, moist, grayish-brown, silty, fine SAND, some gravel (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



| | |
|--|--|
| HA-2 | |
| Additional Details 0-0.2': Grass/Mulch 0.2-1.4': BSM 1.4': Native | |
| No groundwater encountered | |

| | |
|--|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 2.2 |
| to Import/Underdrain: | |
| Total Depth: | 2.2 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, f-m SAND, some silt, trace gravel, fine organics and rootlets (SP-SM) | |
| Native Soil Texture: Dense, moist, brown, silty, f-m SAND, some gravel (SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details 0-0.2': Grass/Mulch 0.2-2.2': BSM 2.2': Native: very moist-wet just above 2.2'; groundwater perched at 2.2'; refusal due to dense conditions | |

Infiltration Test

| | |
|--|--------|
| IT-1 | |
| Water Supply <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 369 |
| Ponded Depth (ft) | 0.54 |
| Total Gallons | 16,940 |
| Steady State Flow Rate (GPM) | 32 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



Additional Details:



IMG_6090.JPG

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: Aurora Ave (SHAU)
Cell: Rain Garden Swale DR10-9

Assessed On:
September 29, 2023



SITE: AURORA AVE (SHAU) CELL: RAIN GARDEN SWALE DR10-9





associated
earth sciences
incorporated

Well Point

SHAU-HA-3-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/29/23

Logged By: PEL

20150387H008

Ending Date: 9/29/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.9

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.9

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 103.2

Water Level Elevation (ft): N/A

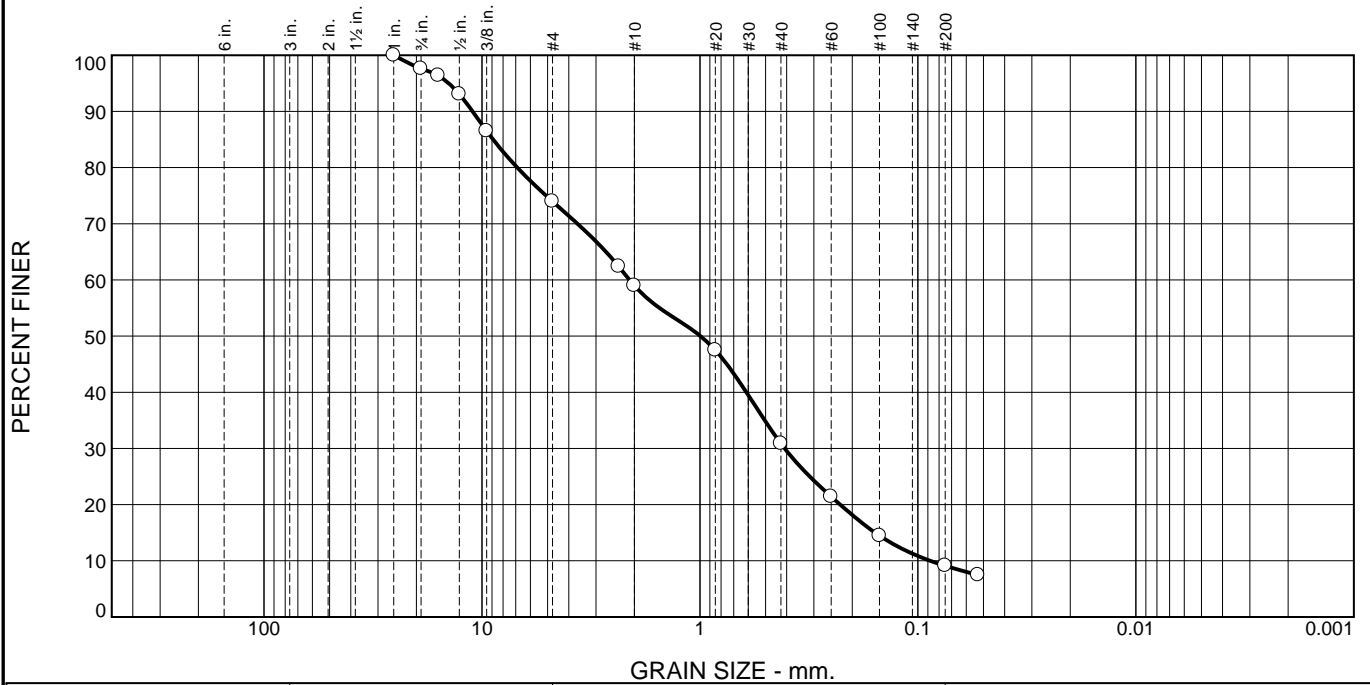
Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | <p>Mulch Topsoil, natural mulch, grass leaves.</p> | | | | | | | <p>Stickup -3.2 to 0 feet Existing bioretention soil 0 to 0.2 feet 3/8-inch Bentonite chips 0.2 to 1 feet 1.25-inch I.D. threaded galvanized steel casing -3.2 to 1.7 feet; duct tape covers screen 1.7 to 2.4 feet Medium grain filter sand 1 to 2.9 feet</p> |
| 1 | | | | <p>Bioretention Soil Mix Loose, moist, dark brown, fine to medium SAND, trace silt, trace gravel; abundant fine organics and rootlets (SP-SM).</p> | | | | | | | |
| 2 | | | | <p>Vashon Advance Outwash Dense, moist, brown, fine to medium SAND, some silt, some gravel; less to no organics; occasional small roots; probed additional 2 to 3 inches (SP-SM).</p> | | | | | | | |
| 3 | | | | <p>No seepage. No caving Refusal due to gravel. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report.</p> | | | | | | | <p>1.25-inch I.D. Stainless steel jacket over stainless steel #60 gauze welded to perforated steel 2.4 to 2.9 feet Cast iron endcap 2.9 to 3.2 feet Cast iron drivepoint 3.2 to 3.5 feet</p> |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

20150387H008 1/24/2024

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 2.4 | 23.6 | 15.0 | 28.1 | 21.8 | 9.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 97.6 | | |
| 5/8" | 96.4 | | |
| 1/2" | 93.1 | | |
| 3/8" | 86.5 | | |
| #4 | 74.0 | | |
| #8 | 62.4 | | |
| #10 | 59.0 | | |
| #20 | 47.5 | | |
| #40 | 30.9 | | |
| #60 | 21.4 | | |
| #100 | 14.5 | | |
| #200 | 9.1 | | |
| #270 | 7.5 | | |

Material Description
gravelly SAND some silt

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 11.0376 D₈₅= 8.8901 D₆₀= 2.1046
 D₅₀= 0.9949 D₃₀= 0.4087 D₁₅= 0.1572
 D₁₀= 0.0878 C_u= 23.97 C_c= 0.90

Remarks

Date Received: 9-29-2023 Date Tested: 10-26-2023

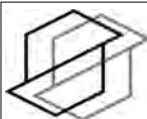
Tested By: FEW

Checked By: JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-SHAU Date Sampled: 9-29-2023
 Sample Number: HA-2 Depth: 0.2-0.6'



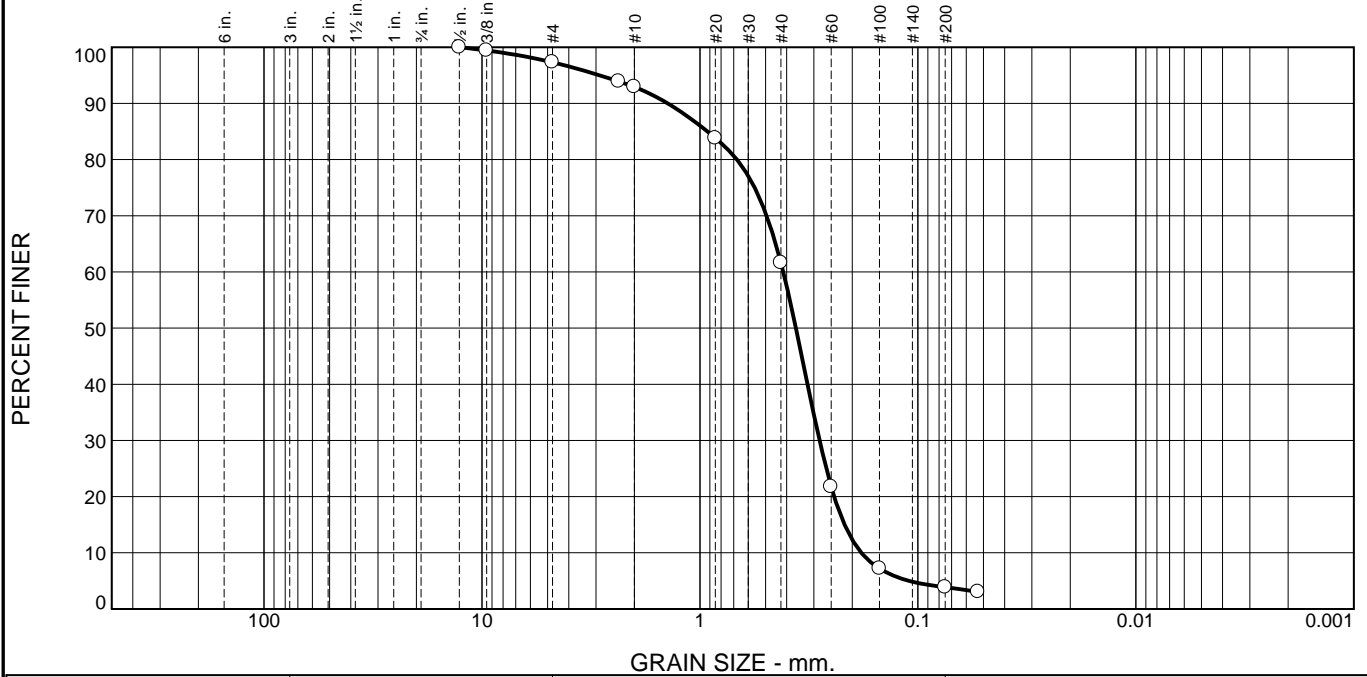
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 2.7 | 4.4 | 31.3 | 57.7 | 3.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.4 | | |
| #4 | 97.3 | | |
| #8 | 93.9 | | |
| #10 | 92.9 | | |
| #20 | 83.8 | | |
| #40 | 61.6 | | |
| #60 | 21.8 | | |
| #100 | 7.2 | | |
| #200 | 3.9 | | |
| #270 | 3.1 | | |

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-3

Coefficients

D₉₀= 1.4052 D₈₅= 0.9244 D₆₀= 0.4147
 D₅₀= 0.3628 D₃₀= 0.2826 D₁₅= 0.2170
 D₁₀= 0.1820 C_u= 2.28 C_c= 1.06

Remarks

Date Received: 9-29-2023 Date Tested: 11-16-2023

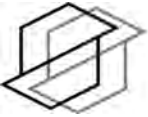
Tested By: FEW

Checked By: CSI/JHS

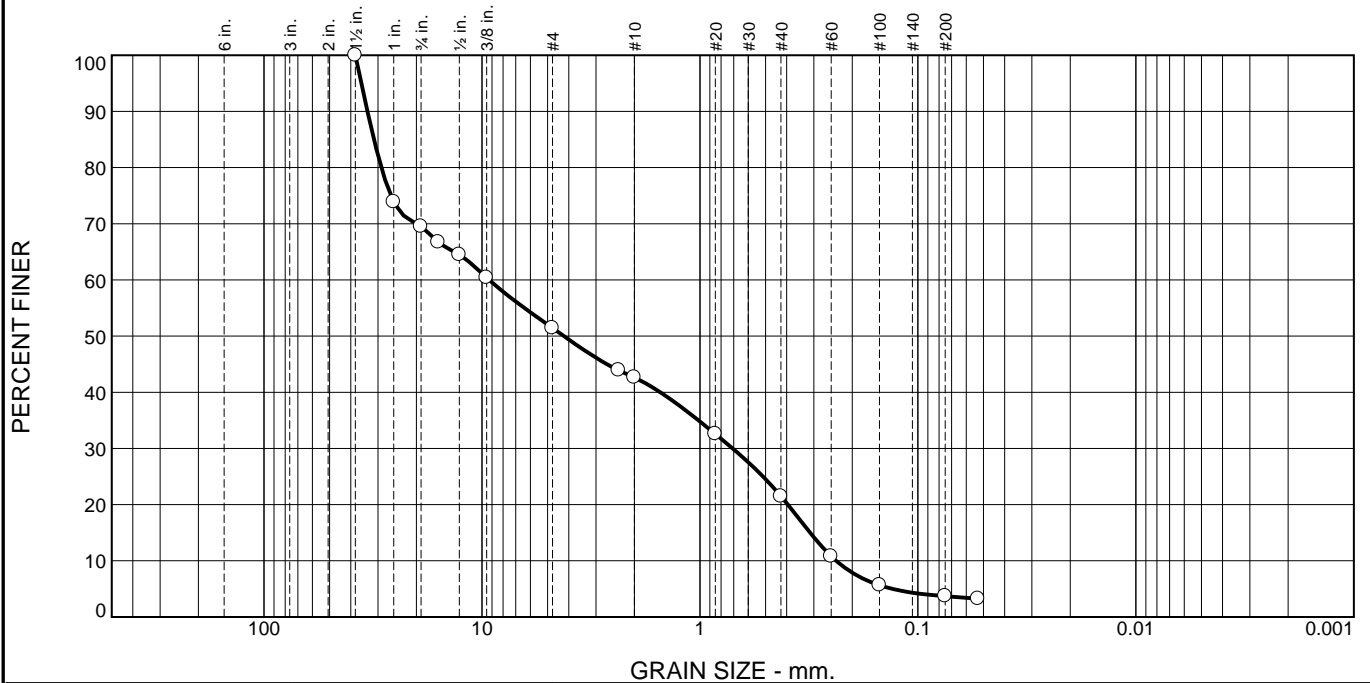
Title: _____

* (no specification provided)

Location: Onsite - BHPS-SHAU Date Sampled: 9-29-2023
 Sample Number: HA-3 Depth: 0.2-1'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 |
|---|--|--|

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 30.5 | 18.0 | 8.9 | 21.1 | 17.8 | 3.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.50" | 100.0 | | |
| 1" | 73.9 | | |
| 3/4" | 69.5 | | |
| 5/8" | 66.7 | | |
| 1/2" | 64.5 | | |
| 3/8" | 60.4 | | |
| #4 | 51.5 | | |
| #8 | 43.9 | | |
| #10 | 42.6 | | |
| #20 | 32.6 | | |
| #40 | 21.5 | | |
| #60 | 10.8 | | |
| #100 | 5.7 | | |
| #200 | 3.7 | | |
| #270 | 3.2 | | |

* (no specification provided)

Material Description

very sandy GRAVEL trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GP AASHTO (M 145)= A-1-a

Coefficients

| | | |
|---------------------------|---------------------------|--------------------------|
| D ₉₀ = 33.5453 | D ₈₅ = 31.3097 | D ₆₀ = 9.2716 |
| D ₅₀ = 4.2069 | D ₃₀ = 0.7082 | D ₁₅ = 0.3122 |
| D ₁₀ = 0.2373 | C _u = 39.08 | C _c = 0.23 |

Remarks

Date Received: 9-29-2023 Date Tested: 10-30-2023

Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - BHPS-SHAU
 Sample Number: HA-3

Depth: 2.2-2.9'

Date Sampled: 9-29-2023

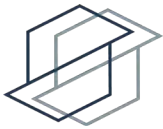


a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 9/29/2023 | Project BHPS-SHAU | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Shoreline, WA | EB/EP No. SHAU-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ 0.2-0.6' | HA-3 @ 0.2-1' |
|--------------------|-----------------|---------------|
| Wet Weight + Pan | 1145.75 | 905.07 |
| Dry Weight + Pan | 1068.53 | 861.91 |
| Weight of Pan | 391.96 | 247.51 |
| Weight of Moisture | 77.22 | 43.16 |
| Dry Weight of Soil | 676.57 | 614.40 |
| % Moisture | 11.41 | 7.02 |

Organic Matter and Ash Content

| | | |
|-------------------------------|---------|--------|
| Dry Soil Before Burn + Pan | 1068.53 | 861.91 |
| Dry Soil After Burn + Pan | 1023.13 | 839.66 |
| Weight of Pan | 391.96 | 247.51 |
| Wt. Loss Due to Ignition | 45.40 | 22.25 |
| Actual Wt. Of Soil After Burn | 631.17 | 592.15 |
| % Organics | 6.71 | 3.62 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------|--------------------------------|--|
| Project Name: | Aurora Avenue | Water Source: | Hydrant |
| Project Number: | 20150387 H008 | Meter: | FM-6 (10-100) |
| Date: | 9/29/2023 | Wetted Area (sq. feet): | 11:15: 362.5ft ² / 15:50: 369 ft ² |
| Weather: | Overcast, | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.54 |
| Performed By: | PEL/CSI | Receptor Soils: | Vashon Advance Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|---|
| 9:00 | 92.4 | | | | Water on |
| 9:02 | 92.3 | | | 157 | |
| 9:07 | 90.7 | | | 614 | |
| 9:15 | 91 | 0.12 | | 1,362 | |
| 9:30 | 83.48 | 0.26 | | 2,584 | Adjust flow - leakage into catch basin through joints |
| 9:45 | 90.46 | 0.52 | | 3,924 | |
| 9:50 | 40.2 | 0.58 | | 4,364 | Decrease flow to 40 gpm |
| 10:00 | 40.4 | 0.5 | 3.72 | 4,786 | |
| 10:15 | 40.1 | 0.46 | | 5,392 | Leakage in basin reduced to 1-2 gpm |
| 10:30 | 40.1 | 0.46 | 3.28 | 5,998 | |
| 10:45 | 39.6 | 0.48 | | 6,591 | |
| 11:00 | 39.8 | 0.52 | 3.12 | 7,187 | |
| 11:15 | 39.6 | 0.54 | | 7,786 | |
| 11:30 | 30.6 | 0.56 | 3.09 | 8,370 | Decrease flow |
| 11:45 | 30.2 | 0.5 | | 8,832 | |
| 12:00 | 30.1 | 0.48 | 3.08 | 9,279 | |
| 12:15 | 30 | 0.46 | | 9,729 | |
| 12:30 | 29.9 | 0.46 | 3.07 | 10,180 | Increase flow |
| 12:45 | 32.3 | 0.48 | | 10,660 | |
| 13:00 | 32.3 | 0.48 | 3.02 | 11,149 | |
| 13:15 | 32.1 | 0.5 | | 11,629 | |
| 13:30 | 31.9 | 0.5 | 3.02 | 12,110 | |
| 13:45 | 32 | 0.5 | | 12,593 | |
| 14:00 | 31.9 | 0.5 | 3.01 | 13,067 | |
| 14:15 | 31.6 | 0.5 | | 13,557 | |
| 14:30 | 31.6 | 0.52 | 3.01 | 14,020 | |
| 14:45 | 34.1 | 0.54 | | 14,509 | |
| 15:00 | 32.2 | 0.54 | 2.98 | 15,001 | |
| 15:10 | 32.2 | 0.54 | | 15,314 | |
| 15:20 | 32.4 | 0.54 | 2.98 | 15,640 | |
| 15:30 | 32.5 | 0.54 | | 15,963 | |
| 15:40 | 32.4 | 0.54 | 2.95 | 16,288 | |
| 15:50 | 32.7 | 0.54 | | 16,622 | |
| 16:00 | 32.5 | 0.54 | | 16,940 | Water off - falling head |
| 16:02 | | 0.52 | | | |
| 16:04 | | 0.5 | 2.96 | | Slight leakage in basin continues 1-2 gpm |

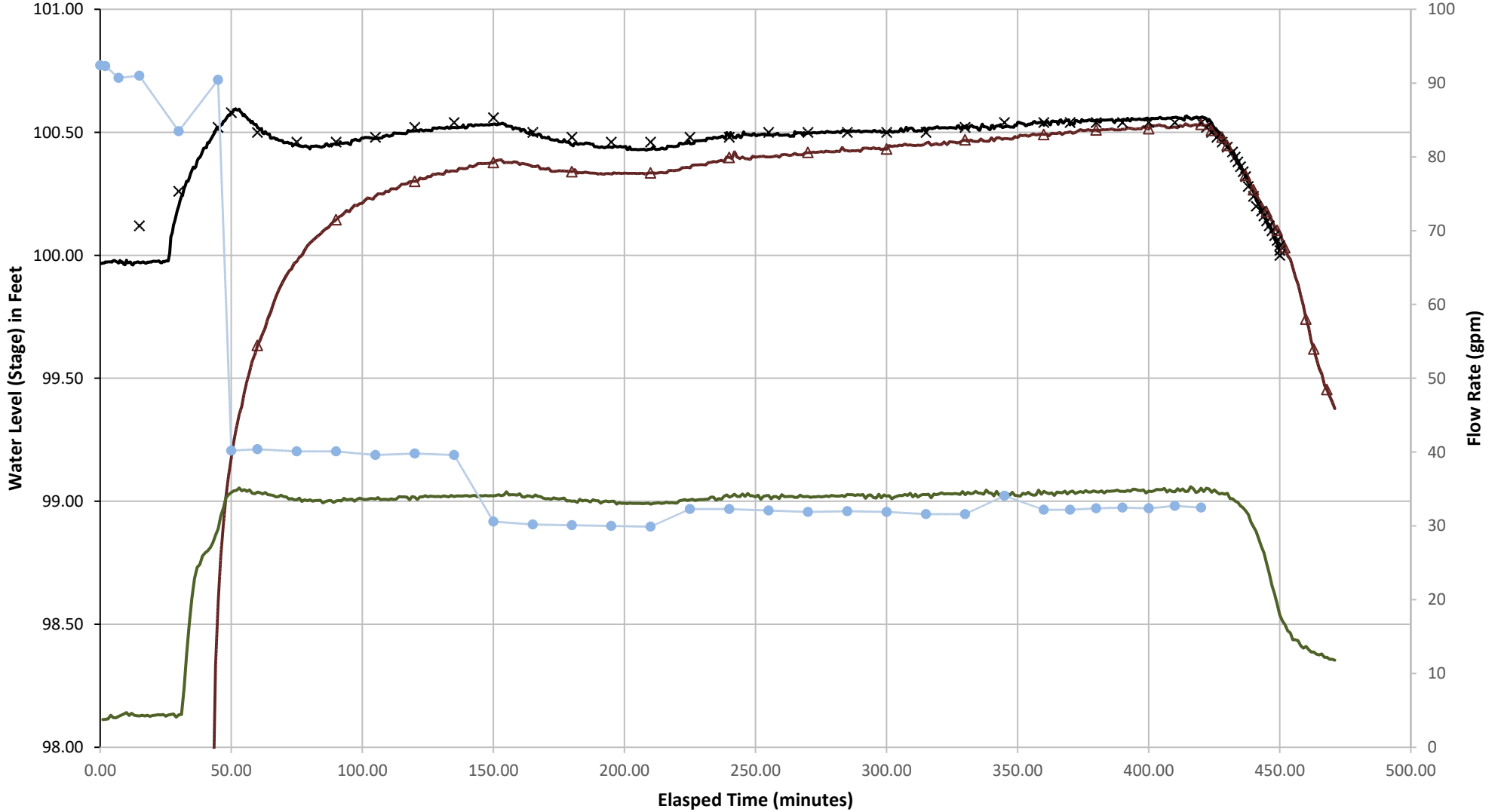
| | | | | | |
|-------|--|------|------|--|--|
| 16:06 | | 0.48 | | | |
| 16:08 | | 0.46 | 2.98 | | |
| 16:10 | | 0.44 | 3 | | |
| 16:12 | | 0.42 | | | |
| 16:13 | | 0.4 | | | |
| 16:14 | | 0.38 | | | |
| 16:15 | | 0.36 | | | |
| 16:16 | | 0.34 | | | |
| 16:17 | | 0.32 | 3.14 | | Basin leakage continues |
| 16:18 | | 0.28 | | | |
| 16:20 | | 0.24 | 3.2 | | |
| 16:21 | | 0.2 | | | |
| 16:23 | | 0.18 | | | |
| 16:24 | | 0.16 | | | |
| 16:25 | | 0.14 | 3.29 | | |
| 16:26 | | 0.12 | | | |
| 16:27 | | 0.1 | | | |
| 16:28 | | 0.08 | | | |
| 16:29 | | 0.06 | 3.36 | | |
| 16:30 | | 0.04 | | | |
| 16:31 | | 0.02 | | | |
| 16:32 | | 0 | 3.48 | | End of falling head; approx. 0.2' of water remaining in upper portion of cell near diffuser and splash pad |
| 16:40 | | | 3.65 | | |
| 16:43 | | | 3.88 | | |
| 16:48 | | | 4 | | |
| 16:55 | | | | | Upper portion of cell is dry |

| | |
|--|------|
| SG Average Infiltration Rate (in/hr) during last hour of inflow: | 8.4 |
| SG Average Infiltration Rate (in/hr) during falling head: | 10.9 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 7.8 |
| WP Average Infiltration Rate (in/hr) during falling head: | 24.3 |

Aurora Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- △ Wellpoint Hand
- Catch Basin Logger
- Staff Gauge #1 Logger
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
Cell: Dunn Residence

Assessed On:
September 25, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2004 and collects runoff from the adjacent residential roadway. The cell is constructed with 1' of bioretention soil above a 1' sand lens which fills the full width of the cell. Beneath the sand lens sits a 1.5' wide pea gravel underdrain trench which contains the 8" perforated underdrain pipe. Water is designed to infiltrate through the soil and sand lens before entering the underdrain and entering the storm drain network.

BIORETENTION SOIL:

Thickness: 0.7-0.8'

The apparent thickness of the bioretention soils ranged from 0.7-0.8' below ground surface before encountering the sand lens. This is slightly less than the 1' specified by the plans. No bioretention soil was encountered in HA-1, possibly due to reworking by homeowners due to slower than desired drainage.

Composition: The plans call for Hydrological Group B soils as the bioretention soil mix. In comparison to the 2019 Ecology specifications, the tested material found a wide range of soil results. On average, the tested soil's sand gradation and silt content greatly exceeded the standard, while the organic content fell below the standard.

Organic Matter Content (% by weight): 4.6

Percent passing #200 sieve: 27.2

Coefficient of Uniformity (Cu): 15.3

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Recent Alluvium

Soil Description: Loose, very moist, brownish gray, sandy, SILT (SM).

BUILT PER PLAN:

Communications with the homeowners indicate that significant modifications were performed to the tested cell due to undesirable standing water in the cell base. Modifications included widening the driveway to the home as well as installing potholes within the bioretention cell filled with sand to increase the infiltration rate. Additionally, Hydrologic Group B soils were only encountered in HA-3 which was situated directly above the underdrain pipe, HA-1-WP and HA-2 encountered fill/reworked native sediments. The Hydrologic Group B soils were designed to be placed across the entire cell base.

GROUNDWATER CONDITIONS:

Groundwater was encountered at 2.7' below ground surface. The temporary wellpoint was screened from 4.2-4.7' below ground surface outside the underdrain gravels in alluvial deposits and responded to testing after approximately 45 minutes. The water level in the wellpoint rose to a maximum elevation of 1.65' below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 5.2

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
Cell: Dunn Residence

Assessed On:
September 25, 2023



Subgrade Soil Rate (in/hr): N/A

Due to the response to testing from the temporary wellpoint, it is clear that not all the water conveyed to the cell entered the underdrain. However, a subgrade soil rate cannot be calculated due to the partial conveyance of water to the underdrain.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Maintenance efforts by the homeowner nearly completely disguise the cell as anything other than part of the adjacent lawn. The cell is covered completely with grasses and is mowed in the same manner as the rest of the homeowner's front yard.

Field Conditions

| | | | |
|-----------------|---------------|------------------|---------------------|
| Weather | Rain | | |
| Recent Rainfall | Today: 0.33" | Yesterday: 0.57" | Two Days Ago: 0.32" |
| Field Reps | Full Day: PEL | Half Day: CSI | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
 Cell: Dunn Residence

Assessed On:
 September 25, 2023



Site Photo: FA_SitePhotos-20230925-171613.jpg



Cell Construction

| | |
|--|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation along street near CB-South |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Pipe Diameter: 8' Full Width Width 1.5' 8in perforated pvc bedded in pea gravel |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Potentially modified drainage by neighbor to the south. Residents informed AESI that the swale used to flood until the southern neighbor made modifications approximately 2 years ago. Modifications included drainage improvements while widening the driveway as well as small diameter potholes within the bio-cell which he backfilled with sand to increase surface water infiltration rates. | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
 Cell: Dunn Residence


Assessed On:
 September 25, 2023



Inlets

| | | |
|---|---|--|
| IN-1 <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 75' Energy Dissipation Angular Rock: n/a Stream Cobble: Functioning Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230925-172106.jpg</p> |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Minor erosion around cobbles near catch basins Additional Details: Stream cobbles around catch basins | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

Design Overflow/Outlet

| | | |
|---|--|--|
| DO - 1 Shape: <input type="checkbox"/> Round Dimensions: <input checked="" type="checkbox"/> Rectangular Length: 2' <input type="checkbox"/> Other Width: 1.7' Additional Details: Stickup (ft) From Ground: 0.3 Relative from staff gauge: Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |  <p>FA_DOPhoto-20230925-172243.jpg</p> |
|---|--|--|

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
 Cell: Dunn Residence

Assessed On:
 September 25, 2023



| | |
|---|--|
| DO - 2 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.7' Width: 1.4' |
| Additional Details: | |
| Stickup (ft) From Ground: 0 Relative from staff gauge: | |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| | |
| FA_DOPhoto-20230925-172536.jpg | |

Cell Surface and Geotech Probe Observations

| | | | | | |
|--|--|---|-------------------------------------|---------------------------------------|---|
| S1A Mulch: | <input checked="" type="checkbox"/> None | <input type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S1B Mulch: | <input checked="" type="checkbox"/> None | <input type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S1C Mulch: | <input checked="" type="checkbox"/> None | <input type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S2 Mulch: | <input checked="" type="checkbox"/> None | <input type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| S3 Mulch: | <input checked="" type="checkbox"/> None | <input type="checkbox"/> Shredded Mulch | <input type="checkbox"/> Fine Mulch | <input type="checkbox"/> Coarse Mulch | Depth(ft): |
| Cell Coverage | | | | | |
| Mulch | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% |
| Cell covered in approximately 0.2' of grass and topsoil. No bare ground. | | | | | |
| Pest Evidence | | | | | |
| Animal Burrows | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Large Deposition of Feces | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | |
| Additional Details: No pest evidence. Grass is well maintained | | | | | |
| Vegetation Description | | | | | |
| Cell is covered in grass approximately 0.2' deep. Grass is well maintained. Taller grass hinders observation of ponded area. | | | | | |
| Additional Details | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
 Cell: Dunn Residence

Assessed On:
 September 25, 2023



Geotechnical Probe Observations: Probe depths from the center of the cell range from 0.5-1.3 feet. The shallowest depths were measured in the center of the cell (0.5-0.75'). The cell was measured to be approximately 13' wide and approximately 75' long. No zones of excessive compaction or erosion were observed.

Hand Auger

| | |
|--|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | |
| to Native Soil: | 1.3 |
| to Import/Underdrain: | 1.3 |
| Total Depth: | 4.7 |
| Rain/Garden Mix Soil Texture: Reworked alluvium: Loose, v. moist, brown sandy silt-SILT, some sand, trace gravel, abundant organics, scattered orange oxidation, lavender hue at base (SM) Native Soil Texture: Loose, very moist, brownish-gray, sandy SILT (SM) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Depth to water from TOC (ft): 4.53 | |
| Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): 1.65 | |
| Additional Details | |
| 0-0.2': Grass | |
| 0.2': fine plastic mesh | |
| 0.2-1.3': Fill (reworked alluvium?) | |
| 1.3-4.7': Recent Alluvium | |
| WP stickup=0.7'. Potential surface water influence in well point from pooling water. Possibly poor surface seal. | |
| Groundwater encountered at 2.7' | |



IMG_6038.JPG


| | |
|--|-----|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 2 |
| to Import/Underdrain: | 0.7 |
| Total Depth: | 2.6 |
| Rain/Garden Mix Soil Texture: Loose, moist, brown, silty f-m SAND, some angular gravel, abundant fine roots (SP-SM) Native Soil Texture: medium dense, wet, dark-gray silty fine SAND, some dark orangeish-brown oxidation (SM) | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
 Cell: Dunn Residence

Assessed On:
 September 25, 2023



| | |
|---|---|
| HA-2 | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
|  | |
| IMG_6042.JPG | |
| <p>Additional Details</p> <p>0-0.2': Topsoil</p> <p>0.2-0.7': Hydrologic soil group B</p> <p>0.7-2': Fill (reworked alluvium?): Loose, v moist, brown sandy SILT with occasional orangeish-brown oxidation (ML)</p> <p>2-2.6': Recent alluvium</p> <p>Groundwater encountered at 2.4'</p> | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.3 |
| to Import/Underdrain: | 0.8 |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Loose, moist-very moist, dark brown, silty f-m SAND, some gravel, abundant organics (SP) Native Soil Texture: [Sand Lens] Loose, very moist, f-m SAND, some gravel | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
|  | |
| IMG_6033.JPG | |
| <p>Additional Details</p> <p>0-0.2: grass</p> <p>0.2-0.8: Hydrologic soil group B</p> <p>0.8-1.3: Sand Lens</p> <p>1.3-1.7: Pea gravel; probed down another 0.2' and encountered a pipe</p> | |

Infiltration Test

| |
|------|
| IT-1 |
|------|

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)
Cell: Dunn Residence

Assessed On:
September 25, 2023



| | |
|--|--------|
| Water Supply | |
| <input checked="" type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-6 (10-100) | |
| Wetted Pond Area (sq. ft) | 491 |
| Ponded Depth (ft) | 0.4 |
| Total Gallons | 11,021 |
| Steady State Flow Rate (GPM) | 26.7 |
| Additional Details: | |
| Wetted area began at 550 square feet due to high flow but was decreased to 491 square feet at the steady state of the test. Some water did seep into the catch basin on the downstream end of the cell through the spacers below the overflow grate, estimated rate of flow directly into the basin was less than 1gpm | |



IMG_6057.JPG

Additional Comments

The under drain for the cell did not appear to run parallel along the lowest point within the cell, which may have caused lower rates. The lowest part of the cell was further away from the curb and curved, while the under drain, based on CB locations and drawings, runs straight along the curb line. Additional information gained from the homeowners shows that some modifications to the cell may have been made to improve infiltration rates and to avoid pooling and/or flooding of the cell during severe rain events. Some surface flow was observed from the test into the catch basin but was estimated to be less than 1 gpm. Sediments matching those shown on the asbuilts provided to us for the cell were only observed in HA-3, which was situated directly over the pipe. The remaining (HA-1-WP and HA-2) excavations generally encountered sediments which appeared consistent with existing fill.

BIORETENTION CELL FIELD ASSESSMENT

Site: Dunn Residence (SMDR)

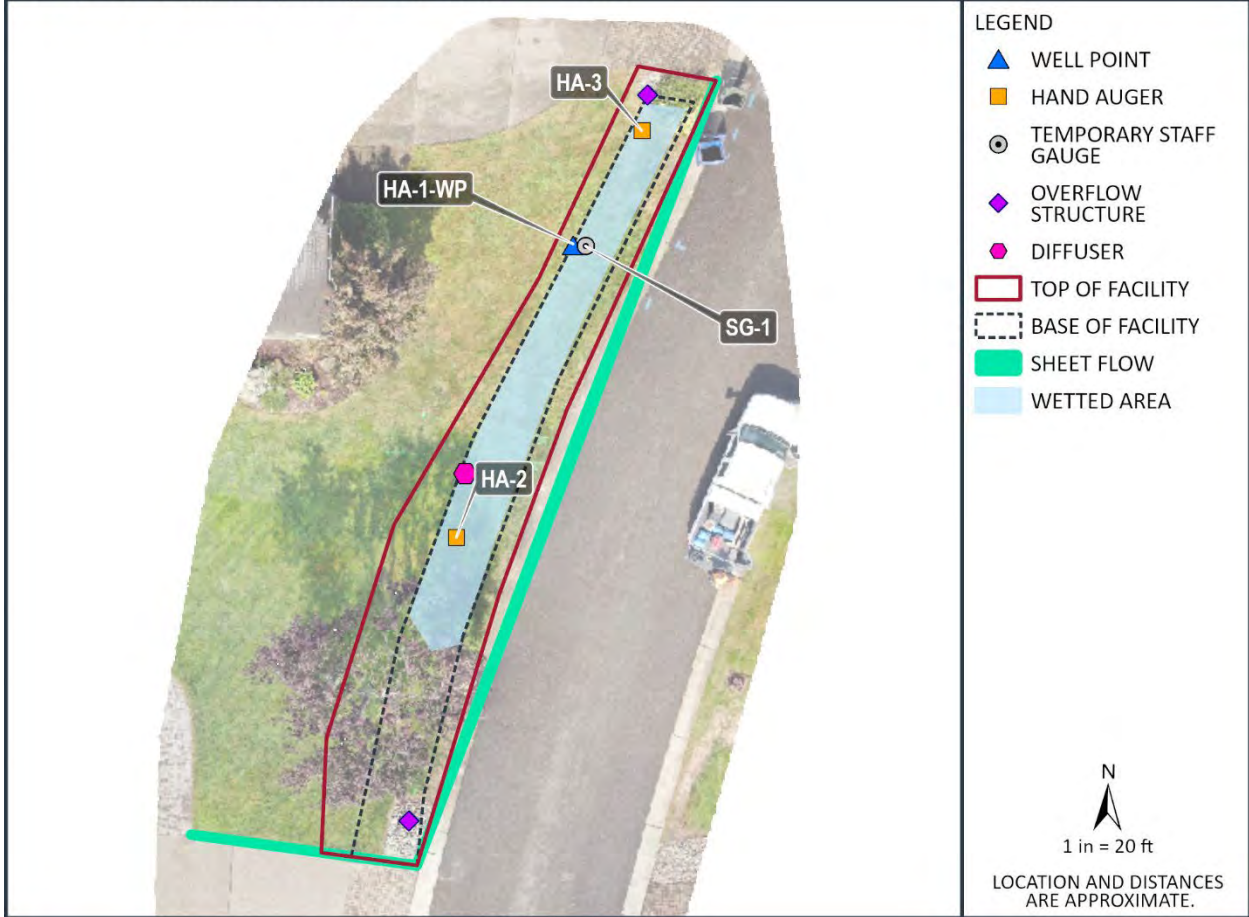
Cell: Dunn Residence

Assessed On:

September 25, 2023



SITE: DUNN RESIDENCE (SMDR) CELL: DUNN RESIDENCE





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Well Point

SMDR-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/25/23

Logged By: PEL

20150387H008

Ending Date: 9/25/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 4.7

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 4.7

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 100.7

Water Level Elevation (ft): N/A

Datum: Project Datum

▼ Groundwater Depth ATD (ft): 2.7

▽ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Grass/Topsoil Grass, topsoil, sod, fine plastic mesh at 0.2 feet. | | | | | | | Stick up -0.7 to 0 feet |
| 0.2 | | | | Fill (Reworked Alluvium?) Loose, very moist, brown with scattered orange oxidation, very silty, fine to medium SAND, trace gravel; fine organics and rootlets (SM). Becomes brownish gray with slight lavender hue. | | | | | | | Onsite grass and topsoil plug 0 to 0.2 feet Onsite soils 0.2 to 2 feet |
| 2 | | | | Recent Alluvium Loose, very moist, brownish gray, sandy, SILT (SM). Loose, very moist to wet, dark gray with occasional orangish brown oxidation, silty, very fine SAND; small rootlets; fine organics (SM). Loose, wet, gray to dark gray, clayey, sandy, SILT; moderate cohesion (ML). Hand Auger became very smooth. | | | | | | | 1.25-inch I.D. threaded galvanized steel casing -0.7 to 3.4 feet; duct tape covers screen 3.4 to 4.2 feet Medium grain silica filter sand 2 to 4.7 feet |
| 3 | | | | As above; transitioning to very wet; increase in organic content; dark brown to black, woody organics. | | | | | | | |
| 5 | | | | No seepage. Groundwater encountered at 2.7 feet. Refusal at rocks. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | 1.25-inch I.D. Stainless steel jacket over stainless steel #60 gauze welded to perforated steel 4.2 to 4.7 feet Cast iron endcap 4.7 to 5 feet Cast iron drivepoint 5 to 5.3 feet |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

12/15/2023

20150387H008



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Exploration Boring

SMDR-HA-2

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 9/25/23

Logged By: SNCF

20150387H008

Ending Date: 9/25/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.6

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): 2.4

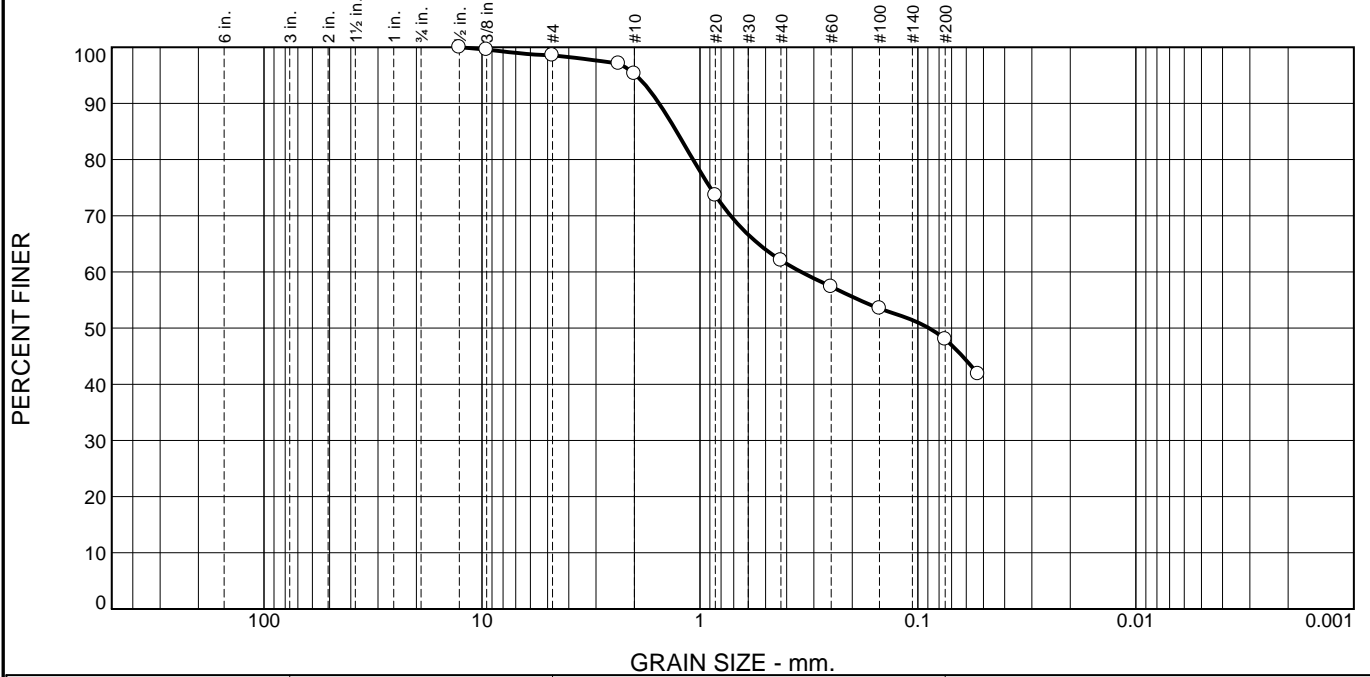
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests | |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|--|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | | |
| 0 | | | | | Grass/Topsoil Grass, topsoil, sod, fine plastic mesh at base | | | | | | | | | |
| 0 | | | | | Hydrologic Soil Group B Loose, moist, dark brown, very silty, gravelly (angular), fine SAND; abundant fine rootlets (SM). | | | | | | | | | |
| 1 | | | | | Fill (Reworked Alluvium) Loose, very moist, brown to dark brown with occasional orangish brown oxidation, sandy, SILT (SM). Loose, very moist, grayish brown with some orangish brown oxidation, sandy, SILT, some rootlets (ML). | | | | | | | | | |
| 2 | | | | | Recent Alluvium Medium dense, wet, dark gray and dark orangish brown, silty, fine SAND (SM). | ▼ | | | | | | | | |
| 3 | | | | | Groundwater encountered at 2.4 feet. No caving. Refusal due to groundwater. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |

12/15/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.4 | 3.3 | 33.2 | 14.1 | 48.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.6 | | |
| #4 | 98.6 | | |
| #8 | 97.1 | | |
| #10 | 95.3 | | |
| #20 | 73.6 | | |
| #40 | 62.1 | | |
| #60 | 57.4 | | |
| #100 | 53.5 | | |
| #200 | 48.0 | | |
| #270 | 41.9 | | |

Material Description
very silty SAND trace gravel

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SM AASHTO (M 145)= A-4(0)

Coefficients
 D₉₀= 1.5405 D₈₅= 1.2794 D₆₀= 0.3434
 D₅₀= 0.0888 D₃₀= D₁₅=
 D₁₀= C_u= C_c=

Remarks

Date Received: 8-25-2023 Date Tested: 11-15-2023

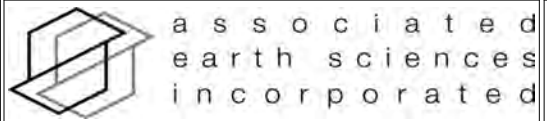
Tested By: FEW

Checked By: CSI/JHS

Title: _____

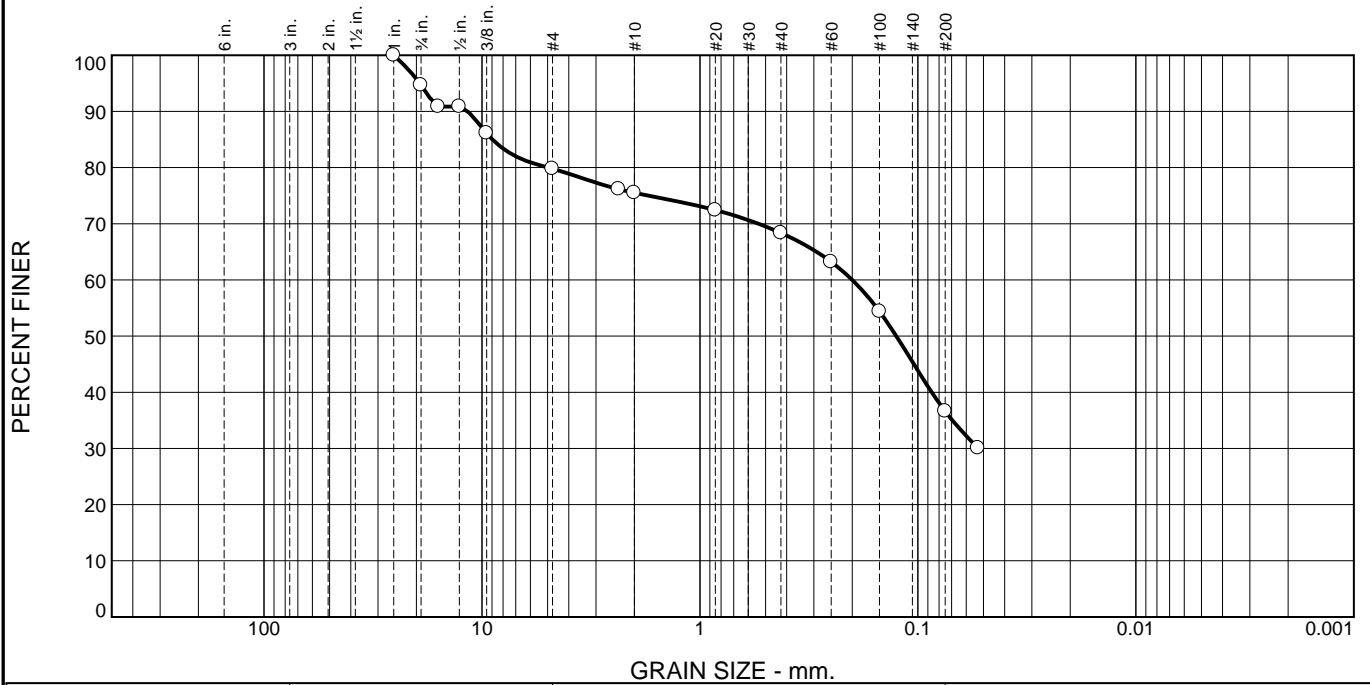
* (no specification provided)

Location: Onsite - BHPS-SMDR Date Sampled: 8-25-2023
 Sample Number: HA-1 Depth: 0.2-0.9'



Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study
 Project No: 20150387 H008 Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.3 | 14.9 | 4.3 | 7.1 | 31.8 | 36.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 94.7 | | |
| 5/8" | 90.9 | | |
| 1/2" | 90.9 | | |
| 3/8" | 86.1 | | |
| #4 | 79.8 | | |
| #8 | 76.2 | | |
| #10 | 75.5 | | |
| #20 | 72.4 | | |
| #40 | 68.4 | | |
| #60 | 63.2 | | |
| #100 | 54.4 | | |
| #200 | 36.6 | | |
| #270 | 30.1 | | |

* (no specification provided)

Material Description

very silty gravelly SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-4(0)

Coefficients

D₉₀= 11.6267 D₈₅= 8.9541 D₆₀= 0.2000
D₅₀= 0.1256 D₃₀= D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8-25-2023 Date Tested: 11-15-2023

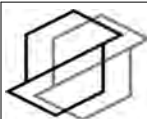
Tested By: FEW

Checked By: CSI/JHS

Title: _____

Location: Onsite - BHPS-SMDR
Sample Number: HA-2 **Depth:** 0.2-0.7'

Date Sampled: 8-25-2023



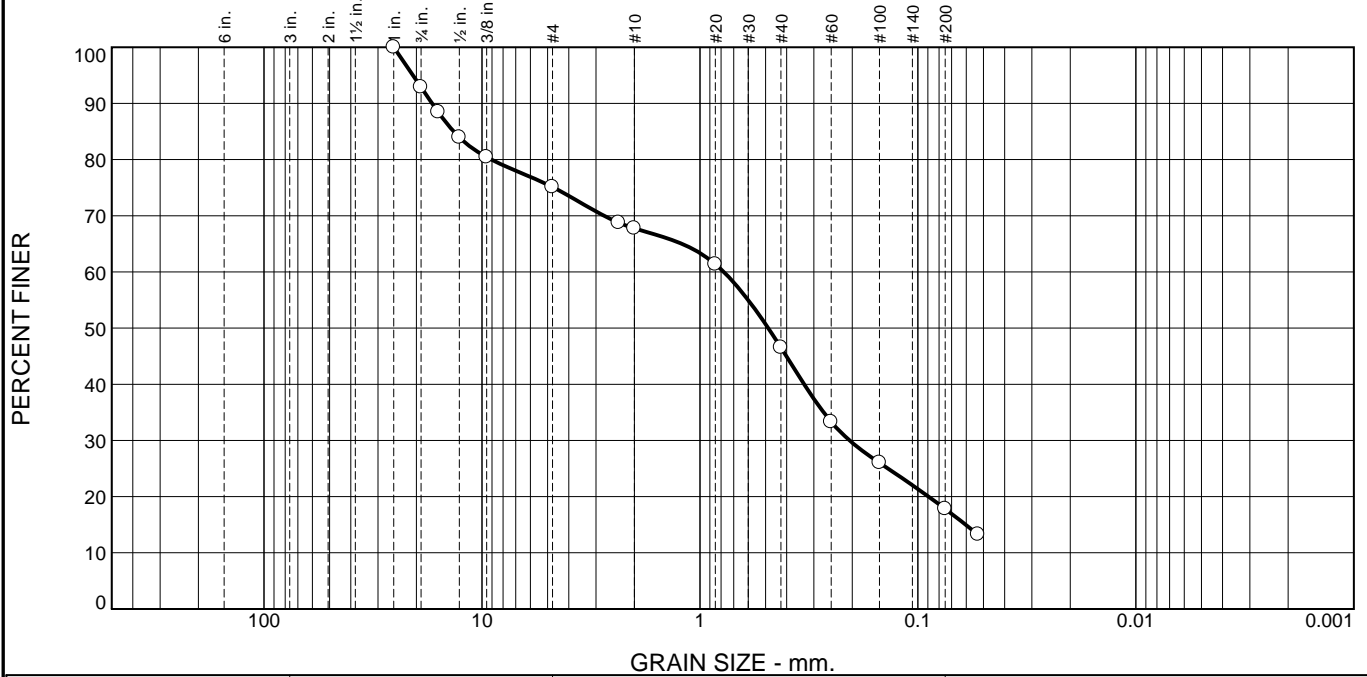
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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 7.1 | 17.8 | 7.3 | 21.3 | 28.7 | 17.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 92.9 | | |
| 5/8" | 88.4 | | |
| 1/2" | 83.9 | | |
| 3/8" | 80.5 | | |
| #4 | 75.1 | | |
| #8 | 68.8 | | |
| #10 | 67.8 | | |
| #20 | 61.4 | | |
| #40 | 46.5 | | |
| #60 | 33.3 | | |
| #100 | 26.0 | | |
| #200 | 17.8 | | |
| #270 | 13.2 | | |

Material Description
gravelly silty SAND

Atterberg Limits (ASTM D 4318)
 PL= NP LL= NV PI=

Classification
 USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients
 D₉₀= 16.9465 D₈₅= 13.4880 D₆₀= 0.7775
 D₅₀= 0.4863 D₃₀= 0.2059 D₁₅= 0.0604
 D₁₀= C_u= C_c=

Remarks

Date Received: 8-25-2023 Date Tested: 11-15-2023

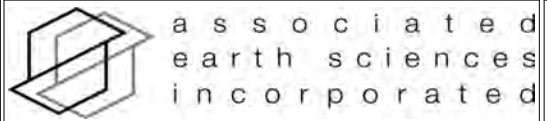
Tested By: FEW

Checked By: CSI/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-SMDR Date Sampled: 8-25-2023
 Sample Number: HA-3 Depth: 0.2-0.8'

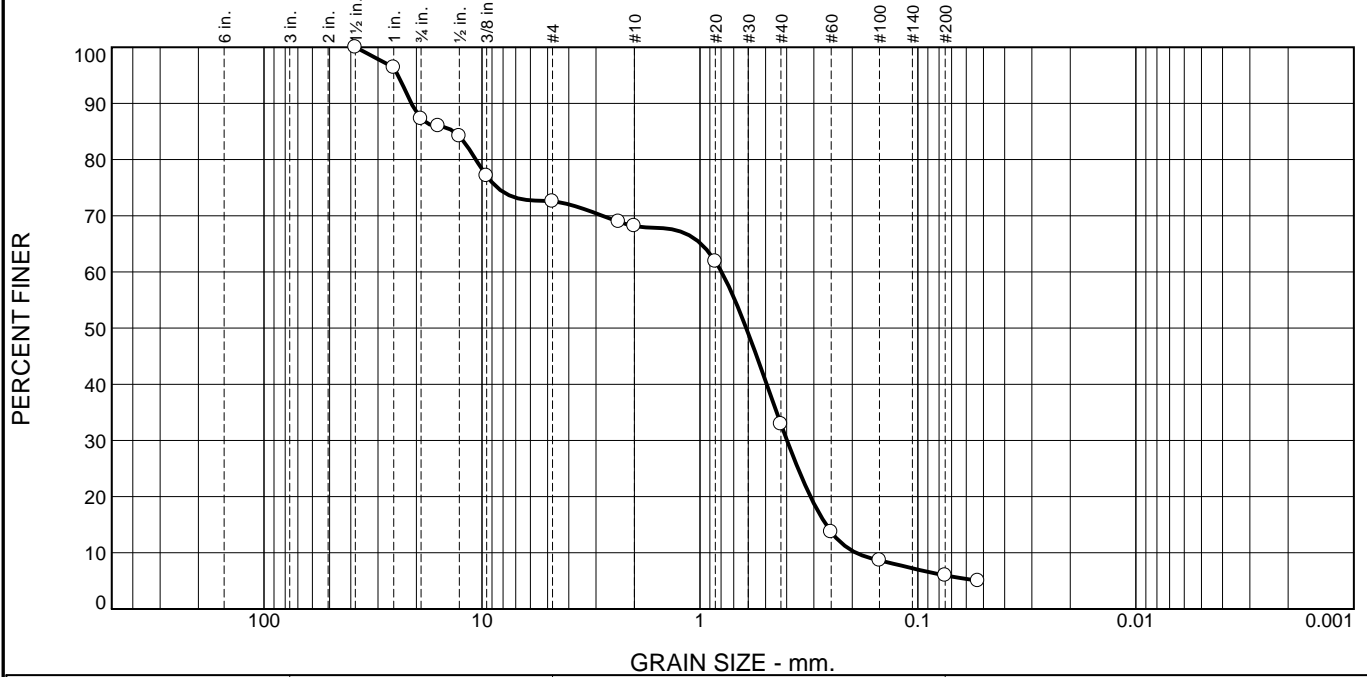


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 12.7 | 14.7 | 4.4 | 35.3 | 26.9 | 6.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 96.4 | | |
| 3/4" | 87.3 | | |
| 5/8" | 86.0 | | |
| 1/2" | 84.2 | | |
| 3/8" | 77.1 | | |
| #4 | 72.6 | | |
| #8 | 68.9 | | |
| #10 | 68.2 | | |
| #20 | 61.9 | | |
| #40 | 32.9 | | |
| #60 | 13.7 | | |
| #100 | 8.7 | | |
| #200 | 6.0 | | |
| #270 | 5.0 | | |

Material Description

Gravelly SAND some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 21.0738 D₈₅= 13.4375 D₆₀= 0.7962
D₅₀= 0.6132 D₃₀= 0.3986 D₁₅= 0.2639
D₁₀= 0.1925 C_u= 4.14 C_c= 1.04

Remarks

Date Received: 8-25-2023 Date Tested: 11-14-2023

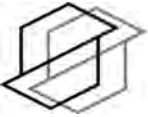
Tested By: FEW

Checked By: CSI/JHS

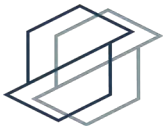
Title: _____

* (no specification provided)

Location: Onsite - SMDR Date Sampled: 8-25-2023
Sample Number: HA-3 Depth: 0.8-1.3'

| | | |
|---|--|--|
|  | associated earth sciences incorporated | Client: City of Olympia Project: Bioretention Hydrologic Performance Monitoring Study Project No: 20150387 H008 |
|---|--|--|

Figure



| | | | | |
|----------------------------------|-------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/25/2023 | Project BHPS-SMDR | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Sumner, WA | EB/EP No. SMDR-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.2-0.9' | HA-2 @ 0.2-0.7' | HA-3 @ 0.2-0.8' |
|--------------------|-----------------|-----------------|-----------------|
| Wet Weight + Pan | 589.7 | 514.8 | 535.6 |
| Dry Weight + Pan | 500.7 | 464.7 | 478.4 |
| Weight of Pan | 259.5 | 265.0 | 260.1 |
| Weight of Moisture | 89.0 | 50.1 | 57.2 |
| Dry Weight of Soil | 241.2 | 199.7 | 218.3 |
| % Moisture | 36.9 | 25.1 | 26.2 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|-------|-------|-------|
| Dry Soil Before Burn + Pan | 500.7 | 464.7 | 478.4 |
| Dry Soil After Burn + Pan | 493.3 | 455.3 | 468.7 |
| Weight of Pan | 259.5 | 265.0 | 260.1 |
| Wt. Loss Due to Ignition | 7.4 | 9.4 | 9.7 |
| Actual Wt. Of Soil After Burn | 233.8 | 190.3 | 208.6 |
| % Organics | 3.1 | 4.7 | 4.5 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|----------------|--------------------------------|---|
| Project Name: | Dunn Residence | Water Source: | Hydrant |
| Project Number: | 2010387H008 | Meter: | FM-6 (10-100) |
| Date: | 9/25/2023 | Wetted Area (sq. feet): | 12:30: 491 ft ² / 15:40: 491 ft ² |
| Weather: | Clear, 60's | Underdrain: | Yes |
| Test No.: | IT-1 | Test Depth (feet): | 0.4 |
| Performed By: | PEL/CSI | Receptor Soils: | Underdrain Gravels/Alluvium |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | CB-1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|-----------|----------------------|---------------------|--------------------------|
| 9:49 | | | 2.96 | | | Water on |
| 9:51 | 51.82 | 0 | 2.96 | 4.53 | 97 | |
| 9:55 | 52 | 0.14 | | 4.53 | 313 | |
| 10:00 | 51.94 | 0.34 | | | 564 | Increase flow to 77 gpm |
| 10:15 | 77.2 | 0.48 | | | 1,744 | Overflow level N CB |
| 10:19 | 29.7 | 0.5 | | | 2,032 | Decrease flow to 29 gpm |
| 10:20 | 22.64 | 0.5 | | | 2,087 | Decrease flow to 22 gpm |
| 10:30 | 22.86 | 0.46 | 2.86 | 4.29 | 2,279 | |
| 10:45 | 22.8 | 0.38 | | | 2,621 | Ponded area = 550 sqft |
| 11:00 | 28.08 | 0.36 | 2.89 | 4.1 | 2,965 | Increase flow to 28 gpm |
| 11:18 | 27.92 | 0.38 | 2.9 | 3.83 | 3,465 | |
| 11:30 | 26.64 | 0.4 | 2.9 | 3.62 | 3,800 | Decrease flow to 26 gpm |
| 11:45 | 26.8 | 0.4 | | | 4,204 | Constant head |
| 12:00 | 26.6 | 0.4 | | | 4,603 | |
| 12:15 | 26.6 | 0.4 | 2.89 | 3.04 | 5,009 | |
| 12:30 | 26.8 | 0.4 | 2.88 | 2.95 | 5,410 | Ponded area = 468.5 sqft |
| 12:45 | 26.7 | 0.4 | 2.88 | 2.84 | 5,802 | Field rate = 5.48 |
| 13:00 | 26.8 | 0.4 | 2.88 | 2.71 | 6,211 | |
| 13:15 | 26.8 | 0.4 | | | 6,621 | |
| 13:30 | 26.8 | 0.4 | | | 7,012 | |
| 13:45 | 26.7 | 0.4 | | | 7,415 | |
| 14:00 | 26.7 | 0.4 | 2.87 | 2.57 | 7,814 | |
| 14:15 | 26.8 | 0.4 | | | 8,216 | |
| 14:30 | 26.8 | 0.4 | | | 8,616 | |
| 14:45 | 26.8 | 0.4 | 2.87 | 2.5 | 9,021 | |
| 15:00 | 26.8 | 0.4 | | | 9,420 | |
| 15:15 | 26.7 | 0.4 | | | 9,841 | |
| 15:20 | 26.6 | 0.4 | | | 9,951 | |
| 15:30 | 26.7 | 0.4 | 2.87 | 2.44 | 10,221 | |
| 15:40 | 26.7 | 0.4 | | | 10,486 | Ponded area = 491 |
| 15:50 | 26.7 | 0.4 | | | 10,755 | |
| 16:00 | 26.7 | 0.4 | 2.87 | 2.4 | 11,021 | Water off |
| 16:06 | | 0.38 | | | | |
| 16:09 | | 0.36 | | | | |
| 16:11 | | 0.34 | | | | |
| 16:15 | | 0.32 | | | | |

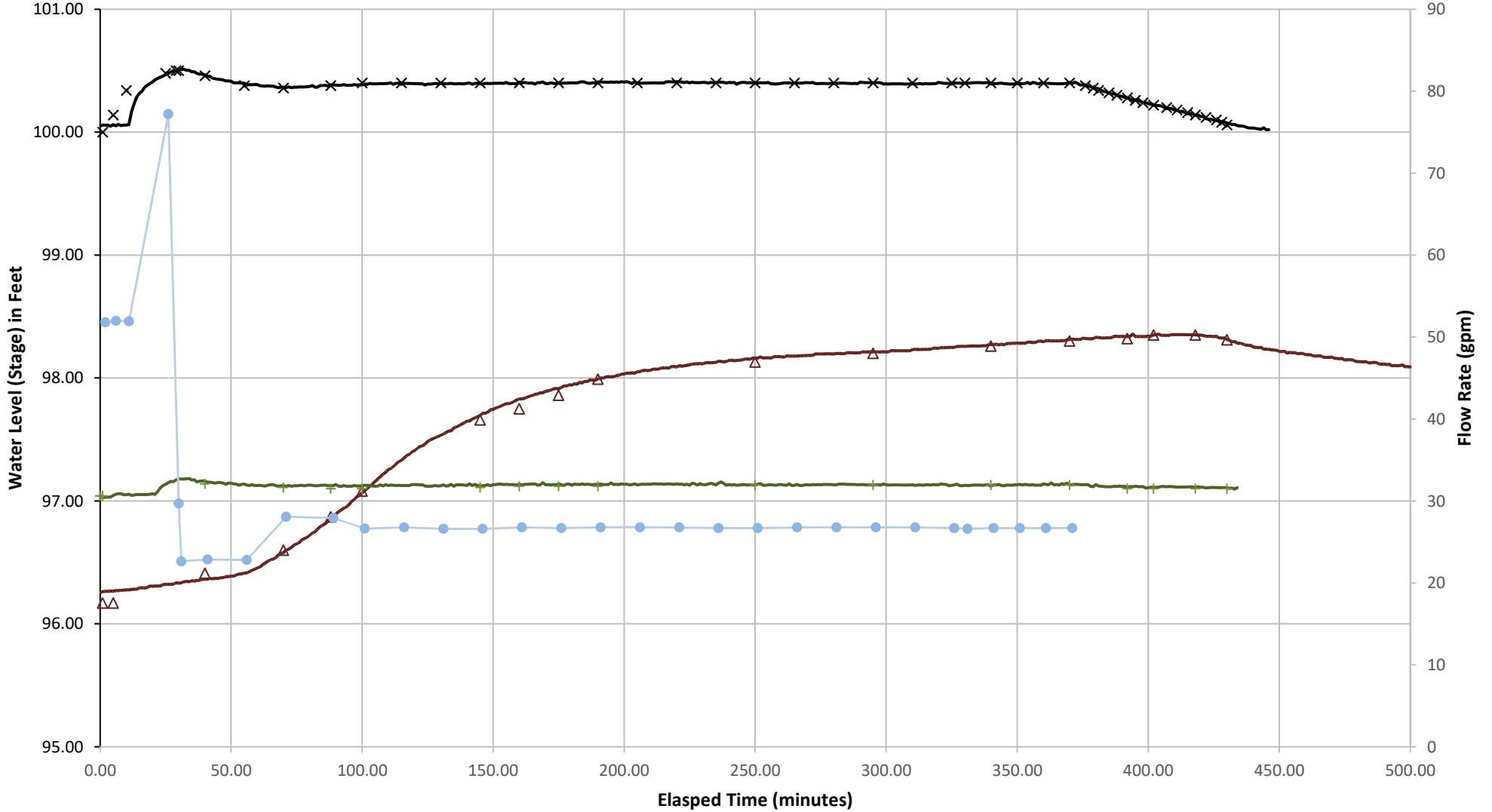
| | | | | | | |
|-------|--|------|-----|------|--|-------------------------------|
| 16:18 | | 0.3 | | | | |
| 16:22 | | 0.28 | 2.9 | 2.38 | | |
| 16:25 | | 0.26 | | | | |
| 16:28 | | 0.24 | | | | |
| 16:32 | | 0.22 | 2.9 | 2.35 | | Upper (South) wetted area dry |
| 16:37 | | 0.2 | | | | |
| 16:41 | | 0.18 | | | | |
| 16:45 | | 0.16 | | | | |
| 16:48 | | 0.14 | 2.9 | 2.35 | | |
| 16:52 | | 0.12 | | | | |
| 16:56 | | 0.1 | | | | |
| 16:58 | | 0.08 | | | | |
| 17:00 | | 0.06 | 2.9 | 2.39 | | End of test |

| | |
|--|-----|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 5.2 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 4.1 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 4.3 |
| WP Average Infiltration Rate (in/hr) during falling head: | 0.1 |

Dunn Residence Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- + Catch Basin Hand
- Catch Basin Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested cell was constructed in 2008 and collects sheet flow runoff from the adjacent parking lot and piped inflow from the building. The cell is constructed with 2" of mulch above 1.5' of bioretention soil above the scarified existing subgrade. All water is designed to infiltrate into the ground.

BIORETENTION SOIL:

Thickness: 1.1-1.4'

The apparent thickness of the bioretention soil ranged from 1.1'-1.4' below ground surface with an average of 1.3'. This is slightly less than the 1.5' called for in the plans.

Composition: No soil specifications were received in the design plans. In comparison to the 2019 Ecology specifications the sand gradation is far coarser than the recommended specifications, while the silt content exceeds the standard. The organic matter content was found to be within the specified range.

Organic Matter Content (% by weight): 5.2

Percent passing #200 sieve: 7.8

Coefficient of Uniformity (Cu): 37.8

Coefficient of Curvature (Cc): 0.6

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Medium dense, moist, light brown, fine to medium sandy, GRAVEL, trace silt (GW-GM)

BUILT PER PLAN:

The observed conditions were generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered in hand augers within the cell. The temporary wellpoint was screened from 0.8-1.3' below ground surface and responded to testing within 30 minutes. The water level in the wellpoint rose to a maximum elevation of approximately 1' below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 38.6

Subgrade Soil Rate (in/hr): >38.6

The water level in the temporary wellpoint never reached the surface elevation. Therefore, the bioretention soils were the material restricting infiltration.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The cell was observed to be in generally working condition.

Field Conditions

| | |
|---------|-------------|
| Weather | Clear, 70's |
|---------|-------------|

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
 Cell: Cell 1

Assessed On:
 July 18, 2023



| | | | |
|-----------------|---------------|---------------|------------------|
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: APJ | Half Day: MJH | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Commercial |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230718-201304.jpg



Site Photo: FA_SitePhotos-20230718-210352.jpg



Site Photo: FA_SitePhotos-20230718-210329.jpg



Site Photo: FA_SitePhotos-20230718-230530.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



Cell Construction

| | |
|--|--|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation lines running down each side of the cell. Both lines were running upon arrival and shut off at 7:30. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 100% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Sheet flow coming from parking lot and bridge. Additionally, there is an inflow pipe coming from the building. Spoke with Jeff of Pierce County who remembered the construction not including bioretention soil mix added to the cell because of time and budget constraints. Topsoil placed on the side slopes and towards the tip of the cell. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



Inlets

IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other
- Diameter: 0.57'

Energy Dissipation

Angular Rock: n/a

Stream Cobble: Functioning

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20230719-010628.jpg

Erosion Present? Yes No

Severity: Minor

Scouring extends laterally 2 feet beyond the inlet with a scour depth of 2-3 inches.

Blockage Present? Yes No

Approximately 20% blocked

Types:

- Sediment Organic Rock
- Trash Vegetation

Additional Details: Organic sediments fill the bottom portion of the pipe.



FA_INBLPhoto-20230719-010618.jpg


Additional Details: Stream cobbles near outlet double as energy dissipation device.

BIORETENTION CELL FIELD ASSESSMENT


Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



| | |
|---|--|
| IN-2 | |
| <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: ' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a |  <p>FA_INphoto-20230718-215631.jpg</p> |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation methods in place for sheet flow from the parking lot. | |

Design Overflow/Outlet

| | |
|--|--|
| DO - 1 | |
| Shape: <input checked="" type="checkbox"/> Round <input type="checkbox"/> Rectangular <input type="checkbox"/> Other Additional Details: Stickup (ft) From Ground: 0.72 Relative from staff gauge: 0.74 | Dimensions: Diameter: 0.66' |
| Damage Indicators: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |  <p>FA_DOPhoto-20230719-010223.jpg</p> |
| Trash Rack: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |

Cell Surface and Geotech Probe Observations

| | |
|---|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth (ft): |
| Cell Coverage | |
| Mulch | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



Other None < 25% 25 - 50% 50 - 75% 75 - 100%

Bare ground and grassy debris cover cell bottom. Trace mulch observed around shrubbery above overflow elevation. Near outflow pipes, heavy leaf litter is observed.

No traditional bioretention soil observed in bioretention cell base. Large recessional gravels fill the base of the cell. Probe data indicates that topsoil was placed to a depth of ~.5 feet, plans call for 1 foot.

Pest Evidence

Animal Burrows Yes No

Animal Plant Damage Yes No

Large Deposition of Feces Yes No

Additional Details:

Vegetation Description

Large shrubs, grasses in the cell base.

Additional Details

Geotechnical Probe Observation: Probe depths from the center of the cell ranged from 0.4-1.2' (plans call for 1.5' BSM). Probe depths were measured to be the shallowest at western end of the cell by HA-1 (0.4-0.8').

The width of the base of the cell was measured to be approximately 4' and probe depths ranged from 0.6-1'. The length of the cell was measured to be approximately 55'.

No underdrain trench was encountered.

Hand Auger

HA-1

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.2

to Native Soil: 0.5

to Import/Underdrain:

Total Depth: 1.5

Rain/Garden Mix Soil Texture: Loose, moist, light brown, gravelly, silty, f SAND-sandy silt. Gravels well graded (SP)
Native Soil Texture: Loose, moist, light brown, GRAVEL (v. coarse, average diameter 2.5" up to 4") some silt, some f sand, trace organics (GP-GM)

Liner Present:

Yes No

Filter Fabric Present:

Yes No

Additional Details

Refusal at 1.5'. No bioretention soil, appears to be tilled native recessional at 0.2.

0-0.2: Surface cover/grass

0.2-0.5: tilled native recessional

0.5-1.5': Vashon Recessional Outwash

No groundwater encountered.

HA-2

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



| | |
|---|---|
| HA-2 | |
| to Bioretention Soil: | 0 |
| to Native Soil: | 1.1 |
| to Import/Underdrain: | |
| Total Depth: | 1.5 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly, silty, f SAND, abundant organics and rootlets. Gravels <1" diameter average (SP) | |
| Native Soil Texture: Loose, moist, brown, silty, f SAND | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details 0-1.1': 'Topsoil' gravelly silty fine sand from surface to 1.1 feet where gravels are found. No groundwater encountered. | |

| | |
|--|---|
| HA-3-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.5 |
| to Import/Underdrain: | |
| Total Depth: | 1.8 |
| Rain/Garden Mix Soil Texture: Loose, moist, dark brown, gravelly, silty, f SAND, trace organics (SP-SM) | |
| Native Soil Texture: Medium dense, moist, light brown, (f-m) sandy, GRAVEL (rounded, average diameter 2"), some silt (GW-GM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 0.99 | |
| Additional Details 0-0.2': Surface cover/grass 0.2-1.5': BSM 1.5-1.8': Vashon Recessional Outwash: Change in density, grain size, color at 1.5' though material is generally similar. WP stickup=5.67' No groundwater encountered. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-6 (10-100)

Wetted Pond Area (sq. ft) 155.25

Ponded Depth (ft) 0.78

Total Gallons 1,139.77

Steady State Flow Rate (GPM) 62

Additional Details:

Performed two tests, one adjacent to inlet 1 and second with diffuser closer to center of pond.



IT_Photo-20230718-201324.jpg



IT_Photo-20230718-201351.jpg



IT_Photo-20230718-231115.jpg

Additional Comments

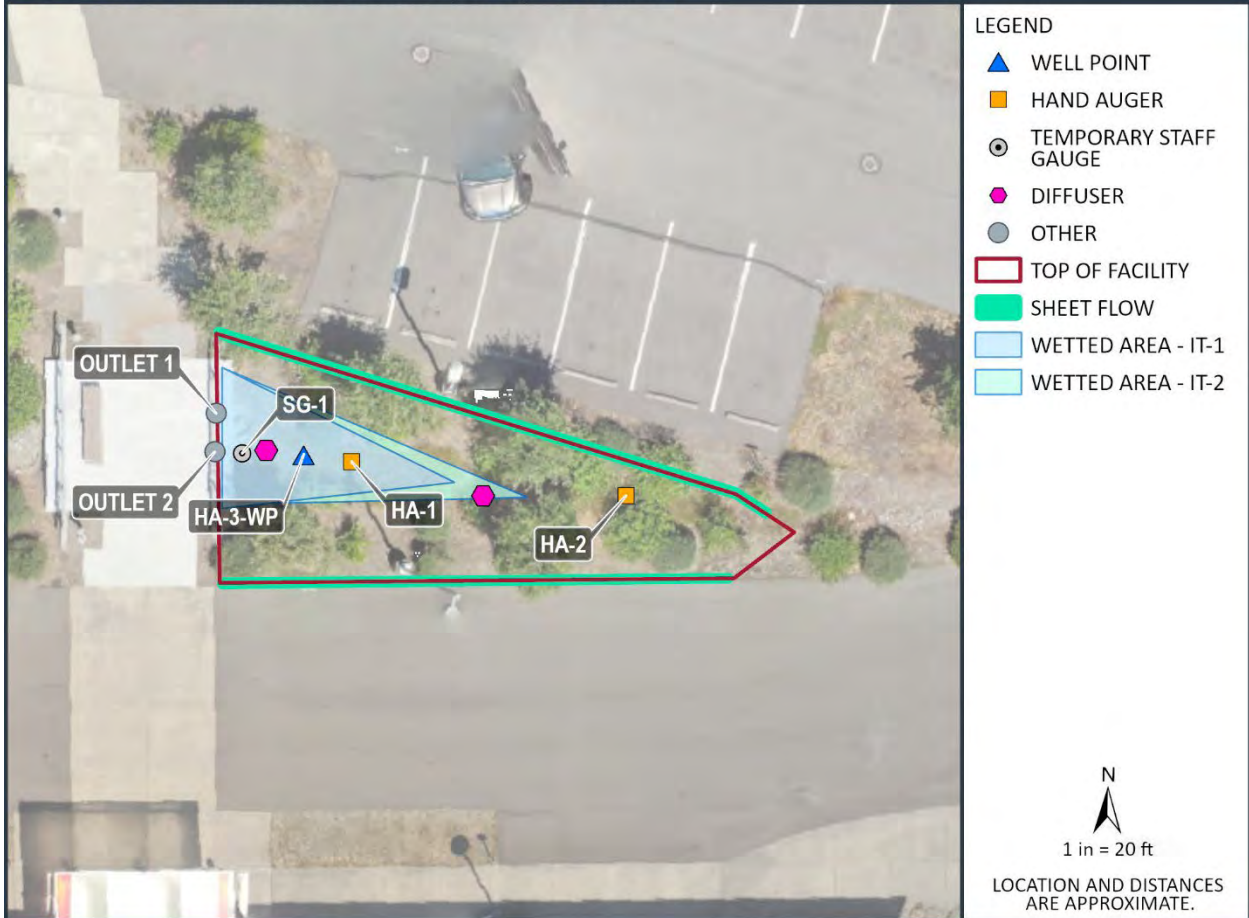
BIORETENTION CELL FIELD ASSESSMENT

Site: Central Maintenance Facility (SPCM)
Cell: Cell 1

Assessed On:
July 18, 2023



SITE: CENTRAL MAINTENANCE FACILITY (SPCM) CELL: CELL 1





associated
earth sciences
incorporated

Well Point

SPCM-HA-3-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 7/18/23

Logged By: SNCF

20150387H008

Ending Date: 7/18/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 1.8

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 1.9

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.7

Water Level Elevation (ft): N/A

Datum: Project Datum

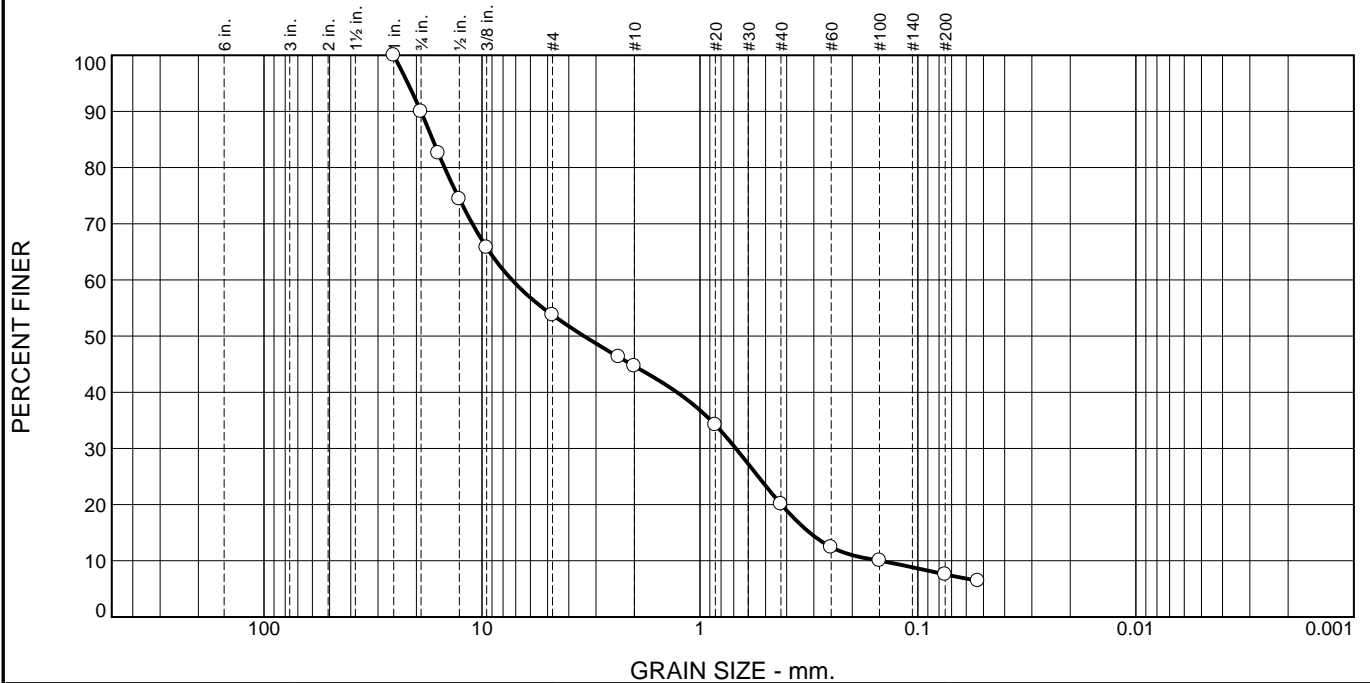
Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | 1 | | Surface Cover Grasses, rootlets, loose organic debris. | | | | | | | <p>Stick-up monument -5.70 to 0 feet 3/8-inch Bentonite chips 0 to 0.3 feet Medium grained silica sand 0.3 to 1.9 feet 1.25-inch I.D. Threaded galvanized steel casing +5.7 to 1.4 feet; duct tape covered screen 0.8 to 1.4 feet 1.25-inch I.D. Stainless steel jacket over stainless steel #60 gauze welded to perforated steel 0.8 to 1.3 feet Cast iron endcap 1.3 to 1.6 feet Cast iron drivepoint 1.6 to 1.9 feet</p> |
| 0.5 | | | | Bioretention Soil Mix Loose, moist, dark brown, very gravelly, medium SAND, some silt; scattered organics (SP-SM). | | | | | | | |
| 1.5 | | 2 | | Vashon Recessional Outwash Medium dense, moist, light brown, fine to medium sandy, GRAVEL, trace silt; rounded gravel (2 inch average diameter) (GW-GM). | | | | | | | |
| 1.8 | | 4 | | No groundwater encountered. Refusal due to difficulty excavating gravel. Soils information from adjacent hand auger explorations can are described in the Site Assessment Field Report. | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 10.0 | 36.2 | 9.1 | 24.6 | 12.5 | 7.6 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 90.0 | | |
| 5/8" | 82.6 | | |
| 1/2" | 74.4 | | |
| 3/8" | 65.8 | | |
| #4 | 53.8 | | |
| #8 | 46.3 | | |
| #10 | 44.7 | | |
| #20 | 34.2 | | |
| #40 | 20.1 | | |
| #60 | 12.4 | | |
| #100 | 10.0 | | |
| #200 | 7.6 | | |
| #270 | 6.4 | | |

* (no specification provided)

Material Description

very gravelly SAND, some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= GP-GM AASHTO (M 145)= A-1-a

Coefficients

D₉₀= 19.0629 D₈₅= 16.8465 D₆₀= 7.2942
D₅₀= 3.4033 D₃₀= 0.6842 D₁₅= 0.3135
D₁₀= 0.1491 C_u= 48.93 C_c= 0.43

Remarks

very gravelly SAND some silt

Date Received: 7-18-2023 Date Tested: 12-5-2023

Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - BHPS-CMF
Sample Number: HA-1

Depth: 1'

Date Sampled: 7-18-2023



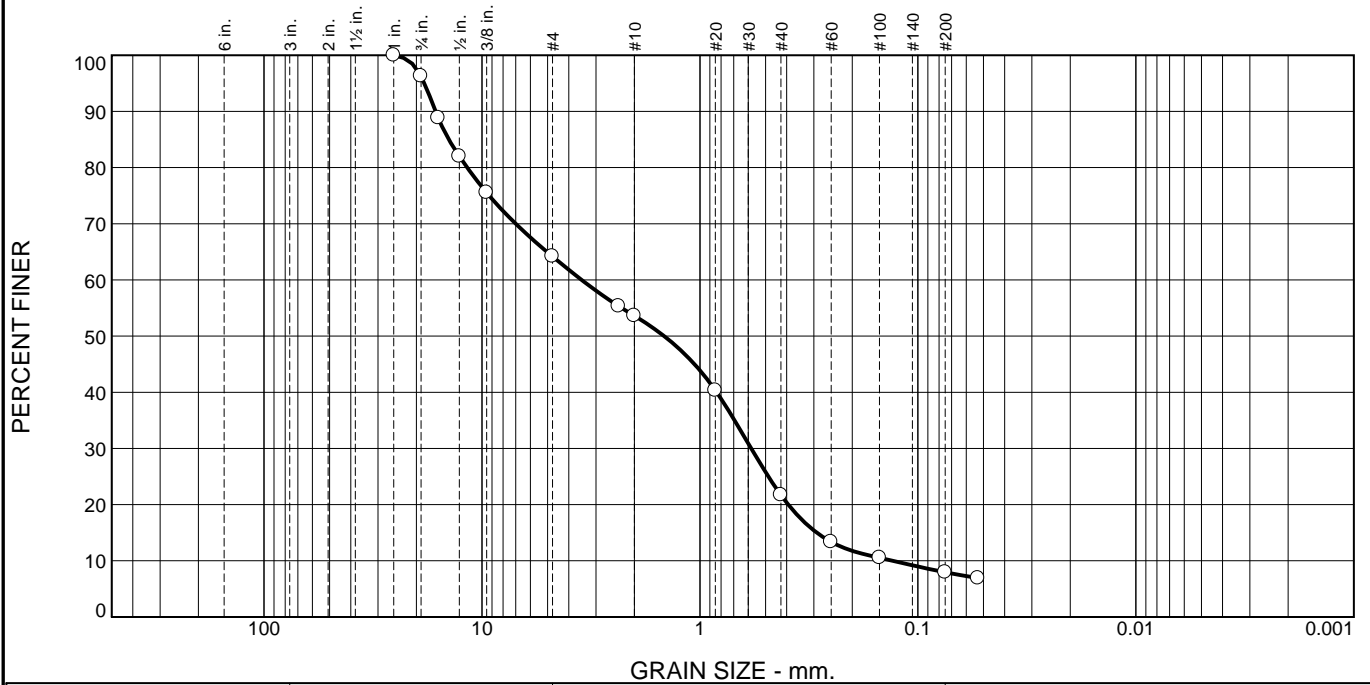
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 3.7 | 32.1 | 10.6 | 31.9 | 13.7 | 8.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1" | 100.0 | | |
| 3/4" | 96.3 | | |
| 5/8" | 88.8 | | |
| 1/2" | 82.0 | | |
| 3/8" | 75.6 | | |
| #4 | 64.2 | | |
| #8 | 55.3 | | |
| #10 | 53.6 | | |
| #20 | 40.3 | | |
| #40 | 21.7 | | |
| #60 | 13.4 | | |
| #100 | 10.5 | | |
| #200 | 8.0 | | |
| #270 | 6.9 | | |

* (no specification provided)

Material Description

very gravelly SAND some silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|---------------------------|---------------------------|--------------------------|
| D ₉₀ = 16.3332 | D ₈₅ = 14.2012 | D ₆₀ = 3.4898 |
| D ₅₀ = 1.4593 | D ₃₀ = 0.5818 | D ₁₅ = 0.2909 |
| D ₁₀ = 0.1306 | C _u = 26.73 | C _c = 0.74 |

Remarks

Date Received: 7-18-2023 Date Tested: 12-8-2023

Tested By: FEW

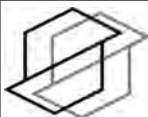
Checked By: APJ/JHS

Title: _____

Location: Onsite - BHPS-CMF
Sample Number: HA-3

Depth: 0.2-0.5'

Date Sampled: 7-18-2023



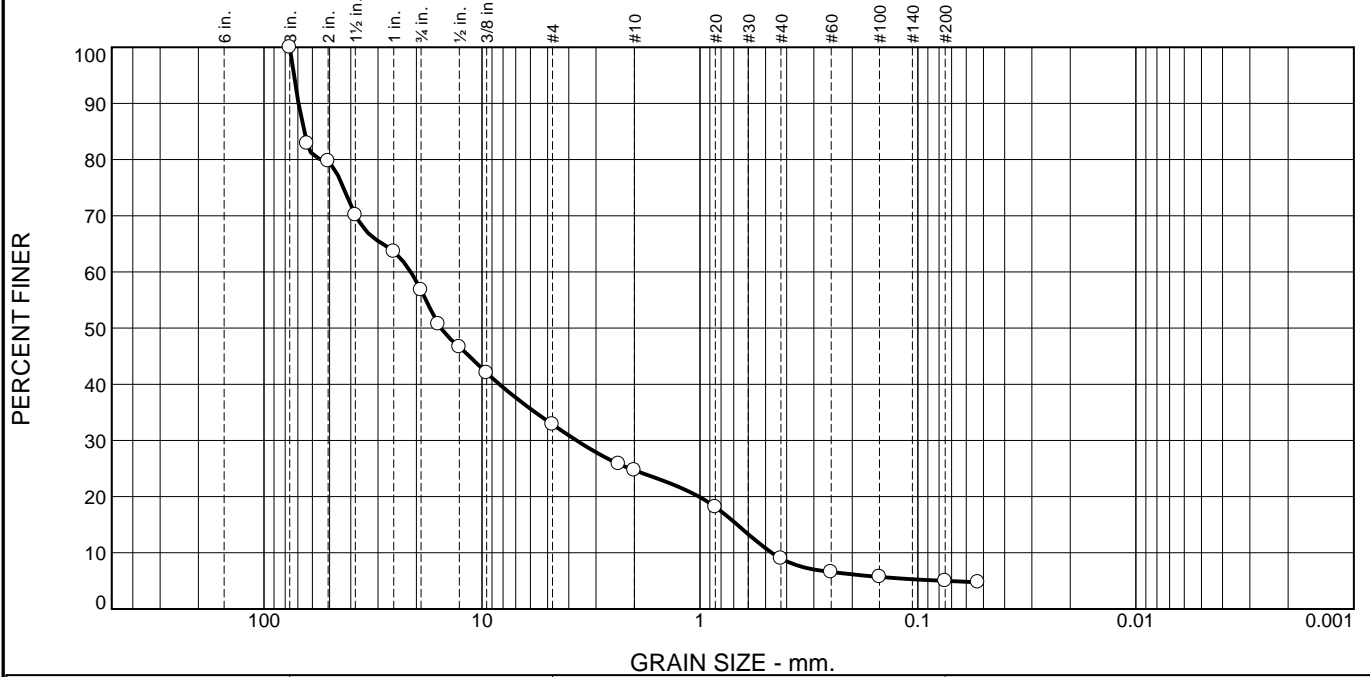
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 43.2 | 23.9 | 8.2 | 15.7 | 4.0 | 5.0 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3" | 100.0 | | |
| 2.5" | 82.9 | | |
| 2" | 79.7 | | |
| 1.5" | 70.1 | | |
| 1" | 63.6 | | |
| 3/4" | 56.8 | | |
| 5/8" | 50.7 | | |
| 1/2" | 46.6 | | |
| 3/8" | 42.0 | | |
| #4 | 32.9 | | |
| #8 | 25.8 | | |
| #10 | 24.7 | | |
| #20 | 18.1 | | |
| #40 | 9.0 | | |
| #60 | 6.6 | | |
| #100 | 5.7 | | |
| #200 | 5.0 | | |
| #270 | 4.8 | | |

* (no specification provided)

Material Description

sandy GRAVEL trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= GW-GM AASHTO (M 145)= A-1-a

Coefficients

| | | |
|---------------------------|---------------------------|---------------------------|
| D ₉₀ = 69.5321 | D ₈₅ = 65.6530 | D ₆₀ = 21.2211 |
| D ₅₀ = 15.4232 | D ₃₀ = 3.6824 | D ₁₅ = 0.6743 |
| D ₁₀ = 0.4680 | C _u = 45.35 | C _c = 1.37 |

Remarks

Date Received: 7-18-2023 Date Tested: 12-12-2023

Tested By: FEW

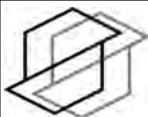
Checked By: APJ/JHS

Title: _____

Location: Onsite - BHPS-CMF
 Sample Number: HA-3

Depth: 1.7-1.8'

Date Sampled: 7-18-2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



**Moisture, Ash, and Organic Matter of Peat
and Other Organic Soils - ASTM 2974**

| | | | | |
|----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 7/18/2023 | Project BHPS-SPCM | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Spanaway, WA | EB/EP No. SPCM-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 1' | HA-3 @ 0.2-0.5' |
|--------------------|-----------|-----------------|
| Wet Weight + Pan | 1685.8 | 1634.8 |
| Dry Weight + Pan | 1613.7 | 1563.2 |
| Weight of Pan | 358.0 | 392.0 |
| Weight of Moisture | 72.2 | 71.7 |
| Dry Weight of Soil | 1255.7 | 1171.2 |
| % Moisture | 5.7 | 6.1 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|--------|
| Dry Soil Before Burn + Pan | 1613.7 | 1563.2 |
| Dry Soil After Burn + Pan | 1549.1 | 1502.5 |
| Weight of Pan | 358.0 | 392.0 |
| Wt. Loss Due to Ignition | 64.5 | 60.7 |
| Actual Wt. Of Soil After Burn | 1191.2 | 1110.5 |
| % Organics | 5.1 | 5.2 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|--|--------------------------------|----------------------------|
| Project Name: | Pierce County Central Maintenance Facility | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 7/18/2023 | Wetted Area (sq. feet): | 12:45: 155 ft ² |
| Weather: | Clear, 70's | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.78 |
| Performed By: | APJ / MJH | Receptor Soils: | Vashon Recessional Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|----------------------------------|
| 10:14 | | | | 28 | Water on |
| 10:15 | | | | | Water off |
| 10:18 | | | | 0 | |
| 10:20 | 28 | 0.36 | | | Water very while |
| 10:21 | | | | | Flow up to 79 gpm |
| 10:23 | 79.3 | 0.54 | | 270 | |
| 10:25 | 80.3 | 0.66 | Dry | 388 | Pond slightly increasing |
| 10:32 | 79.4 | 0.74 | | 910 | |
| 10:35 | 68 | 0.76 | | 1,203 | Trickle of water into pipe |
| 10:40 | 69 | 0.76 | 6.75 | 1,525 | Flow down 45 gpm still trickles |
| 10:42 | 45 | | | 1,636 | |
| 10:50 | 45 | 0.64 | 6.76 | 2,027 | |
| 10:52 | 46 | | | 2,023 | Flow up 60 get closer to outflow |
| 10:55 | | 0.69 | | | |
| 11:00 | 62.78 | 0.7 | 6.73 | 2,587 | |
| 11:15 | 62.24 | 0.74 | | 3,565 | |
| 11:30 | 62.7 | 0.74 | 6.66 | 4,455 | |
| 11:45 | 63.2 | 0.74 | 6.67 | 5,462 | |
| 12:00 | 62.68 | 0.75 | 6.67 | 6,355 | |
| 12:16 | 63.24 | 0.76 | 6.68 | 7,392 | |
| 12:30 | 62.9 | 0.76 | 6.68 | 8,254 | |
| 12:45 | 64.81 | 0.77 | | 9,189 | |
| 13:00 | 62.9 | 0.77 | 6.69 | 10,178 | |
| 13:15 | 64 | 0.78 | 6.69 | 11,087 | |
| 13:20 | 62.61 | 0.78 | 6.69 | 11,398 | Water Off |
| 13:21 | | 0.7 | 6.71 | | |
| 13:23 | | 0.6 | | | |
| 13:27 | | 0.48 | 6.8 | | |
| 13:32 | | 0.34 | | | |
| 13:35 | | 0.2 | | | |
| 13:36 | | 0.06 | | | |
| 13:36:30 | | 0 | 6.81 | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 38.6 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 32.4 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 38.8 |
| WP Average Infiltration Rate (in/hr) during falling head: | 11.3 |

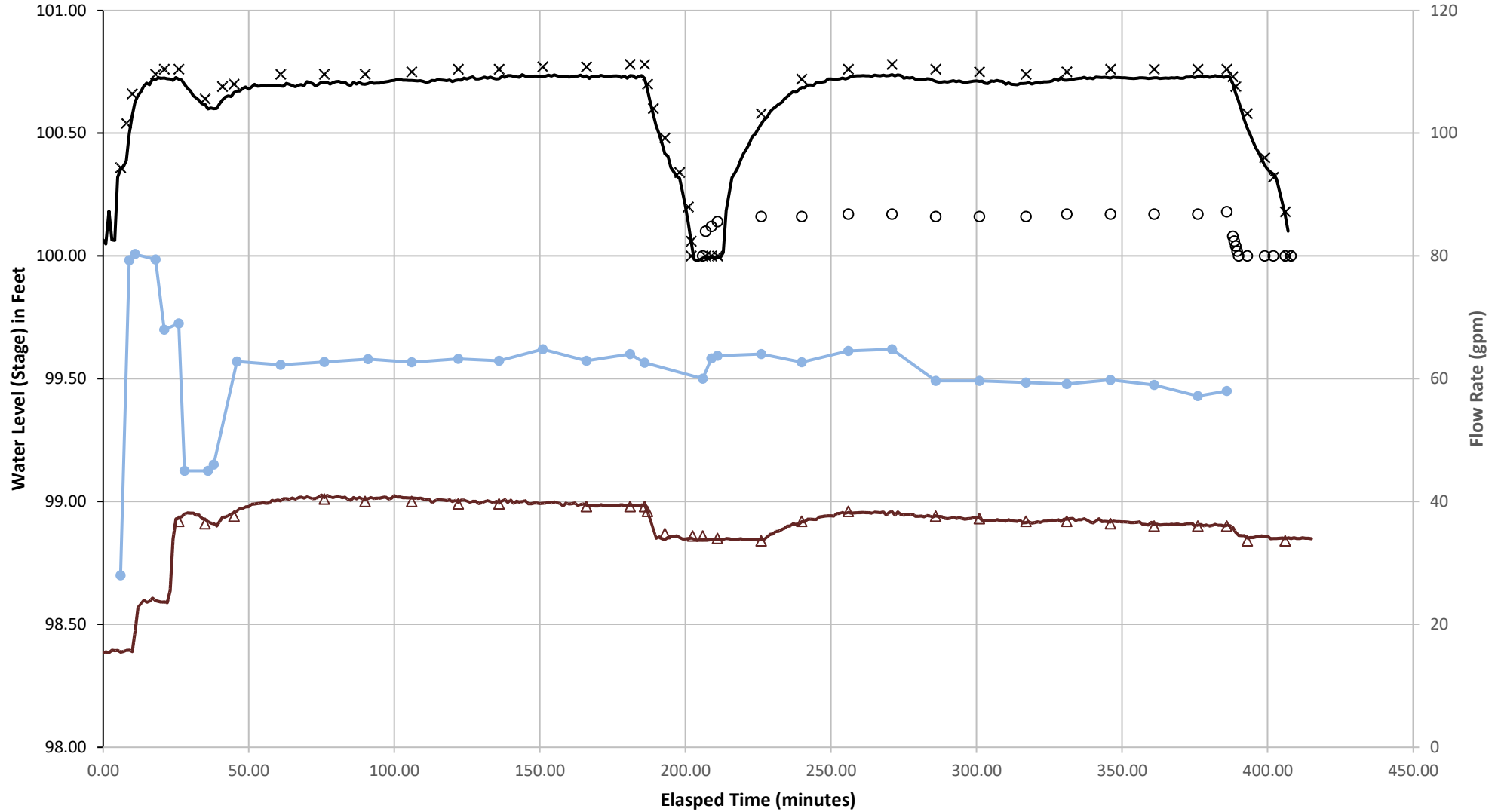
| | | | |
|------------------------|--|--------------------------------|----------------------------|
| Project Name: | Pierce County Central Maintenance Facility | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM- 6 (10-100) |
| Date: | 7/18/2023 | Wetted Area (sq. feet): | 15:45: 229 ft^2 |
| Weather: | Clear 70's | Underdrain: | No |
| Test No.: | IT-2 | Test Depth (feet): | 0.76 |
| Performed By: | APJ / MJH | Receptor Soils: | Vashon Recessional Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|------------------------------|
| 13:40 | 60 | | | 6.81 | 0 | Water on |
| 13:41 | | 0 | 0.1 | | | |
| 13:43 | 63.3 | 0 | 0.12 | | 176 | |
| 13:45 | 63.74 | 0 | 0.14 | 6.82 | 322 | Water reaching SG-1 at 13:50 |
| 14:00 | 64 | 0.58 | 0.16 | 6.83 | 1,270 | |
| 14:14 | 62.68 | 0.72 | 0.16 | 6.75 | 2,200 | |
| 14:30 | 64.54 | 0.76 | 0.17 | 6.71 | 3,208 | |
| 14:45 | 64.81 | 0.78 | 0.17 | | 4,166 | Water flowing out <1 gpm |
| 15:00 | 59.66 | 0.76 | 0.16 | 6.73 | 5,049 | Flow down |
| 15:15 | 59.66 | 0.75 | 0.16 | 6.74 | 5,946 | |
| 15:31 | 59.37 | 0.74 | 0.16 | 6.75 | 6,917 | |
| 15:45 | 59.14 | 0.75 | 0.17 | 6.75 | 7,754 | |
| 16:00 | 59.82 | 0.76 | 0.17 | 6.76 | 8,652 | |
| 16:15 | 58.98 | 0.76 | 0.17 | 6.77 | 9,557 | |
| 16:30 | 57.19 | 0.76 | 0.17 | 6.77 | 10,444 | |
| 16:40 | 58 | 0.76 | 0.18 | 6.77 | 11,048 | Water off |
| 16:42 | 0 | 0.73 | 0.08 | | | |
| 16:42 | | | 0.06 | | | |
| 16:43 | | | 0.04 | | | |
| 16:43 | | 0.69 | 0.02 | | | |
| 16:44 | | | 0 | | | |
| 16:47 | | 0.58 | | 6.83 | | |
| 16:53 | | 0.4 | | | | |
| 16:56 | | 0.32 | | | | |
| 17:00 | | 0.18 | | 6.83 | | |
| 17:02 | | 0 | | | | |

| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 25.0 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 20.9 |
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 24.9 |
| WP Average Infiltration Rate (in/hr) during falling head: | 10.8 |

Central Maintenance Facility Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are unsurveyed and are used for relative reference. Elevation 100 represents ground surface.

- x Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- IT-2 Staff Gauge #2 Hand Data
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
Cell: Bioretention Area B

Assessed On:
August 24, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

This bioretention facility is one of 12 facilities constructed in 2013 to treat runoff in the Spanaway Lake, and Spanaway Creek basin. The bioretention facilities are designed to exceed the Washington State Department of Ecology (Ecology) requirements to treat 91% of the total annual runoff volume. Bioretention Area B is designed to treat 3,227 square feet of the adjacent parking lot's impervious pavement with a designed infiltration rate of 3in/hr. Water enters the cell through two curb cuts and is designed to infiltrate through 2 ft of bioretention soil before reaching the underlying native outwash soil. All water is designed to infiltrate into the ground and there is no emergency overflow bypass.

BIORETENTION SOIL:

Thickness: 1.55-2.5 ft

The apparent thickness of bioretention soil based on the probe data and hand augers ranged from 1.55-2.5 ft below the ground surface with an average thickness of 1.9 ft.

Composition:

The available plans call out bioretention soil mix specifications in a section called special provisions, which was unavailable at the time of this study. In other sections of the design, reference is made to current Ecology specifications. In comparison to the 2019 Ecology specification, the tested soil did not meet the recommended guidelines for organic content or sand gradation. The tested soil had higher percentages of medium to coarse sand and did not meet the recommended range of organic matter.

Organic Matter Content (% by weight): 2.2

Percent passing #200 sieve: 1.6

Coefficient of Uniformity (Cu): 2.8

Coefficient of Curvature (Cc): 1.0

SUBGRADE CONDITIONS:

Geologic Unit: Vashon Recessional Outwash

Soil Description: Medium dense, slightly moist, tannish-brown, gravelly, fine to medium SAND, some silt, some organics and rootlets (SP).

BUILT PER PLAN:

The bioretention soil mix does not meet the recommended Ecology specifications, otherwise the bioretention cell was generally consistent with the design plans.

GROUNDWATER CONDITIONS:

No groundwater was encountered during our explorations and the WellPoint, screened in the bioretention soil from 1.6'-1.8' did not respond to infiltration testing.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 103

Subgrade Soil Rate (in/hr): >103

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
 Cell: Bioretention Area B

Assessed On:
 August 24, 2023



MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The angular rocks for energy dissipation of the inlets are slightly buried, otherwise bioretention area B appears to be in good condition.

Field Conditions

| | | | |
|-----------------|-----------------------|------------------|------------------|
| Weather | CLEAR 55-75 | | |
| Recent Rainfall | Today: 0" | Yesterday: 0.05" | Two Days Ago: 0" |
| Field Reps | Full Day: Sam Seabury | | Half Day: CSI |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 2 | Predominate Landuse | Parkland |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 5 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20230824-075012.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
 Cell: Bioretention Area B

Assessed On:
 August 24, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments Water is conveyed into the cell from the adjacent parking lot via two curb cuts. Water is designed to infiltrate through the bioretention soil before reaching the underlying native subgrade. There is no designed overflow. | |

Inlets

| | |
|--|---|
| IN-1 | |
| <input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: | |
| Width: 1.77' Energy Dissipation Angular Rock: Buried Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: Plants have overgrown angular rocks, still moderately functional as energy dissipation. | |


FA_INphoto-20230824-075254.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
 Cell: Bioretention Area B

Assessed On:
 August 24, 2023



| | |
|--|---|
| <p>IN-2</p> <p><input checked="" type="checkbox"/> Curb cut <input type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other:</p> <p>Width: 1.83'</p> <p>Energy Dissipation Angular Rock: Functioning Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a</p> |  <p>FA_INphoto-20230824-075537.jpg</p> |
| <p>Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Rocks are settled a little bit into the ground</p> | <p>Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No</p> |
| <p>Additional Details: Leaves and plant debris throughout angular rocks</p> | |

Cell Surface and Geotech Probe Observations

| | |
|--|--|
| <p>Mulch: <input type="checkbox"/> None <input checked="" type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch Depth (ft): 0.1</p> | |
| <p>Cell Coverage</p> | |
| Mulch | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input checked="" type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input checked="" type="checkbox"/> 75 - 100% |
| <p>Some mulch throughout cell, scattered. Cell is clear of garbage</p> | |
| <p>Pest Evidence</p> | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| <p>Additional Details: No animal evidence besides lot of bees in cell</p> | |
| <p>Vegetation Description vegetation covers majority of cell Work is limited by vegetation</p> | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
 Cell: Bioretention Area B

Assessed On:
 August 24, 2023




Additional Details

Geotechnical Probe Observation: Probe depths through the center of the cell ranged from 1.55-2.5' (plans call for minimum of 2' of BSM). Probe depths were measured to be the shallowest along the northern and southern edges of the cell (1.55-1.6').

No underdrain trench was encountered. The length of the cell was measured to be approximately 43' and the width of the cell was measured to be approximately 19'.

No excessive erosion or compaction were observed.

Hand Auger

| | |
|--|---|
| HA-1-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.9 |
| to Import/Underdrain: | |
| Total Depth: | 2.1 |
| Rain/Garden Mix Soil Texture: Loose slightly moist brown fine to medium SAND, some silt, some organics (SP) Native Soil Texture: Medium dense, slightly moist, tannish-brown gravelly fine to medium SAND, some silt, some organics and rootlets (SP) | |
| Liner Present: | Filter Fabric Present: |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail | |
| Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | |
| Depth to water from TOC (ft): | |
| Respond to Testing: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Shallowest Depth to water during testing from Ground Surface (ft): | |
|  | |
| FA_FPhoto-20230824-151309.jpg | |
| Additional Details | |

| | |
|---|------------------------|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | 1.7 |
| to Import/Underdrain: | |
| Total Depth: | 1.7 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown fine to medium SAND, some silt, some organics (SP) Native Soil Texture: | |
| Liner Present: | Filter Fabric Present: |
| | |


BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
 Cell: Bioretention Area B

Assessed On:
 August 24, 2023



| | |
|--|---|
| HA-2 | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
|  | |
| FA_FPhoto-20230824-152008.jpg | |
| Additional Details | |

| | |
|---|---|
| HA-3 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 2.1 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, fine to medium SAND, some silt, some organics (SP) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| | |
|  | |
| FA_FPhoto-20230824-152426.jpg | |
| Additional Details | |
| Stopped digging due to excessive caving and no returns. BOH=2.1' | |

| | |
|---|-----|
| HA-4 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.4 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, fine to medium SAND, some silt, some organics (SP) | |
| Native Soil Texture: | |
| | |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
Cell: Bioretention Area B

Assessed On:
August 24, 2023



| | |
|---|---|
| HA-4 | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |

| | |
|---|---|
| HA-5 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.5 |
| Rain/Garden Mix Soil Texture: Loose, slightly moist, brown, fine to medium SAND, some silt, some organics (SP) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |

Infiltration Test

| | |
|--|-------|
| IT-1 | |
| Water Supply <input type="checkbox"/> Hydrant <input checked="" type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# FM-4 (3-50) | |
| Wetted Pond Area (sq. ft) | 6.112 |
| Ponded Depth (ft) | 0.04 |
| Total Gallons | 2,397 |
| Steady State Flow Rate (GPM) | 6.5 |

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)
Cell: Bioretention Area B

Assessed On:
August 24, 2023



Additional Details:

Infiltration rate is the constant head calculation. As soon as water shut off the water drained immediately. Additional details available in the executive summary.



IT_Photo-20230824-154740.jpg



IT_Photo-20230824-154741.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: Spanaway Park (SPSP)

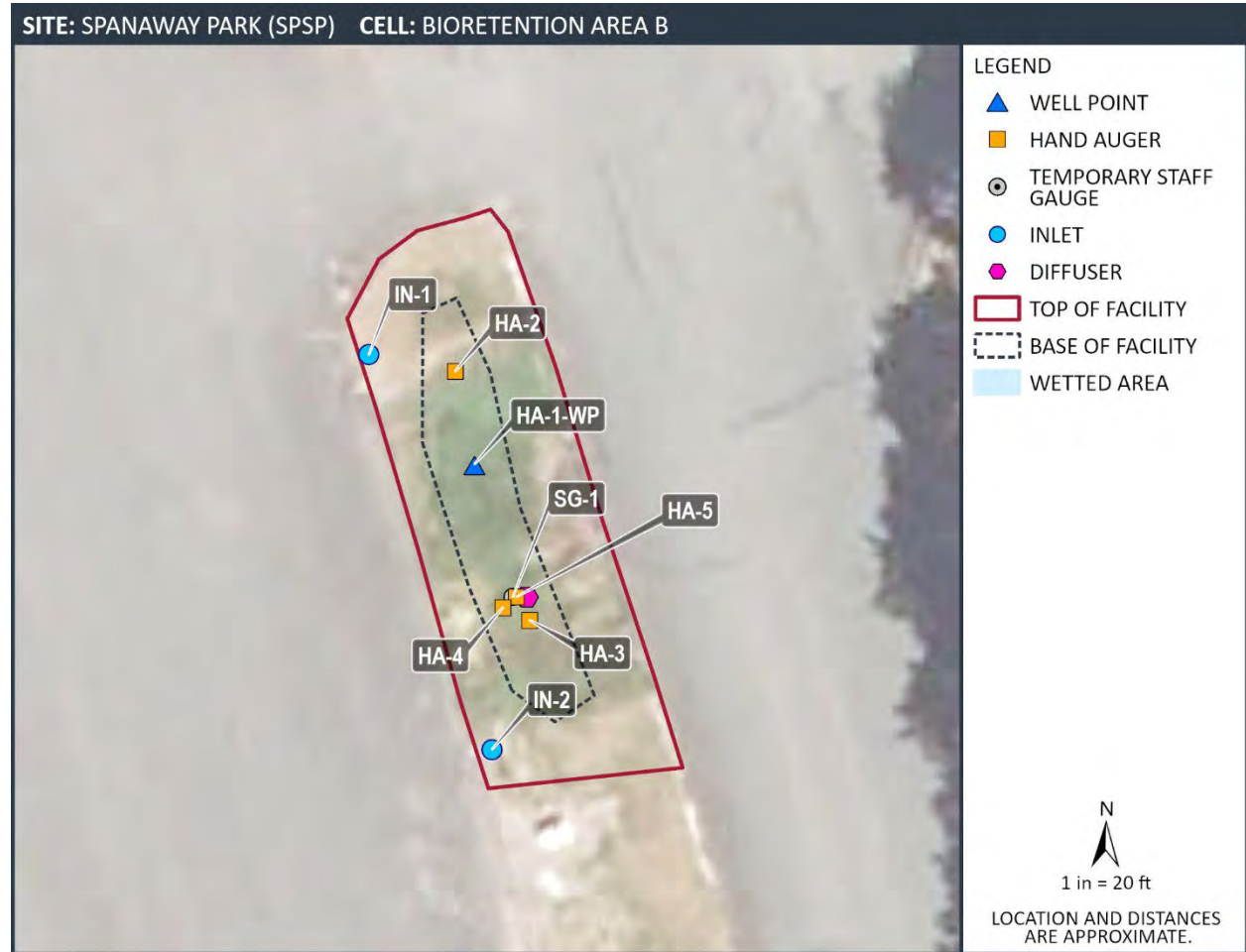
Cell: Bioretention Area B

Assessed On:

August 24, 2023



Additional Comments





associated
earth sciences
incorporated

Well Point

SPSP-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/24/23

Logged By: CSI

20150387H008

Ending Date: 8/24/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.1

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.4

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.1

Water Level Elevation (ft): N/A

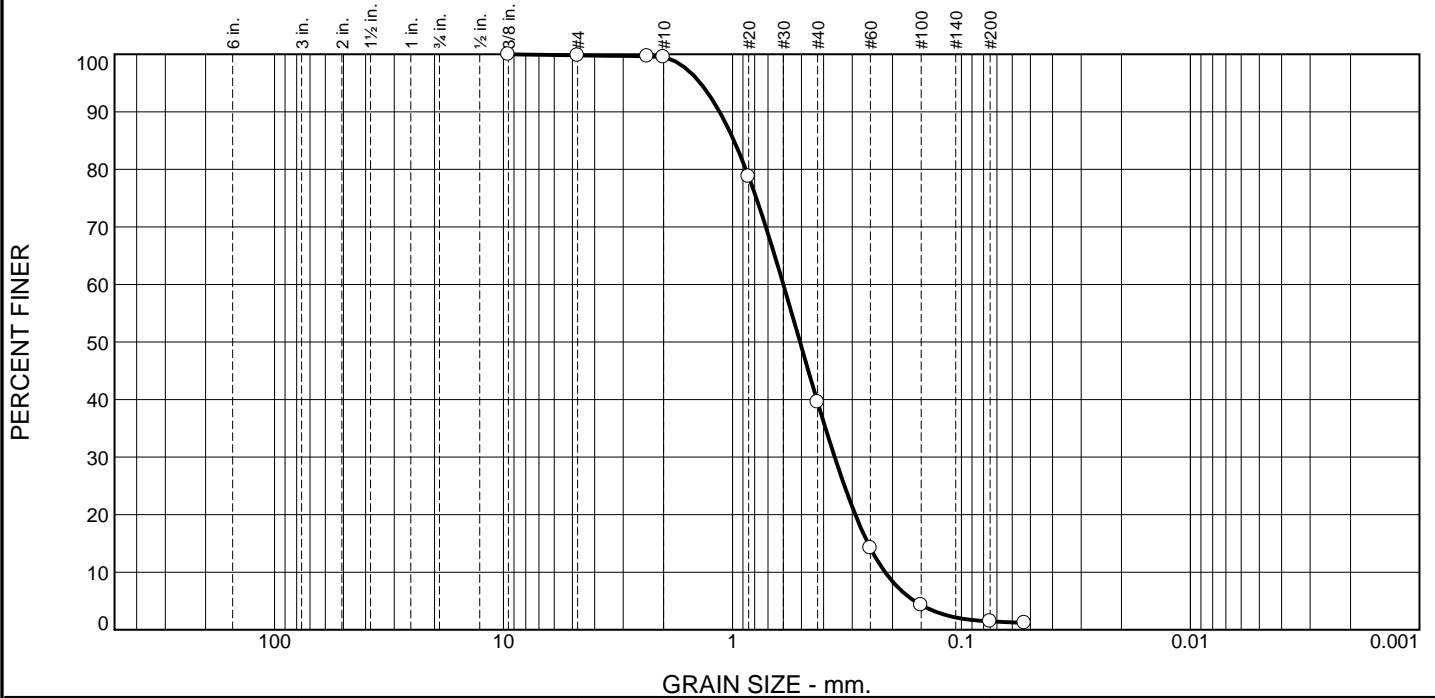
Datum: Project Datum

Groundwater Depth ATD (ft): Not encountered Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Natural mulch and bark mulch. | | | | | | | Stickup -5.1 to 0 feet Onsite bioretention soil mix 0 to 1.3 feet 1.25-inch I.D. threaded galvanized steel casing -5.1 to -0.6 feet; duct tape covers screen -0.6 to 1.6 feet. 3/8-inch bentonite chips 1.3 to 1.5 feet Medium silica filter sand 1.5 to 2.1 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.6 to 1.8 feet Cast iron endcap 1.8 to 2.1 feet Cast iron drivepoint 2.1 to 2.4 feet |
| 1 | | | | Bioretention Soil Mix Loose, slightly moist, brown, fine to medium SAND, some silt; some organics (SP-SM). | | | | | | | |
| 2 | | | | Encountered gravel (1/2-inch to 1 inch in diameter). | | | | | | | |
| 2 | | | | Vashon Recessional Outwash Medium dense, slightly moist, tannish-brown, gravelly, fine to medium SAND, some silt; some organics and rootlets (SP). | | | | | | | |
| 3 | | | | No groundwater encountered. Hole terminated at 2.1 feet due to excessive caving and no returns. | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

20150387H008 1/24/2024

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.2 | 0.3 | 59.9 | 38.1 | 1.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 99.8 | | |
| #8 | 99.7 | | |
| #10 | 99.5 | | |
| #20 | 78.8 | | |
| #40 | 39.6 | | |
| #60 | 14.2 | | |
| #100 | 4.3 | | |
| #200 | 1.5 | | |
| #270 | 1.2 | | |

* (no specification provided)

Material Description

SAND trace gravel trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 1.1379 | D ₈₅ = 0.9847 | D ₆₀ = 0.5995 |
| D ₅₀ = 0.5070 | D ₃₀ = 0.3579 | D ₁₅ = 0.2559 |
| D ₁₀ = 0.2157 | C _u = 2.78 | C _c = 0.99 |

Remarks

Date Received: 8-24-2023 Date Tested: 11-8-2023

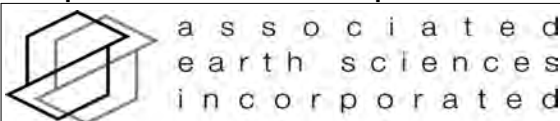
Tested By: FEW

Checked By: CSI/JS

Title: _____

Location: Onsite - BHPS-Spanaway-SPSP
 Sample Number: HA-4 Depth: 0-0.4'

Date Sampled: 8-24-2023

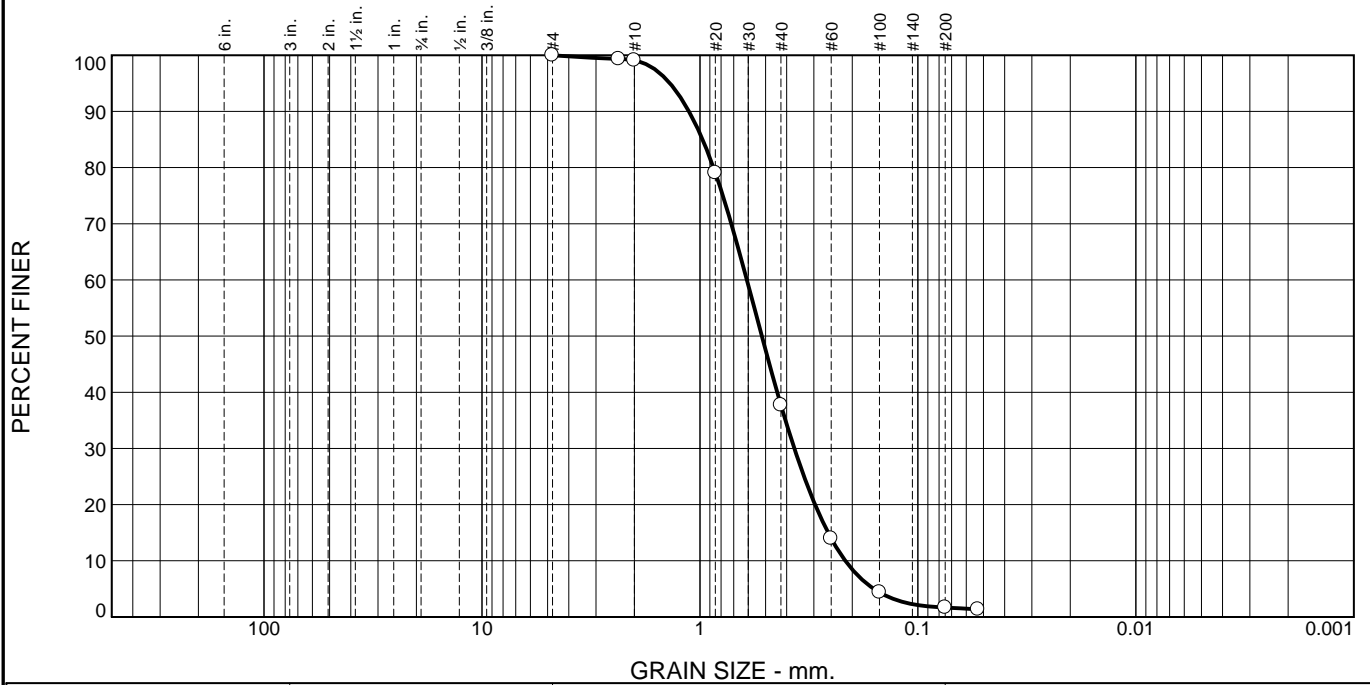


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.0 | 0.9 | 61.4 | 36.0 | 1.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #4 | 100.0 | | |
| #8 | 99.3 | | |
| #10 | 99.1 | | |
| #20 | 79.1 | | |
| #40 | 37.7 | | |
| #60 | 14.0 | | |
| #100 | 4.4 | | |
| #200 | 1.7 | | |
| #270 | 1.4 | | |

Material Description

SAND trace silt

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 1.1227 D₈₅= 0.9729 D₆₀= 0.6091
 D₅₀= 0.5201 D₃₀= 0.3689 D₁₅= 0.2582
 D₁₀= 0.2153 C_u= 2.83 C_c= 1.04

Remarks

Date Received: 8-24-2023 Date Tested: 11-8-2023

Tested By: FEW

Checked By: CSI/JHS

Title: _____

* (no specification provided)

Location: Onsite - Spanaway-SPSP
Sample Number: HA-5 **Depth:** 0-0.5'

Date Sampled: 8-24-2023

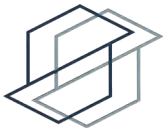


a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/24/2023 | Project BHPS-SPSP | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Spanaway, Wa. | EB/EP No. SPSP-HA | Depth Various | |

Moisture Content

| Sample ID | HA-4 @ 0-0.4' | HA-5 @ 0-0.5' |
|--------------------|---------------|---------------|
| Wet Weight + Pan | 539.1 | 511.3 |
| Dry Weight + Pan | 530.1 | 487.9 |
| Weight of Pan | 260.0 | 260.0 |
| Weight of Moisture | 9.0 | 23.4 |
| Dry Weight of Soil | 270.1 | 227.9 |
| % Moisture | 3.3 | 10.3 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 530.1 | 487.9 |
| Dry Soil After Burn + Pan | 524.9 | 482.4 |
| Weight of Pan | 260.0 | 260.0 |
| Wt. Loss Due to Ignition | 5.2 | 5.5 |
| Actual Wt. Of Soil After Burn | 264.9 | 222.4 |
| % Organics | 1.9 | 2.4 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

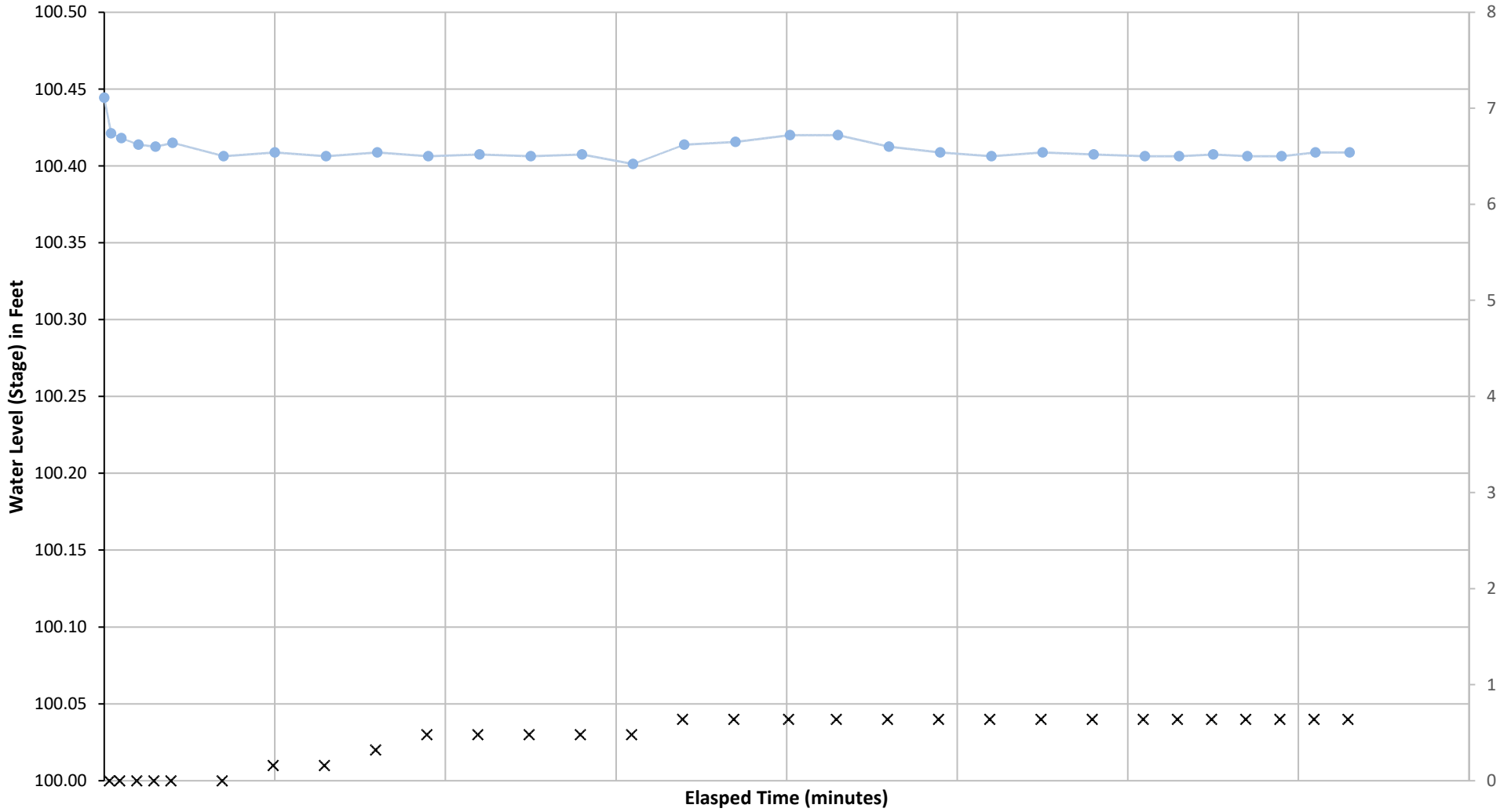
| | | | |
|------------------------|-----------------------------|--------------------------------|----------------------------|
| Project Name: | Spanaway Park Cell 6 Area B | Water Source: | Hosebib |
| Project Number: | 20150387H008 | Meter: | FM-4 (3-50) |
| Date: | 8/24/2023 | Wetted Area (sq. feet): | 13:30: 6.1ft ² |
| Weather: | Clear, 70s | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.04 |
| Performed By: | SS | Receptor Soils: | Vashon Recessional Outwash |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|--|
| 9:25 | 7.11 | 0 | Dry | | Water on |
| 9:27 | 6.74 | 0 | | 17 | |
| 9:30 | 6.69 | 0 | | 36 | |
| 9:35 | 6.62 | 0 | | 69 | |
| 9:40 | 6.6 | 0 | | 103 | |
| 9:45 | 6.64 | 0 | | 135 | Moved diffuser |
| 10:00 | 6.5 | 0 | | 235 | |
| 10:15 | 6.54 | 0.01 | | 337 | Added catch basin logger |
| 10:30 | 6.5 | 0.01 | | 430 | |
| 10:45 | 6.54 | 0.02 | | 530 | |
| 11:00 | 6.5 | 0.03 | | 624 | |
| 11:15 | 6.52 | 0.03 | | 725 | |
| 11:30 | 6.5 | 0.03 | | 821 | |
| 11:45 | 6.52 | 0.03 | | 919 | |
| 12:00 | 6.42 | 0.03 | | 1,014 | |
| 12:15 | 6.62 | 0.04 | | 1,116 | |
| 12:30 | 6.65 | 0.04 | | 1,214 | |
| 12:46 | 6.72 | 0.04 | | 1,330 | |
| 13:00 | 6.72 | 0.04 | | 1,417 | |
| 13:15 | 6.6 | 0.04 | | 1,517 | |
| 13:30 | 6.54 | 0.04 | | 1,609 | |
| 13:45 | 6.5 | 0.04 | | 1,717 | |
| 14:00 | 6.54 | 0.04 | | 1,805 | |
| 14:15 | 6.52 | 0.04 | | 1,906 | |
| 14:30 | 6.5 | 0.04 | | 2,004 | |
| 14:40 | 6.5 | 0.04 | | 2,067 | |
| 14:50 | 6.52 | 0.04 | | 2,139 | |
| 15:00 | 6.5 | 0.04 | | 2,198 | |
| 15:10 | 6.5 | 0.04 | | 2,266 | |
| 15:20 | 6.54 | 0.04 | | 2,332 | |
| 15:30 | 6.54 | 0.04 | Dry | 2,397 | Water off. Water instantly infiltrated as soon as water was shut off |

| | |
|---|-------|
| Average Infiltration Rate (in/hr) during last hour of inflow: | 103.3 |
| Average Infiltration Rate (in/hr) during falling head: | N/A |

Spanaway Park Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used for relative reference. Elevation 100 represents ground surface.

x Staff Gauge #1 Hand Data

—●— Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)
Cell: Raingarden 1

Assessed On:
October 5, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The tested bioretention cell was constructed in 2012 and collects runoff from the adjacent street. The cell is designed to have 1.5 ft of bioretention soil mix in the base which tapers out on the side slopes. Below the bioretention soil is 0.5 ft of scarified subsoil. All water is designed to infiltrate into the native soil, however there is a notched weir structure in the berm that is designed to disperse the energy of any overflow with a rock energy dissipation/ dispersion pad. Overflow water will discharge into the yards of adjacent residential properties.

BIORETENTION SOIL:

Thickness: 0.3-2.2 ft

The apparent thickness of the bioretention soil based on probe data and hand augers ranged from 0.3-2.2 ft below the ground surface with an average thickness of 1.7 ft. The soil is thicker in the base of the cell, otherwise it is consistent with the design.

Composition:

Plans call out special soil mix for bioretention area shall consist of 2 parts compost and 3 parts mineral aggregate with 8-10 percent organic matter. Mineral aggregate and compost material specifications are noted in page 7 of the design plans. The tested samples have significantly higher fine sand and silt content than the aggregate material specifications per design and the 2019 Ecology specifications. The tested samples also had a higher organic content than the special soil mix specifications per design and the 2019 Ecology specifications.

Organic Matter Content (% by weight): 29.3

Percent passing #200 sieve: 19.2

Coefficient of Uniformity (Cu): N/A

Coefficient of Curvature (Cc): N/A

SUBGRADE CONDITIONS:

Geologic Unit: Fill/Unknown

Soil Description: Slightly moist, dense, light brown to grey, gravelly, silty, fine to medium SAND, some coarse sand (SM)

Soil is stated as Alderwood gravelly, sandy loam over Vashon glacial till plains in the Targeted Drainage Report by Snohomish County Public Works. The drainage report references a geotechnical report that states 1-2 ft of fill observed over weathered till.

BUILT PER PLAN:

The overflow weir structure was buried by sediment upon arrival to the site, sediment was removed by field staff in the locating of the structure, gravel dispersion features remain buried. Special soil mix does not meet the specifications per the design for the bioretention soil. Otherwise, the cell was generally constructed consistent with the design plans.

GROUNDWATER CONDITIONS:

The temporary Wellpoint we installed was screened 1.2-1.7 ft below ground surface, and did not encounter groundwater. The Wellpoint responded to infiltration testing with the minimum measured

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)
 Cell: Raingarden 1

Assessed On:
 October 5, 2023



water level above the ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 39
 Subgrade Soil Rate (in/hr): 17.6

The bioretention soil infiltration rate was calculated during the first hour of testing before the storage in the bioretention soil was full. The constant head rate from the final hour of testing represents the infiltration rate of the subgrade soils. The infiltration rate of the subgrade soils is not consistent with the mapped geology of weathered Vashon Till. Hand augers completed within the cell did not fully penetrate the underlying subgrade due to the presence of dense gravels.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

The overflow weir was buried by mulch/ wood chips, for this feature to function as designed this structure should be kept clear.

Field Conditions

| | | | |
|-----------------|---------------------|---------------|------------------|
| Weather | Overcast 50s | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Evan Paul | | Half Day: |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 1 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: FA_SitePhotos-20231005-153847.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)

Cell: Raingarden 1

Assessed On:
October 5, 2023



Site Photo: FA_SitePhotos-20231005-153928.jpg



Site Photo: FA_SitePhotos-20231005-155452.jpg



Site Photo: FA_SitePhotos-20231005-153955.jpg



Site Photo: FA_SitePhotos-20231005-155517.jpg



Site Photo: FA_SitePhotos-20231005-154009.jpg



Site Photo: FA_SitePhotos-20231005-172206.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)

Cell: Raingarden 1

Assessed On:

October 5, 2023



Cell Construction

| | |
|--|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments This bioretention cell is rectangular and contained by earth berms on 3 sides and an earth/asphalt berm on the 4th side. Water is conveyed to the cell via a catch basin located on the south side of the cell which collects water from adjacent road and drains into the cell through a 10" black corrugated pipe. Water is designed to infiltrate through the bioretention soil before reaching the scarified native soil/ fill. A designed over flow spillway is constructed on the southwest side of the cell, where water will overflow into the backyard of the adjacent residence. | |

Inlets

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)

Cell: Raingarden 1

Assessed On:

October 5, 2023



IN-1

- Curb cut Sheet Flow
- Dispersed Flow Pipe
- Other:

Pipe:

Material

- PVC Metal Concrete Other

Diameter: 0.83'

Energy Dissipation

Angular Rock: Buried

Stream Cobble: n/a

Water Wheel: n/a

Splash Block: n/a

Concrete Apron: n/a



FA_INphoto-20231005-160719.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)

Cell: Raingarden 1

Assessed On:
October 5, 2023



Erosion Present? Yes No

Blockage Present? Yes No
Approximately 10% blocked

Types:

Sediment Organic Rock
 Trash Vegetation

Additional Details:



FA_INBLPhoto-20231005-160709.jpg

Additional Details:

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)

Cell: Raingarden 1

Assessed On:

October 5, 2023



Hand Auger

| | |
|--|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 2 |
| to Import/Underdrain: | |
| Total Depth: | 2.1 |
| Rain/Garden Mix Soil Texture: Slightly moist, medium dense, dark to grey brown, silty, fine to medium SAND, some coarse sand, abundant organics (SM) | |
| Native Soil Texture: Fill: Slightly moist, dense, light brown to grey, gravelly, silty, fine to medium SAND, some coarse sand (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |

| | |
|--|---|
| HA-2 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |
| to Native Soil: | 1.7 |
| to Import/Underdrain: | |
| Total Depth: | 1.9 |
| Rain/Garden Mix Soil Texture: Slightly moist, medium dense, dark to grey brown, silty, fine to medium SAND, some coarse sand, abundant organics (SM) | |
| Native Soil Texture: Fill: Slightly moist, dense brown to grey with some oxidation, gravelly, silty, fine to medium SAND, some coarse sand (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details | |

| | |
|--|-----|
| HA-3-WP | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 | |
| <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.2 |

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)
 Cell: Raingarden 1

Assessed On:
 October 5, 2023



| | |
|--|---|
| HA-3-WP | |
| to Native Soil: | 2 |
| to Import/Underdrain: | |
| Total Depth: | 2.3 |
| Rain/Garden Mix Soil Texture: Slightly moist, medium dense, dark brown to black, silty, fine to medium SAND, some coarse sand, trace gravel, abundant organics (SM) Native Soil Texture: Fill: Slightly moist, dense brown to grey with some oxidation, gravelly, silty, fine to medium SAND, some coarse sand (SM) | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Well Point Detail Is the well point dry? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth to water from TOC (ft): Respond to Testing: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Shallowest Depth to water during testing from Ground Surface (ft): 0 | |
| Additional Details Shallowest depth to water during the test was above the ground surface. | |



FA_FPhoto-20231005-172432.jpg

Infiltration Test

| | |
|--|----------|
| IT-1 | |
| Water Supply <input type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input checked="" type="checkbox"/> Water Truck | |
| AESI Meter# | |
| Wet ed Pond Area (sq. ft) | 54 |
| Ponded Depth (ft) | 0.22 |
| Total Gallons | 3,685.17 |
| Steady State Flow Rate (GPM) | 10 |
| Additional Details: Additional test details can be found in the executive summary. | |



IT_Photo-20231005-172507.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: 174th cul-de-sac (ST174)

Cell: Raingarden 1

Assessed On:
October 5, 2023



SITE: 174TH CUL-DE-SAC (ST174) CELL: RAINGARDEN 1





associated
earth sciences
incorporated

Well Point

ST174-HA-3-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 10/4/23

Logged By: EAP

20150387H008

Ending Date: 10/4/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2.3

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.3

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 105.1

Water Level Elevation (ft): N/A

Datum: Project Datum

∇ Groundwater Depth ATD (ft): N/A

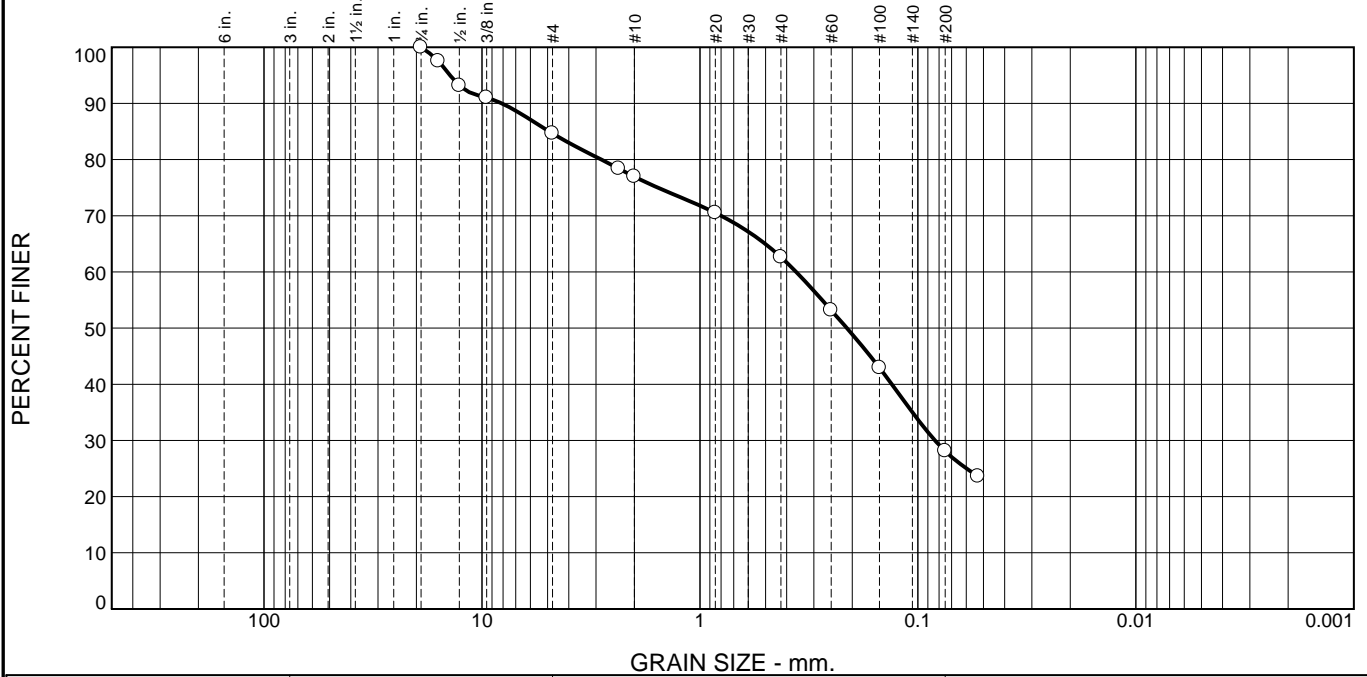
∇ Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|---|-------------|----------|----|----|----|-----|--|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Coarse, rectangular, woody bark chips. | | | | | | | Stickup -5.1 to 0 feet Existing bioretention soils 0 to 0.8 feet 1.25-inch I.D. threaded galvanized steel casing - 5.1 to -0.8 feet; duct tape covers screen -0.8 to 1.2 feet 3/8-inch bentonite chips 0.8 to 1 feet Medium grain silica sand 1 to 2.3 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.2 to 1.7 feet Cast iron endcap 1.7 to 2 feet Cast iron drivepoint 2 to 2.3 feet |
| 0.8 | Hand | 1 | [Symbol] | Bioretention Soil Mix Medium dense, slightly moist, dark brown to black, silty, fine SAND, trace gravel; abundant organics (SM). | | | | | | | |
| 1.2 | Hand | 2 | [Symbol] | Medium dense, slightly moist, gray to brown, fine to medium SAND, trace coarse sand, trace gravel; abundant organics (SP-SM). | | | | | | | |
| 2.3 | | | | Fill Dense, slightly moist, brown, gravelly, silty, fine SAND; hard digging (SM). No seepage. No caving. Refusal at 2.3 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |

12/18/2023

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 15.3 | 7.7 | 14.4 | 34.5 | 28.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 97.5 | | |
| 1/2" | 93.2 | | |
| 3/8" | 91.0 | | |
| #4 | 84.7 | | |
| #8 | 78.4 | | |
| #10 | 77.0 | | |
| #20 | 70.5 | | |
| #40 | 62.6 | | |
| #60 | 53.2 | | |
| #100 | 42.9 | | |
| #200 | 28.1 | | |
| #270 | 23.6 | | |

Material Description

gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 8.1157 D₈₅= 4.9146 D₆₀= 0.3619
D₅₀= 0.2119 D₃₀= 0.0835 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 10-05-2023 Date Tested: 11-29-2023

Tested By: FEW

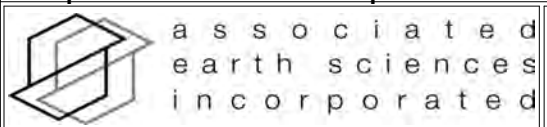
Checked By: EAP/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Stanwood-174th Cul de Sac
Sample Number: HA-1 Depth: 2'

Date Sampled: 10-5-2023

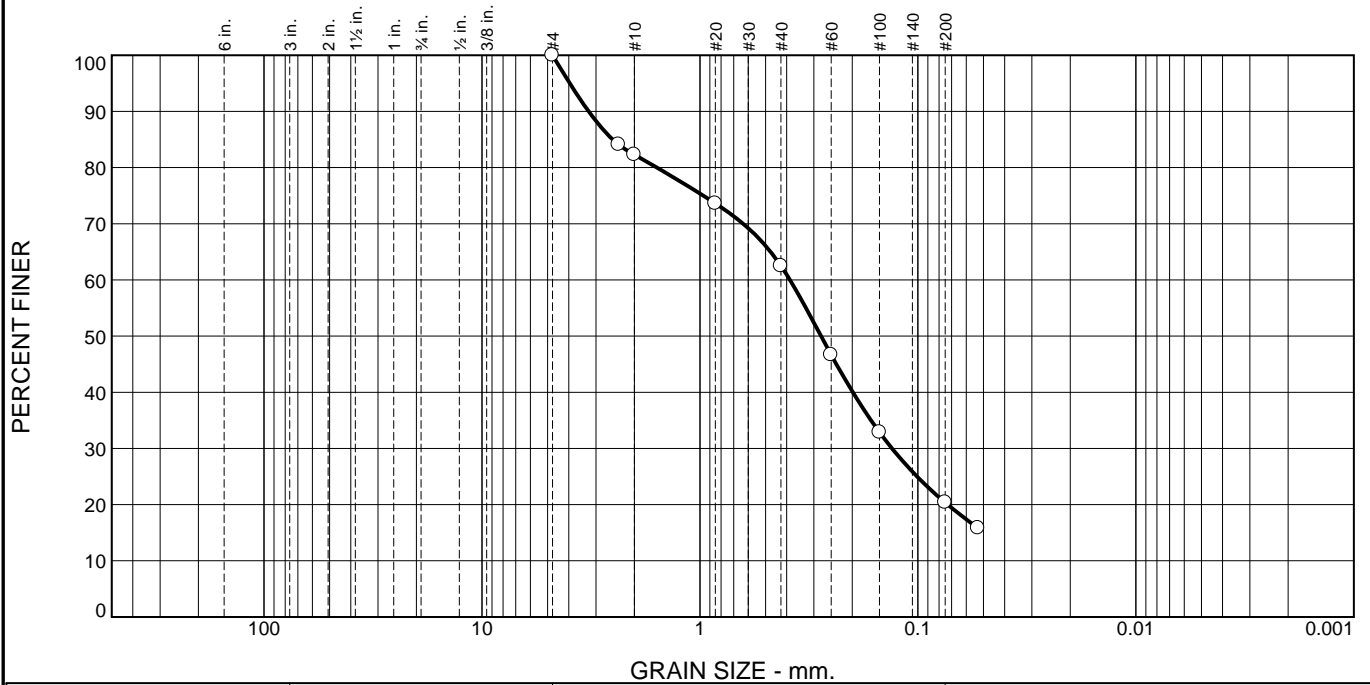


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 0.0 | 17.7 | 19.8 | 42.1 | 20.4 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| #4 | 100.0 | | |
| #8 | 84.1 | | |
| #10 | 82.3 | | |
| #20 | 73.6 | | |
| #40 | 62.5 | | |
| #60 | 46.7 | | |
| #100 | 32.9 | | |
| #200 | 20.4 | | |
| #270 | 15.8 | | |

Material Description

silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 3.2403 D₈₅= 2.5151 D₆₀= 0.3863
D₅₀= 0.2782 D₃₀= 0.1314 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 10-05-2023 Date Tested: 11-29-2023

Tested By: FEW

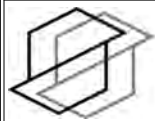
Checked By: EAP/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Stanwood-174th Cul de Sac
Sample Number: HA-2 **Depth:** .4'

Date Sampled: 10-5-2023



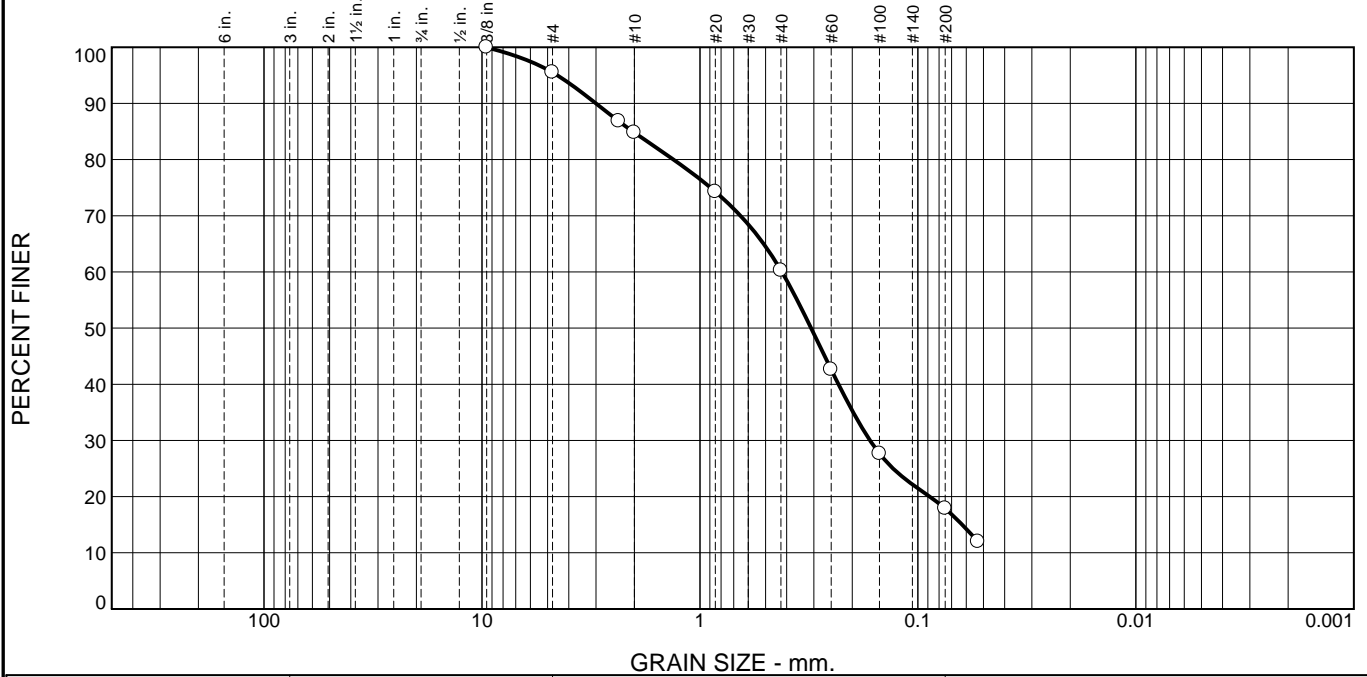
a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 4.5 | 10.7 | 24.5 | 42.4 | 17.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/8" | 100.0 | | |
| #4 | 95.5 | | |
| #8 | 86.8 | | |
| #10 | 84.8 | | |
| #20 | 74.3 | | |
| #40 | 60.3 | | |
| #60 | 42.6 | | |
| #100 | 27.7 | | |
| #200 | 17.9 | | |
| #270 | 12.0 | | |

Material Description

silty SAND trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 3.0029 D₈₅= 2.0306 D₆₀= 0.4208
D₅₀= 0.3089 D₃₀= 0.1658 D₁₅= 0.0626
D₁₀= C_u= C_c=

Remarks

Date Received: 10-05-2023 Date Tested: 11-27-2023

Tested By: FEW

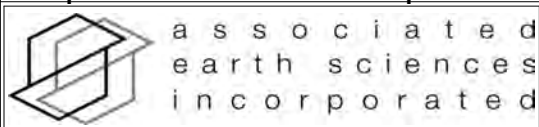
Checked By: EAP/JHS

Title: _____

* (no specification provided)

Location: Onsite - BHPS-Stanwood - 174 Cul de Sac
Sample Number: HA-3WP Depth: 0.3'

Date Sampled: 10-5-2023

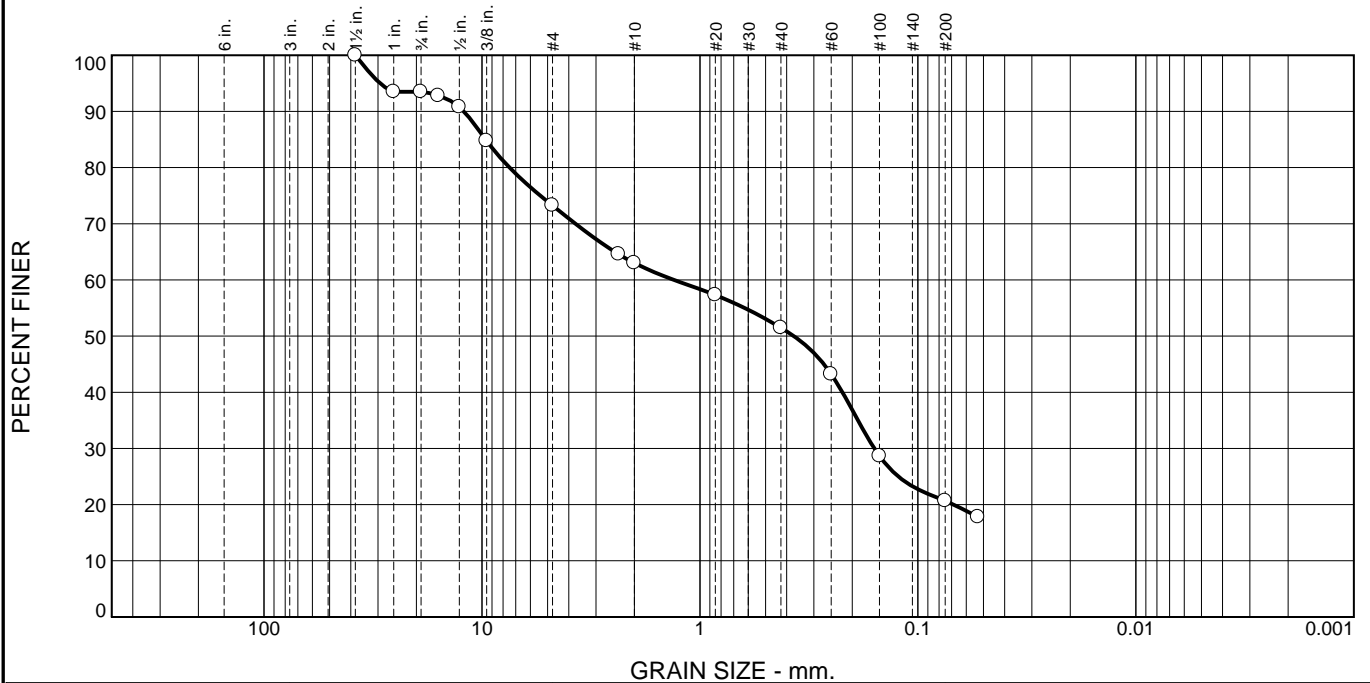


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 6.5 | 20.2 | 10.3 | 11.5 | 30.8 | 20.7 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 93.5 | | |
| 3/4" | 93.5 | | |
| 5/8" | 92.8 | | |
| 1/2" | 90.8 | | |
| 3/8" | 84.8 | | |
| #4 | 73.3 | | |
| #8 | 64.6 | | |
| #10 | 63.0 | | |
| #20 | 57.3 | | |
| #40 | 51.5 | | |
| #60 | 43.2 | | |
| #100 | 28.7 | | |
| #200 | 20.7 | | |
| #270 | 17.8 | | |

* (no specification provided)

Material Description

gravelly silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 12.1055 D₈₅= 9.6274 D₆₀= 1.3146
D₅₀= 0.3709 D₃₀= 0.1584 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 10-05-2023 Date Tested: 11-29-2023

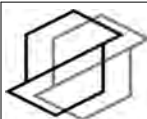
Tested By: FEW

Checked By: EAP/JHS

Title: _____

Location: Onsite - BHPS-Stanwood-174th Cul de Sac
Sample Number: HA-3-WP **Depth:** 2.2'

Date Sampled: 10-5-2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|----------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 10/5/2023 | Project BHPS - ST174 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Stanwood, Wa. | EB/EP No. ST174-HA | Depth Various | |

Moisture Content

| Sample ID | HA-2 @ .4' | HA-3 @ 0.3' |
|--------------------|------------|-------------|
| Wet Weight + Pan | 904.8 | 447.2 |
| Dry Weight + Pan | 673.9 | 374.9 |
| Weight of Pan | 392.0 | 258.1 |
| Weight of Moisture | 230.8 | 72.4 |
| Dry Weight of Soil | 281.9 | 116.8 |
| % Moisture | 81.9 | 62.0 |

Organic Matter and Ash Content

| | | |
|-------------------------------|-------|-------|
| Dry Soil Before Burn + Pan | 673.9 | 374.9 |
| Dry Soil After Burn + Pan | 583.2 | 344.1 |
| Weight of Pan | 392.0 | 258.1 |
| Wt. Loss Due to Ignition | 90.7 | 30.8 |
| Actual Wt. Of Soil After Burn | 191.2 | 86.0 |
| % Organics | 32.2 | 26.3 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|---------------------|--------------------------------|--|
| Project Name: | 174th Pl Cul-de-sac | Water Source: | Water Truck |
| Project Number: | 20150387H008 | Meter: | FM-3 (3-50) |
| Date: | 10/5/2023 | Wetted Area (sq. feet): | 09:03 37.4 ft ² / 10:04 54 ft ² / 11:36 54 ft ² |
| Weather: | Clear | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.22 |
| Performed By: | EAP | Receptor Soils: | Fill/Unknown |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|----------------------|---------------------|---|
| 8:10 | 14.42 | 0 | | | Water on |
| 8:20 | 15.37 | 0.02 | | 137 | TD = 6.8' btoc |
| 8:30 | 15.79 | 0.08 | 6.01 | 295 | |
| 8:45 | 15.79 | 0.1 | 5.56 | 530 | |
| 9:00 | 15.68 | 0.12 | 5.31 | 766 | |
| 9:16 | 15.52 | 0.14 | 5.19 | 1,015 | |
| 9:30 | 15.4 | 0.16 | 5.11 | 1,232 | |
| 9:45 | 15.26 | 0.18 | 5.07 | 1,462 | |
| 10:00 | 15.12 | 0.19 | 5.04 | 1,689 | |
| 10:05 | 10.06 | | | | Decrease flow to 10 gpm |
| 10:09 | 12.04 | | | | Head started decreasing so increased flow to 12 gpm |
| 10:15 | 12.08 | 0.18 | 5.05 | 1,879 | |
| 10:30 | 11.93 | 0.19 | 5.04 | 2,059 | |
| 10:35 | 10.93 | | | | Decrease flow |
| 10:45 | 10.92 | 0.19 | 5.04 | 2,228 | |
| 11:00 | 10.85 | 0.19 | 5.04 | 2,392 | |
| 11:15 | 10.8 | 0.2 | 5.03 | 2,554 | |
| 11:30 | 10.7 | 0.2 | 5.03 | 2,716 | |
| 11:32 | 10.07 | | | | Decrease flow |
| 11:45 | 10.04 | 0.2 | 5.03 | 2,867 | |
| 12:00 | 9.95 | 0.2 | 5.02 | 3,017 | |
| 12:15 | 9.86 | 0.2 | 5.02 | 3,166 | |
| 12:30 | 10 | 0.21 | 5.02 | 3,315 | |
| 12:45 | 9.95 | 0.22 | 5.01 | 3,466 | |
| 13:00 | 10.04 | 0.22 | 5 | 3,615 | |
| 13:07 | | 0.22 | 5 | 3,685 | Water off |
| 13:10 | | 0.18 | 5.05 | | |
| 13:11 | | 0.16 | 5.06 | | |
| 13:12 | | 0.14 | 5.09 | | |
| 13:13 | | 0.12 | 5.11 | | |
| 13:14 | | 0.1 | 5.13 | | |
| 13:15 | | 0.08 | 5.15 | | |
| 13:16 | | 0.06 | 5.17 | | |
| 13:17 | | 0.04 | 5.19 | | |
| 13:18 | | 0.02 | 5.21 | | |

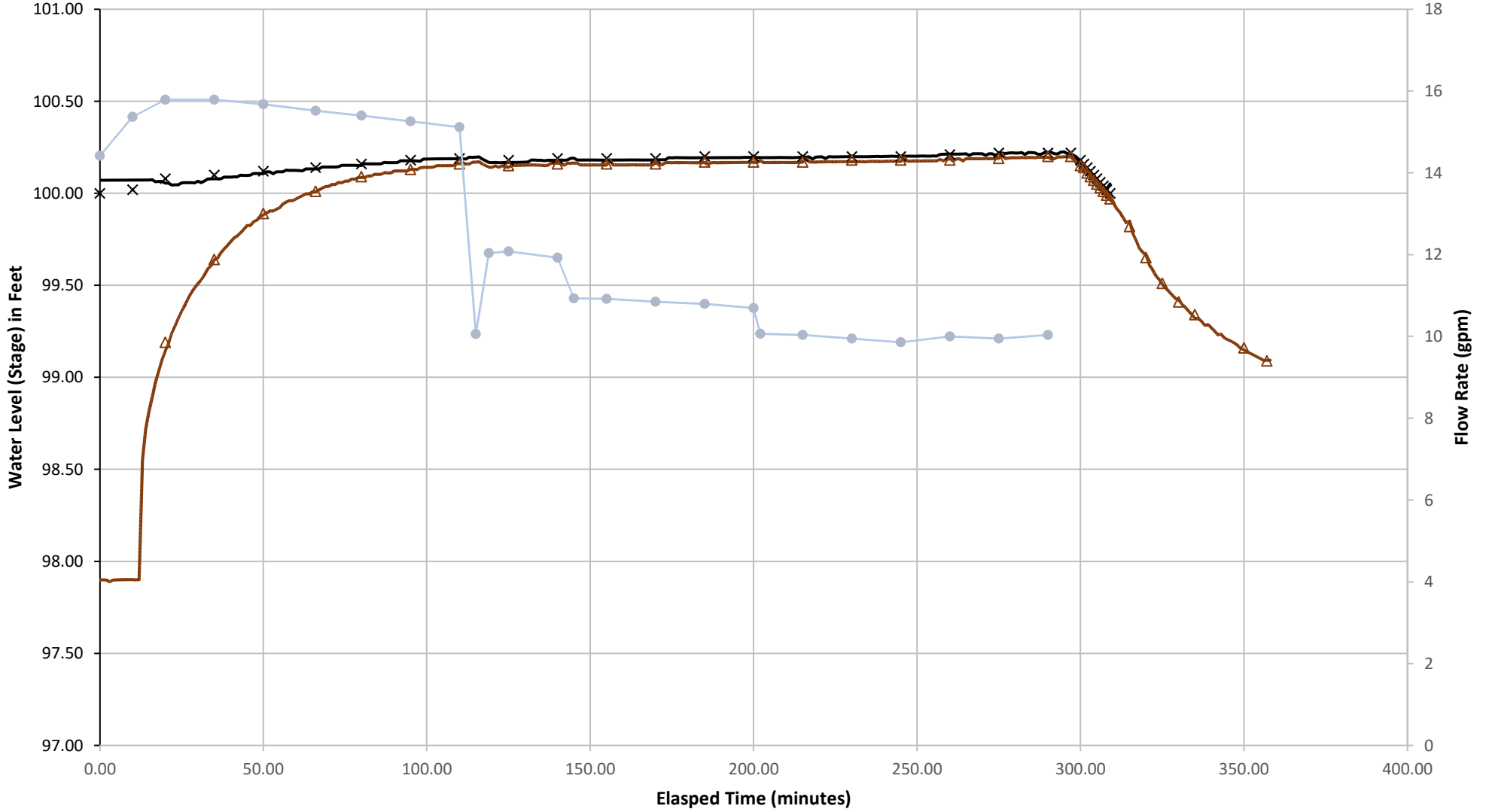
| | | | | | |
|-------|--|---|------|--|--|
| 13:19 | | 0 | 5.23 | | |
| 13:25 | | | 5.38 | | |
| 13:30 | | | 5.55 | | |
| 13:35 | | | 5.69 | | |
| 13:40 | | | 5.79 | | |
| 13:45 | | | 5.86 | | |
| 14:00 | | | 6.04 | | |
| 14:07 | | | 6.11 | | |

| | |
|---|------|
| SG-1 Average Infiltration Rate (in/hr) during first hour of inflow: | 39.0 |
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 17.6 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 13.1 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 18.0 |
| WP Average Infiltration Rate (in/hr) during falling head: | 13.5 |

174th Cul de Sac Infiltration Test

Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not referenced and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
- Staff Gauge #1 Logger
- △ Wellpoint Hand
- Wellpoint Logger
- Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 1

Assessed On:
August 22, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The bioretention facilities at the Woods at Golden Given Habitat for Humanity housing development was constructed in 2012. As built plans were not provided for this site and the manner in which water is conveyed to the cell is not immediately apparent. It is assumed that all water is designed to infiltrate through bioretention soil, through drain rock and then into the ground.

BIORETENTION SOIL:

Thickness: 0.3-1.2 ft

The apparent thickness of loose bioretention soil based on probe data and hand augers ranged from 0.3-1.2 ft, with shallower depths near the edges. One zone of compaction was observed in the north central end of the cell, adjacent to landscape rockery where base of cell probe measurements were 0.2' to 0.3' deep. Based on multiple young children active in the area during testing, this is a possible play area for children.

Composition:

Without available plans for this site, bioretention soil specifications are unknown. In comparison to the 2019 Ecology specifications for bioretention soil, all samples met the organic content specification. Only one sample (HA-2) was mostly consistent with the 2019 Ecology guidelines for grain size distribution, with slightly higher silt content. The other two tested sample were not consistent with the 2019 Ecology specifications for grain size distribution and had high percentages of gravels and fines.

Organic Matter Content (% by weight): 6.5

Percent passing #200 sieve: 17.4

Coefficient of Uniformity (Cu): 18.5

Coefficient of Curvature (Cc): 1.2

SUBGRADE CONDITIONS:

Geologic Unit: Fill/ Unknown

Soil Description: N/A

Hand augers were unable to reach subgrade due to the presence of drain rock beneath the bioretention soil. The site is mapped as Vashon Till by Booth, Troost and Schimel (2009).

BUILT PER PLAN:

Without available plans for this site, bioretention facility specifications are unknown. A catch basin was observed outside and adjacent to the cell, northeast and next to the road, but the stick-up height is about 0.1 feet above adjacent porous pavement. The pipes inside the catch basin face east/west, with water flowing from under the street, not from the cell (south). Water was not flowing in the catch basin at the start of the test, but audibly flowing during and after the test. Signs in the neighborhood stated Tacoma water was flushing their water mains. It is unclear what was intended for this catch basin structure and if it relates to the bioretention facility.

GROUNDWATER CONDITIONS:

The WellPoint we installed was screened 1.7-2.2 ft below ground surface and did not encounter groundwater. The WellPoint responded to infiltration testing and rose to a minimum depth of 0.18 ft

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 1

Assessed On:
August 22, 2023



below ground surface.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): 28

Subgrade Soil Rate (in/hr): 0.2

Bioretention soil infiltration rate was calculated using the data from staff gauge 1. Subgrade soil infiltration rate was calculated using the first hour of falling head in the WellPoint. Hydrant pressure fluctuates throughout the test, possibly due to water main flushing in the neighborhood. Field staff dropped flow rate at 14:23 due to lateral flow into an animal burrow, burrow filled at 15:15 and pond stabilized.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

Communication with residents may be useful to explain the purpose of bioretention facilities and how they are designed to operate. Two bioretention cells have been filled in at this location, cells numbered 4 and 10, due to potential lack of understanding and/or conflicting desired use for the space.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------------------|------------------|
| Weather | Cloudy, 70s | | |
| Recent Rainfall | Today: 0.01" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | Half Day: Catherine Ikeda | |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Count: 2 | Standing Water Present? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)

Cell: Cell 1

Assessed On:
August 22, 2023



Site Photo: FA_SitePhotos-20230822-122121.jpg

Site Photo: FA_SitePhotos-20230822-122122.jpg



Site Photo: FA_SitePhotos-20230822-122150.jpg



BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 1


Assessed On:
 August 22, 2023



Cell Construction

| | |
|---|---|
| Irrigation | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Irrigation show in design plans, not observed on site, plants appear dry and struggling. |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 20% |
| Standing Water | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Comments The manner in which water is conveyed to the cell was not clearly observed, or described in the plans provided to the project. There is indication that houses labeled 7 and 9 have some relationship to the bioretention cell, possibly the roof run off is intended to be directed to the cell. No inlet pipes were observed leading to the cell. The concrete pathway to house 8 provides some sheet flow into the cell. The pavement around 2 sides of the cell is porous concrete and has a 0% slope, and is not a likely source of runoff. Water appears to be designed to infiltrate through the bioretention soil before reaching a layer of angular gravel above native soils. The adjacent pervious pavement may act as an overflow feature. The catch basin observed to the north east of the cell is higher in elevation than the pavement, and did not appear to be part of the cell design. | |

Inlets

| | | |
|---|---|---|
| IN-1 <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: Width: 35' Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |  <p>FA_INphoto-20230822-203840.jpg</p> |
| Erosion Present? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Severity: Minor Some scours were observed where water has entered the cell in the SW corner adjacent to walkway leading to house, this could be from pressure washing sidewalk or surface irrigation runoff. | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: No energy dissipation features were observed. | | |

BIORETENTION CELL FIELD ASSESSMENT


Site: The Woods at Golden Given (TAWG)
Cell: Cell 1

Assessed On:
August 22, 2023



Design Overflow/Outlet

| | |
|---|-------------|
| DO - 1 | |
| Shape: | Dimensions: |
| <input type="checkbox"/> Round | |
| <input type="checkbox"/> Rectangular | |
| <input checked="" type="checkbox"/> Other: Pervious pavement of the adjacent street (cell will overflow into street before the catch basin located outside of the cell to the NE) | |
| Additional Details: 34' along the east side of cell, 16.6' along south side of cell. | |
| Stickup (ft) | |
| From Ground: 0.1 | |
| Relative from staff gauge: 0.6 | |
| Damage Indicators: | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Trash Rack: | |
| <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |
| Additional Details: | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |



FA_DOPhoto-20230822-223817.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 1

Assessed On:
 August 22, 2023



| | |
|---|--|
| DO - 2 | |
| Shape: <input type="checkbox"/> Round <input checked="" type="checkbox"/> Rectangular <input type="checkbox"/> Other | Dimensions: Length: 1.45' Width: 1.45' |
| Additional Details: | |
| Stickup (ft) From Ground: 0.25 Relative from staff gauge: 0.7 | |
| Damage Indicators: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No This catch basin may not be part of the design for this cell as it is several feet outside of the perimeter of the cell. The height of the trash rack is slightly above the level of the adjacent pervious pavement roadway. Pipes were observed in the catch basin conveying a consistent flow of water from the east, to the west for the entirety of the test, and after water was shut off. Folding signs for water main flushing were observed in the neighborhood, which may be the source of the flowing water. | |
| Trash Rack: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Approximately 0% blocked Additional Details: The spaces between the trash rack bars were too narrow to fit a water level tape or place a pressure transducer into the catch basin to track water levels for the duration of the test. | |
| Overflow Blocked? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | |



FA_DOPhoto-20230822-224049.jpg

Cell Surface and Geotech Probe Observations

| | | | | | | |
|---|--|---|-----------------------------------|-----------------------------------|---|------------------|
| Mulch: <input type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input checked="" type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | | | | | | Depth (ft): 0.15 |
| Cell Coverage | | | | | | |
| Mulch | <input type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input checked="" type="checkbox"/> 75 - 100% | |
| Bare Ground | <input type="checkbox"/> None | <input checked="" type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Other | <input checked="" type="checkbox"/> None | <input type="checkbox"/> < 25% | <input type="checkbox"/> 25 - 50% | <input type="checkbox"/> 50 - 75% | <input type="checkbox"/> 75 - 100% | |
| Grass and herbaceous weeds grow over the mulch layer. Garbage was observed in the cell. | | | | | | |
| Pest Evidence | | | | | | |
| Animal Burrows | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Animal Plant Damage | <input type="checkbox"/> Yes | <input checked="" type="checkbox"/> No | | | | |
| Large Deposition of Feces | <input checked="" type="checkbox"/> Yes | <input type="checkbox"/> No | | | | |
| Additional Details: Some scat erred animal feces found in the cell. Potentially could be from house pets as the cell is located in a neighborhood. A small animal burrow was observed in the base of the north end of the cell, water was flowing into this early in the test, but ponded up by 1515. A ground hornet nest was observed in the east side slope of the cell, as water rose the hornets grew more agitated, this limited access to that zone of the cell. | | | | | | |
| Vegetation Description | | | | | | |

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 1

Assessed On:
 August 22, 2023



Vegetation consists of mostly grass and a few small shrubs. Observation of testing was not limited by vegetation.

Additional Details

Geotech Probe Observations: At the cell base, probe measurements found 0.3-1.2' of bioretention soil, with an average of 0.8', before encountering the underlying native soil. On the cell edges, less than 1 foot of soil was encountered above native soils. Bioretention facility as built plans were not available for this site. One zone of compaction was observed in the north central end of the cell, adjacent to landscape rockery where base of cell probe measurements were 0.2' to 0.3' deep. This could be a play area for children in the neighborhood. The central eastern area of the cell was not probed due to the presence of ground hornets.

Hand Auger

HA-2

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.15

to Native Soil:

to Import/Underdrain: 1

Total Depth: 1

Rain/Garden Mix Soil Texture: Loose, slightly moist, gray-brown, fine to medium sand, some silt, some coarse sand, trace gravel, sparse organics (SP-SM)

Native Soil Texture:

Liner Present:
 Yes No

Filter Fabric Present:
 Yes No
 Filter fabric located 1' below ground surface. Fabric is sitting on top of angular gravel.



FA_FPhoto-20230822-122908.jpg

Additional Details

HA-3

Zone 1 Zone 2 Zone 3
 Outside Cell

Depth (ft)

to Bioretention Soil: 0.15

to Native Soil:

to Import/Underdrain: 1

Total Depth: 1

Rain/Garden Mix Soil Texture: Loose, slightly moist, gray-brown, silty fine to medium sand, some coarse sand, some gravel, abundant organics (SM)

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 1

Assessed On:
 August 22, 2023



| | | |
|---|--|---|
| HA-3 | |  |
| Native Soil Texture: | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Filter fabric found at 1', located above angular gravel | |
| Additional Details | | FA_FPhoto-20230822-123508.jpg |

| | | |
|---|--|--|
| HA-1WP | | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | | |
| Depth (ft) | | |
| to Bioretention Soil: | 0.15 | |
| to Native Soil: | | |
| to Import/Underdrain: | 1.2 | |
| Total Depth: | 2 | |
| Rain/Garden Mix Soil Texture: Medium dense, slightly moist, grey brown silty fine to medium SAND, some coarse sand, some gravel, few organics (SM) | | |
| Native Soil Texture: Drain Rock: Loose, slightly moist, gray, angular, coarse GRAVEL, trace sand, trace silt (GP) | | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Filter fabric found at 1.2', located above angular gravel | |

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 1

Assessed On:
 August 22, 2023



HA-1WP

Well Point Detail

Is the well point dry? Yes No
 Depth to water from TOC (ft):
 Respond to Testing: Yes No
 Shallowest Depth to water during testing from Ground Surface (ft): 0.18



FA_FPhoto-20230822-123611.jpg



FA_FPhoto-20230822-205339.jpg

Additional Details

Excessive caving was observed at depths below 1.2', bot om of hole was 2' below ground surface due to no returns. Native soil was not encountered.

Infiltration Test

IT-1

Water Supply

Hydrant Hose Bib Irrigation Tap Water Truck

AESI Meter# FM-6 (10-100)

Wet ed Pond Area (sq. ft) 206

Ponded Depth (ft) 0.26

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 1

Assessed On:
August 22, 2023



| | |
|--|--------|
| Total Gallons | 23,119 |
| Steady State Flow Rate (GPM) | 58 |
| Additional Details: Hydrant fluctuates pressure through out the test, possibly due to water main flushing in neighborhood. Field staff dropped flow rate at 14:23 due to lateral flow into an animal burrow, burrow filled at 15:15 and pond stabilized. Additional test details can be found in the executive summary. | |



IT_Photo-20230822-223017.jpg



IT_Photo-20230822-223048.jpg



IT_Photo-20230822-223205.jpg

Additional Comments

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)

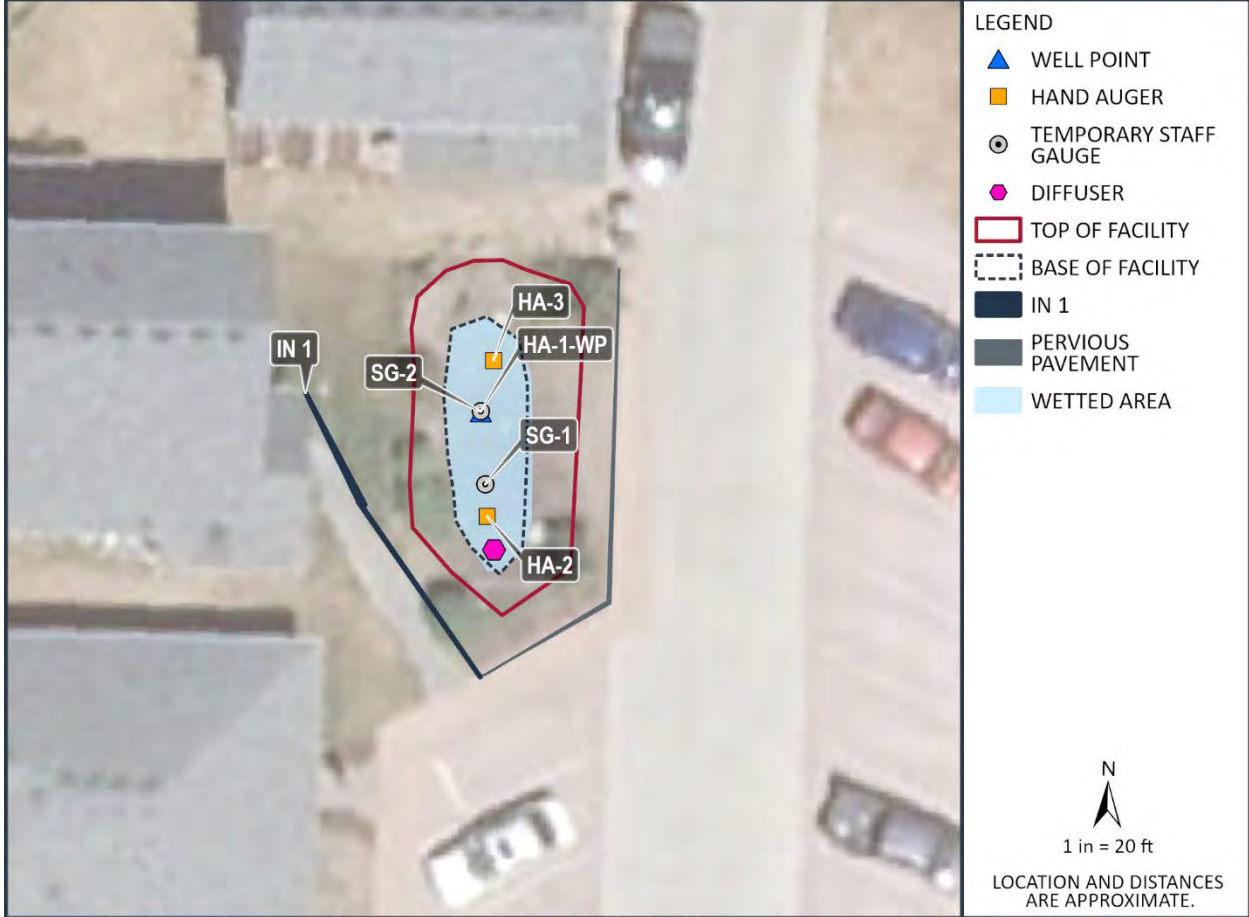
Cell: Cell 1

Assessed On:

August 22, 2023



SITE: THE WOODS AT GOLDEN GIVEN (TAWG) CELL: CELL 1





associated
earth sciences
incorporated

Well Point

TWGG-1-HA-1-WP

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/22/23

Logged By: CSI

20150387H008

Ending Date: 8/22/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 2

Hammer Weight/Drop: N/A

Well Completion Depth (ft): 2.8

Hole Diameter (in): 4

Well Tag No.: N/A

Ground Surface Elevation (ft): 100

Top of Well Casing Elevation (ft): 104.8

Water Level Elevation (ft): N/A

Datum: Project Datum

Groundwater Depth ATD (ft): N/A

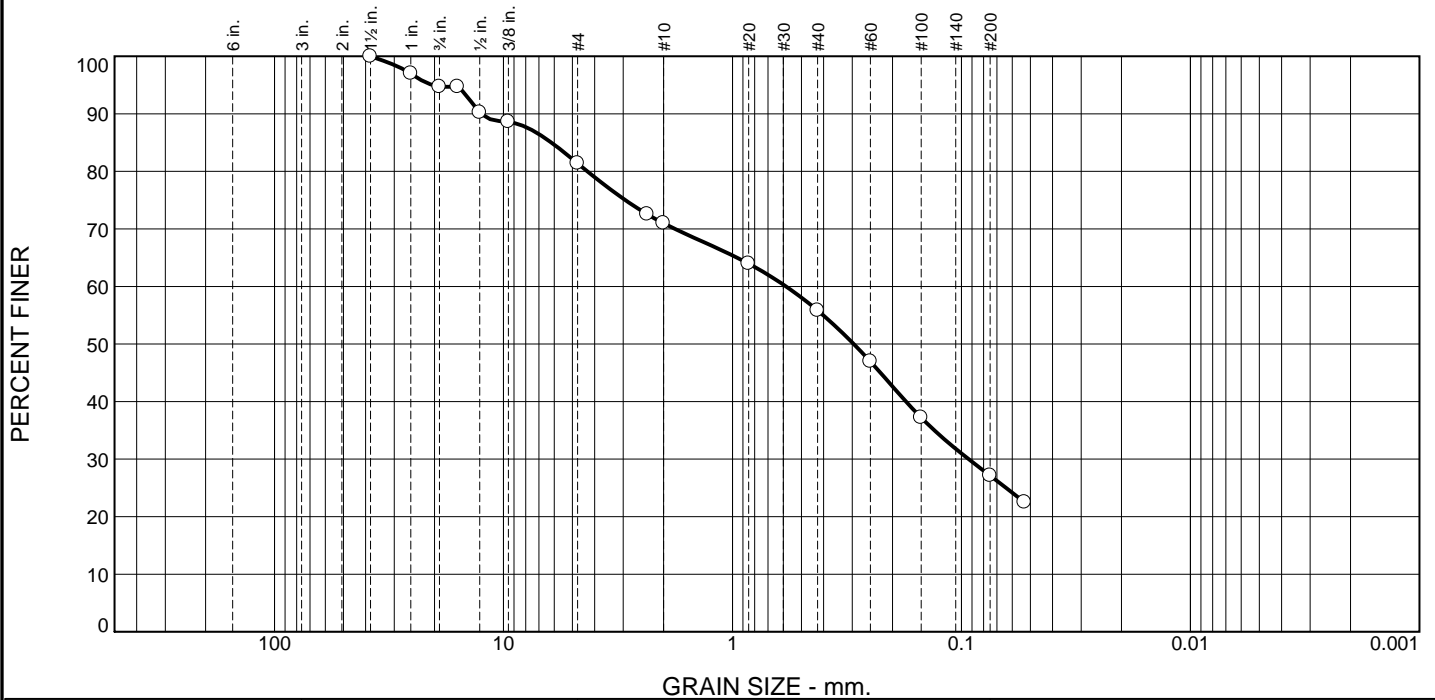
Groundwater Depth Post Drilling (ft) (Date): (N/A)

| Depth (ft) | Sample Type | Sample No. | Graphic Symbol | Description | Water Level | Blows/6" | | | | | Well Construction |
|------------|-------------|------------|----------------|--|-------------|----------|----|----|----|-----|---|
| | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | Mulch Bark mulch and grass. | | | | | | | Stickup -4.8 to 0 feet 1.25-inch I.D. threaded galvanized steel casing -4.8 to -0.3 feet; duct tape covers screen -0.3 to 1.7 feet 3/8-inch Bentonite chips 0.7 to 0.9 feet Native gravel 0.9 to 2 feet 1.25-inch I.D. stainless steel jacket over stainless steel #60 gauze welded to perforated steel 1.7 to 2.2 feet Cast iron endcap 2.2 to 2.5 feet Cast iron drivepoint 2.5 to 2.8 feet |
| 0.5 | | | | Bioretention Soil Mix Medium dense, slightly moist, grayish brown, gravelly, silty, fine SAND, some medium to coarse sand; some organics (SP). | | | | | | | |
| 1.2 | | | | Black filter fabric at 1.2 feet. | | | | | | | |
| 1.5 | | | | Import Gravel Loose, slightly moist, gray, coarse angular GRAVEL (GP). | | | | | | | |
| 2 | | | | No seepage. Moderate caving 0.15 to 1.2 feet; excessive caving 1.2 to 2 feet. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | |
| 3 | | | | | | | | | | | |
| 4 | | | | | | | | | | | |
| 5 | | | | | | | | | | | |
| 6 | | | | | | | | | | | |
| 7 | | | | | | | | | | | |

1/2/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 5.3 | 13.3 | 10.4 | 15.2 | 28.7 | 27.1 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1.5" | 100.0 | | |
| 1" | 97.0 | | |
| 3/4" | 94.7 | | |
| 5/8" | 94.7 | | |
| 1/2" | 90.2 | | |
| 3/8" | 88.6 | | |
| #4 | 81.4 | | |
| #8 | 72.6 | | |
| #10 | 71.0 | | |
| #20 | 64.0 | | |
| #40 | 55.8 | | |
| #60 | 47.0 | | |
| #100 | 37.2 | | |
| #200 | 27.1 | | |
| #270 | 22.5 | | |

* (no specification provided)

Material Description

gravelly, silty SAND

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 12.5241 D₈₅= 6.1755 D₆₀= 0.5830
D₅₀= 0.2955 D₃₀= 0.0931 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8/22/2023 Date Tested: 10/6/2023

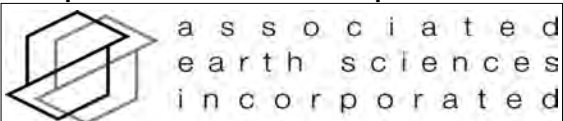
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Woods at Golden Given Cell 1
Sample Number: HA-1 **Depth:** 0.15-1.2'

Date Sampled: 8/22/2023

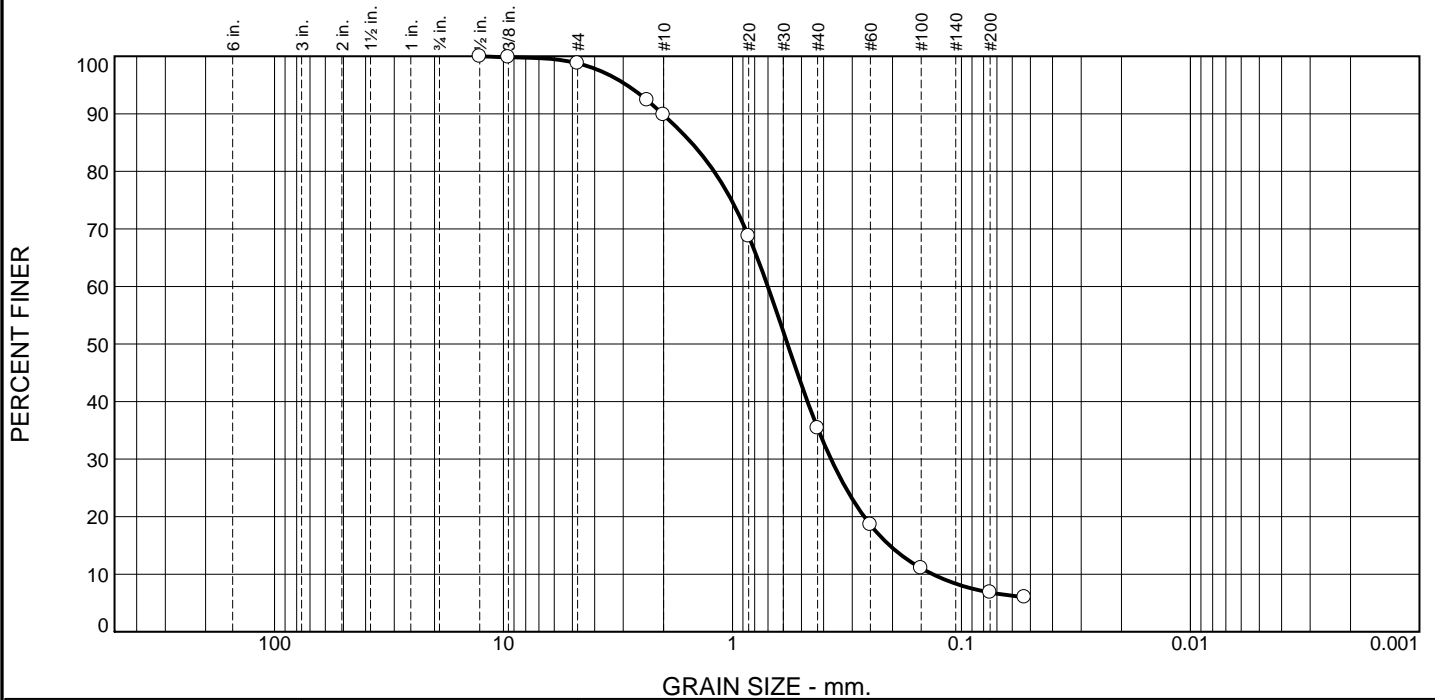


Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 1.2 | 9.0 | 54.4 | 28.6 | 6.8 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 1/2" | 100.0 | | |
| 3/8" | 99.8 | | |
| #4 | 98.8 | | |
| #8 | 92.4 | | |
| #10 | 89.8 | | |
| #20 | 68.7 | | |
| #40 | 35.4 | | |
| #60 | 18.6 | | |
| #100 | 11.0 | | |
| #200 | 6.8 | | |
| #270 | 6.0 | | |

* (no specification provided)

Material Description

SAND, some silt, trace gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SP-SM AASHTO (M 145)= A-1-b

Coefficients

| | | |
|--------------------------|--------------------------|--------------------------|
| D ₉₀ = 2.0229 | D ₈₅ = 1.5108 | D ₆₀ = 0.7007 |
| D ₅₀ = 0.5748 | D ₃₀ = 0.3713 | D ₁₅ = 0.2059 |
| D ₁₀ = 0.1337 | C _u = 5.24 | C _c = 1.47 |

Remarks

Date Received: 8/22/2023 Date Tested: 10/6/2023

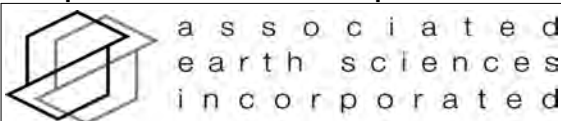
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - Woods at Golden Given Cell 1
 Sample Number: HA-2 Depth: 0.15-1'

Date Sampled: 8/22/2023

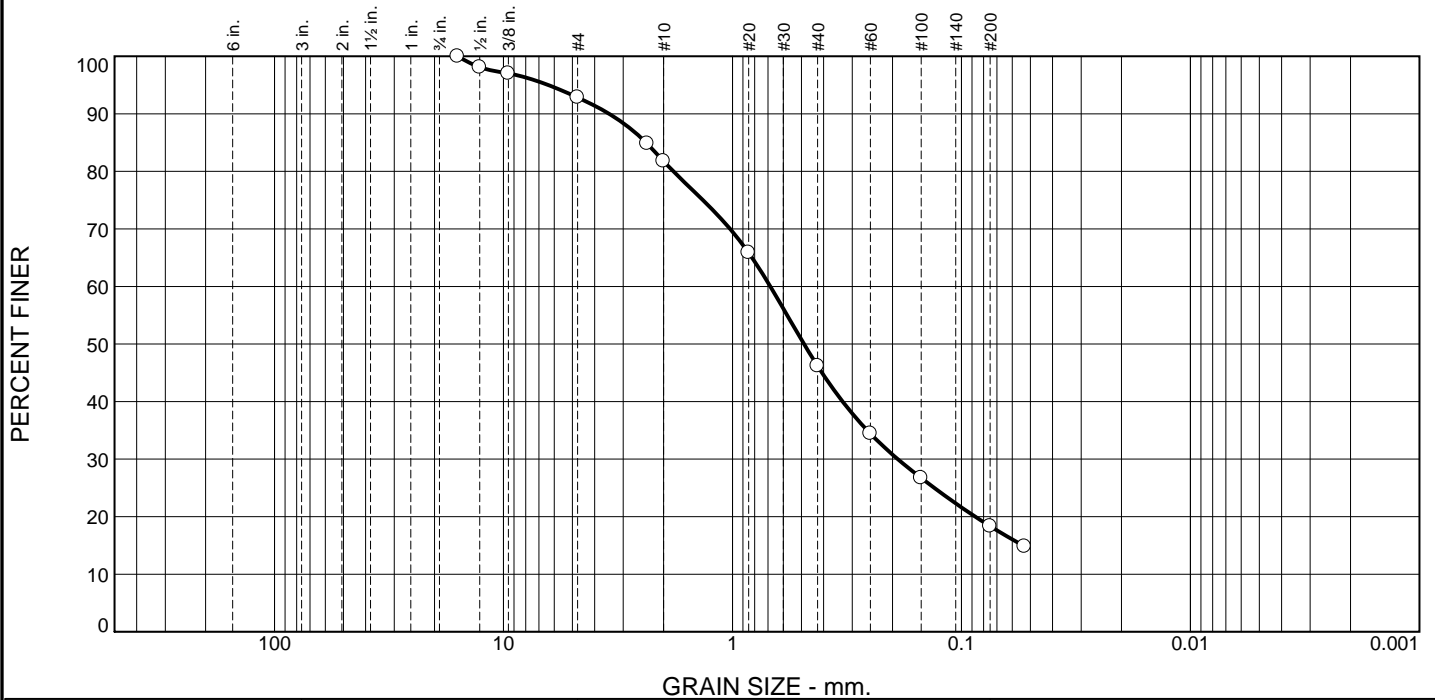


Client: City of Olympia
 Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 7.2 | 11.0 | 35.6 | 27.9 | 18.3 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 98.1 | | |
| 3/8" | 97.0 | | |
| #4 | 92.8 | | |
| #8 | 84.8 | | |
| #10 | 81.8 | | |
| #20 | 65.9 | | |
| #40 | 46.2 | | |
| #60 | 34.4 | | |
| #100 | 26.7 | | |
| #200 | 18.3 | | |
| #270 | 14.8 | | |

* (no specification provided)

Material Description

silty SAND, some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 3.4538 D₈₅= 2.3832 D₆₀= 0.6834
D₅₀= 0.4870 D₃₀= 0.1897 D₁₅= 0.0539
D₁₀= C_u= C_c=

Remarks

Date Received: 8/22/2023 Date Tested: 10/6/2023

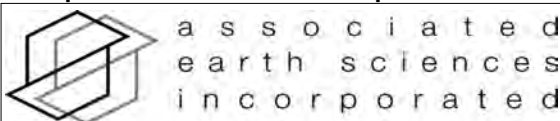
Tested By: FEW

Checked By: APJ/SNCF/JHS

Title: _____

Location: Onsite - Woods at Golden Given Cell 1
Sample Number: HA-3 **Depth:** 0.15-1'

Date Sampled: 8/22/2023



Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|--------------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/22/2023 | Project BHPS - TAWG Cell 1 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Tacoma, WA | EB/EP No. TAWG-1-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0.15-1.2' | HA-2 @ 0.15-1' | HA-3 @ 0.15-1' |
|--------------------|------------------|----------------|----------------|
| Wet Weight + Pan | 890.30 | 1100.50 | 862.60 |
| Dry Weight + Pan | 858.91 | 1083.03 | 829.46 |
| Weight of Pan | 247.50 | 391.99 | 247.10 |
| Weight of Moisture | 31.39 | 17.47 | 33.14 |
| Dry Weight of Soil | 611.41 | 691.04 | 582.36 |
| % Moisture | 5.13 | 2.53 | 5.69 |

Organic Matter and Ash Content

| | | | |
|-------------------------------|--------|---------|--------|
| Dry Soil Before Burn + Pan | 858.91 | 1083.03 | 829.46 |
| Dry Soil After Burn + Pan | 822.66 | 1046.05 | 781.07 |
| Weight of Pan | 247.50 | 391.99 | 247.10 |
| Wt. Loss Due to Ignition | 36.25 | 36.98 | 48.39 |
| Actual Wt. Of Soil After Burn | 575.16 | 654.06 | 533.97 |
| % Organics | 5.93 | 5.35 | 8.31 |

ASSOCIATED EARTH SCIENCES, INC

911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|-------------------------------|--------------------------------|--|
| Project Name: | Woods at Golden Given-Cell #1 | Water Source: | Hydrant |
| Project Number: | 20150387H008 | Meter: | FM-6 (10-100) |
| Date: | 8/22/2023 | Wetted Area (sq. feet): | 1125: 106.5 ft^2/ 1300: 146 ft^2 / 15:08: 207 ft^2 / 16:00: 204 ft^2 |
| Weather: | Scattered showers | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.16 |
| Performed By: | SNCF / CSI | Receptor Soils: | Gravel Sump/Qvt |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Staff Gauge #2 (ft) | Wellpoint (ft, btoc) | Totalizer (gallons) | Comments |
|--------------|-----------------|---------------------|---------------------|----------------------|---------------------|--|
| 10:20 | 63.75 | | | | | Water on |
| 10:21 | 68.2 | 0.14 | | | 56 | |
| 10:22 | 68.6 | 0.15 | | | 132 | |
| 10:27 | 64.3 | 0.14 | | 6.87 | 449 | |
| 10:30 | 64 | 0.14 | | 6.82 | 677 | |
| 10:45 | 64.5 | 0.14 | | | 1,625 | |
| 11:00 | 64.5 | 0.14 | | | 2,612 | |
| 11:15 | 67.3 | 0.16 | | 5.95 | 3,580 | |
| 11:30 | 63.9 | 0.16 | | 5.55 | 4,577 | |
| 11:45 | 64.4 | 0.18 | | 5.41 | 5,538 | |
| 12:00 | 65.5 | 0.18 | | 5.37 | 6,519 | |
| 12:15 | 65.5 | 0.19 | | 5.33 | 7,520 | |
| 12:30 | 68.7 | 0.2 | | 5.3 | 8,548 | Light rain begins |
| 12:45 | 65.6 | 0.2 | | 5.29 | 9,557 | Rain stops |
| 13:00 | 65.6 | 0.2 | 0.09 | 5.26 | 10,544 | Set SG-2 on WP |
| 13:17 | 69.08 | 0.22 | 0.12 | 5.22 | 11,739 | |
| 13:30 | 69.7 | 0.22 | 0.13 | | 12,595 | |
| 13:45 | 68.6 | 0.22 | 0.15 | 5.16 | 13,677 | |
| 14:00 | 68.8 | 0.24 | 0.16 | | 14,657 | |
| 14:15 | 68.1 | 0.24 | 0.17 | 5.12 | 15,785 | |
| 14:23 | 59.1 | 0.24 | 0.16 | | 16,263 | Flow into animal burrow, dropped flow rate |
| 14:30 | 58 | 0.22 | 0.14 | 5.1 | 16,653 | |
| 14:53 | 58.5 | 0.23 | 0.15 | | 18,016 | |
| 15:08 | 58.9 | 0.23 | 0.16 | 5.07 | 18,884 | CB flowing, but not from cell , water coming from other side of street |
| 15:15 | 58.8 | 0.24 | 0.16 | 5.07 | 19,263 | Animal burrow filled in with no flow |
| 15:34 | 58.4 | 0.24 | 0.18 | 5.05 | 20,430 | |
| 15:45 | 58.7 | 0.25 | 0.18 | 5.04 | 21,059 | |
| 15:50 | 59.7 | 0.25 | 0.18 | 5.04 | 21,377 | |
| 16:00 | 59 | 0.25 | 0.18 | 5.04 | 21,935 | |
| 16:10 | 58.9 | 0.26 | 0.19 | 5.04 | 22,530 | |
| 16:20 | 58.3 | 0.26 | 0.19 | 5.03 | 23,120 | Water off |
| 16:20:30 | | 0.25 | 0.18 | | | |
| 16:21 | | 0.22 | 0.17 | | | |
| 16:22 | | 0.19 | 0.14 | | | |
| 16:22:30 | | 0.16 | 0.12 | | | |

| | | | | | | |
|----------|--|------|------|------|--|--|
| 16:23 | | 0.14 | 0.08 | 5.05 | | |
| 16:23:30 | | 0.13 | 0.07 | | | |
| 16:24 | | 0.1 | 0.05 | 5.06 | | |
| 16:24:30 | | 0.09 | 0.04 | 5.07 | | |
| 16:25 | | 0.07 | 0.02 | 5.07 | | |
| 16:26 | | 0.04 | 0 | 5.08 | | |
| 16:26:30 | | 0 | | 5.08 | | |
| 16:28 | | | | 5.09 | | |
| 16:30 | | | | 5.1 | | |
| 16:32 | | | | 5.11 | | |
| 16:40 | | | | 5.13 | | |
| 16:45 | | | | 5.15 | | |
| 16:55 | | | | 5.17 | | |
| 17:00 | | | | 5.18 | | |
| 17:06 | | | | 5.2 | | |

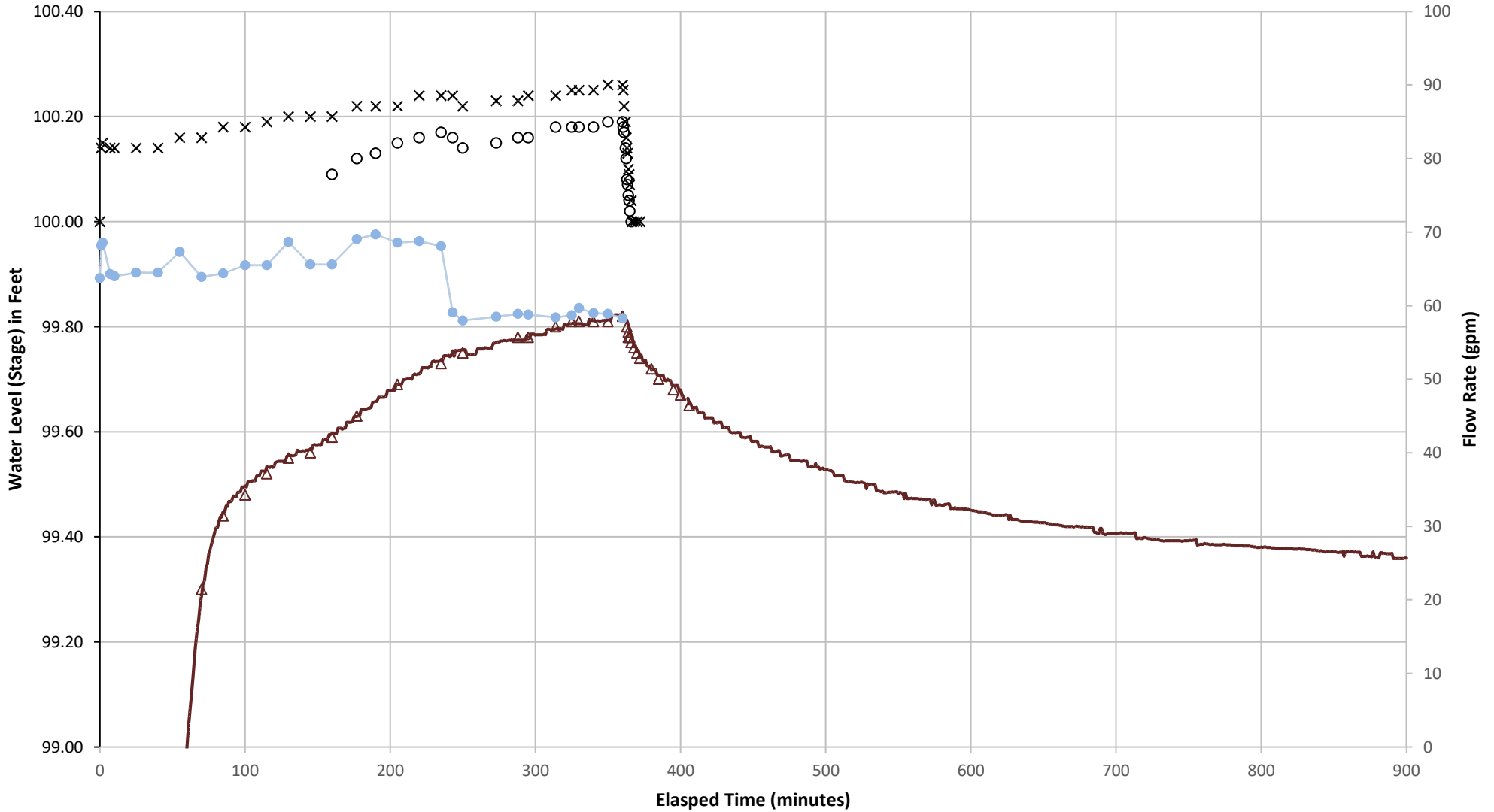
| | |
|--|------|
| SG-1 Average Infiltration Rate (in/hr) during last hour of inflow: | 27.8 |
| SG-1 Average Infiltration Rate (in/hr) during falling head: | 26.4 |

| | |
|--|------|
| SG-2 Average Infiltration Rate (in/hr) during last hour of inflow: | 27.7 |
| SG-2 Average Infiltration Rate (in/hr) during falling head: | 24.5 |

| | |
|--|------|
| WP Average Infiltration Rate (in/hr) during last hour of inflow: | 28.4 |
| WP Average Infiltration Rate (in/hr) during falling head: | 2.7 |

| | |
|--|-----|
| WP Average Infiltration Rate (in/hr) during falling head (Logger; Minute 600-900): | 0.2 |
|--|-----|

Woods at Golden Given (Cell 1) Infiltration Test Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not surveyed and should be used as a relative reference. Elevation 100 represents ground surface.

- × Staff Gauge #1 Hand Data
 - Staff Gauge #2 Hand Data
- Staff Gauge #1 Logger
 - Wellpoint Logger
 - Catch Basin Logger
- Δ Wellpoint Hand
 - Δ Catch Basin Hand
 - Flow Rate (gpm)

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 7

Assessed On:
August 22, 2023



EXECUTIVE SUMMARY

PLAN REVIEW:

The bioretention facilities at the Woods at Golden Given Habitat for Humanity housing development was constructed in 2012. As built plans were not provided for this site and the manner in which water is conveyed to the cell is not immediately apparent. It is assumed that all water is designed to infiltrate through bioretention soil and then into the ground. Due to standing water in the cell no hand augers were completed in the cell base.

BIORETENTION SOIL:

Thickness: 0.7- 0.8 ft

Bioretention soil thickness range of 0.7-0.8 ft is based on depth of soil in three hand augers located on the side of the cell, as the base of the cell was under water prior to field staff arriving. Hand augers were limited by groundwater and no sample returns due to saturation turning the soil into a slurry.

Composition:

Without available plans for this site, bioretention soil specifications are unknown. In comparison to the 2019 Ecology specifications for bioretention soil, one tested sample (HA-1) met the organic content specification, the other tested sample (HA-2) exceeded the organic content with a 11.65%. The two tested samples were not consistent with the 2019 Ecology specifications for grain size distribution and had high percentages of gravels and fines.

Organic Matter Content (% by weight): 9.3

Percent passing #200 sieve: 22.2

Coefficient of Uniformity (Cu): 31.2

Coefficient of Curvature (Cc): 1.3

SUBGRADE CONDITIONS:

Geologic Unit: Unknown/Vashon Till

Soil Description: N/A

Hand augers were unable to reach subgrade due to high water table in this cell. The site is mapped as Vashon Till by Booth, Troost and Schimel (2009).

BUILT PER PLAN:

Without available plans for this site, bioretention facility specifications are unknown.

GROUNDWATER CONDITIONS:

Standing water was observed at 0.28 ft depth in the cell upon arrival to the site. A staff gauge and pressure transducer were set to monitor falling head of the existing ponded water. Water presence possibly due to City of Tacoma's regional water main and hydrant flushing as signs were observed in the street adjacent to the housing development.

INFILTRATION TEST RESULTS:

Bioretention Soil Rate (in/hr): N/A

Subgrade Soil Rate (in/hr): 0.1

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 7

Assessed On:
 August 22, 2023



Infiltration test based on falling head of existing ponded water, which provides the infiltration rate for the subgrade, mapped as Vashon Till.

MAINTENANCE OBSERVATIONS/CONSIDERATIONS:

This cell may not function well as a bioretention facility, consider observing conditions after heavy rains to determine if this cell overflows and will need improvements, or if it is able to contain and infiltrate rainwater in a timely manner as designed.

Field Conditions

| | | | |
|-----------------|-------------------------|---------------|---------------------------|
| Weather | Clear, 70's | | |
| Recent Rainfall | Today: 0" | Yesterday: 0" | Two Days Ago: 0" |
| Field Reps | Full Day: Sarah Faubion | | Half Day: Catherine Ikeda |

Cell Overview

| | | | |
|--------------------------------|---|----------------------------|---|
| Number of Inlets | 1 | Predominate Landuse | Residential |
| Design Outlet/Overflow | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Standing Water Present? | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No |
| Underdrain or Dispersion Pipe? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Observation Port? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Existing Staff Gauge? | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Hand Augers | 3 Taken | | |
| Infiltration Test Recorded | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No | | |



Site Photo: IMG_5209.jpg

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 7

Assessed On:
 August 22, 2023



Site Photo: Cell7.jpg



Site Photo: Cell 7 AM.JPG

Cell Construction

| | |
|-----------------------------|---|
| Irrigation | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Sheet Flow | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No 50% |
| Standing Water | <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No Depth: 0.28' Possible Cause: <input type="checkbox"/> Recent Rain <input type="checkbox"/> Clogged bottom <input type="checkbox"/> Blocked Underdrain <input checked="" type="checkbox"/> Unknown Standing water perhaps due to City of Tacoma's regional hydrant flushing. |
| Underdrain/ Dispersion Pipe | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Cleanouts | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

Additional Comments

The manner in which water is conveyed to the cell was not clearly observed, or described in the plans provided to the project. There is indication that house labeled 20 may have some relationship to the bioretention cell, possibly the roof run off is intended to be directed to the cell. No inlet pipes were observed leading to the cell. The concrete pathway to house 20 provides some sheet flow into the cell. The pavement around 2 sides of the cell is porous concrete and has a 0% slope, and is not a likely source of runoff. Water appears to be designed to infiltrate through the bioretention soil before reaching a layer of angular gravel above native soils. The adjacent pervious pavement may act as an overflow feature, but this is unclear.

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 7

Assessed On:
August 22, 2023



Inlets

| | |
|--|---|
| IN-1 | |
| <input type="checkbox"/> Curb cut <input checked="" type="checkbox"/> Sheet Flow <input type="checkbox"/> Dispersed Flow <input type="checkbox"/> Pipe <input type="checkbox"/> Other: | |
| Width: 42' | |
| Energy Dissipation Angular Rock: n/a Stream Cobble: n/a Water Wheel: n/a Splash Block: n/a Concrete Apron: n/a | |
| Erosion Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Blockage Present? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: No energy dissipation features were observed. | |

Cell Surface and Geotech Probe Observations

| | |
|---|--|
| Mulch: <input checked="" type="checkbox"/> None <input type="checkbox"/> Shredded Mulch <input type="checkbox"/> Fine Mulch <input type="checkbox"/> Coarse Mulch | Depth (ft): |
| Cell Coverage | |
| Mulch | <input checked="" type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Bare Ground | <input type="checkbox"/> None <input checked="" type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| Other | <input type="checkbox"/> None <input type="checkbox"/> < 25% <input type="checkbox"/> 25 - 50% <input checked="" type="checkbox"/> 50 - 75% <input type="checkbox"/> 75 - 100% |
| The cell was covered with natural mulch and dead grasses for roughly 75% of the cell. | |
| Pest Evidence | |
| Animal Burrows | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Animal Plant Damage | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Large Deposition of Feces | <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
| Additional Details: | |
| Vegetation Description Grasses and low shrubs appear vibrant and healthy, vegetation does not hinder access. | |
| Additional Details Cell was under water prior to, and after, the test, no probe data was collected. | |

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 7

Assessed On:
August 22, 2023



Hand Auger

| | |
|---|---|
| HA-1 | |
| <input checked="" type="checkbox"/> Zone 1 <input type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.7 |
| Rain/Garden Mix Soil Texture: Slightly dense, wet, dark brown, silty, fine to medium SAND, some coarse sand, some fine gravel, abundant organics (SM) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |
|  | |
| HA-1.JPG | |
| Additional Details | |
| Groundwater was encountered at 0.1' below ground surface | |

| | |
|--|---|
| HA-2 | |
| <input type="checkbox"/> Zone 1 <input checked="" type="checkbox"/> Zone 2 <input type="checkbox"/> Zone 3 <input type="checkbox"/> Outside Cell | |
| Depth (ft) | |
| to Bioretention Soil: | 0.1 |
| to Native Soil: | |
| to Import/Underdrain: | |
| Total Depth: | 0.8 |
| Rain/Garden Mix Soil Texture: Slightly dense, moist to wet, dark brown, silty fine to medium SAND, some coarse sand, some gravel, abundant organics (SM) | |
| Native Soil Texture: | |
| Liner Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No | Filter Fabric Present: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No |

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 7

Assessed On:
 August 22, 2023



HA-2



HA-2.JPG

Additional Details

Groundwater was encountered at 0.5' below ground surface

HA-3

Zone 1 Zone 2 Zone 3

Outside Cell

Depth (ft)

to Bioretention Soil: 0.15

to Native Soil:

to Import/Underdrain:

Total Depth: 0.8

Rain/Garden Mix Soil Texture: Slightly dense, moist to wet, dark brown, silty fine to medium SAND, some coarse sand, some gravel, abundant organics (SM)

Native Soil Texture:

Liner Present:

Yes No

Filter Fabric Present:

Yes No

BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
 Cell: Cell 7

Assessed On:
 August 22, 2023



HA-3



HA-3.JPG

Additional Details

Infiltration Test

| | |
|---|------|
| IT-1 | |
| Water Supply <input type="checkbox"/> Hydrant <input type="checkbox"/> Hose Bib <input type="checkbox"/> Irrigation Tap <input type="checkbox"/> Water Truck | |
| AESI Meter# | |
| Wetted Pond Area (sq. ft) | 244 |
| Ponded Depth (ft) | 0.28 |
| Total Gallons | 0 |
| Steady State Flow Rate (GPM) | 0 |
| Additional Details: Upon arrival onsite, the cell was already full with water. The presumed source of water is from fire hydrant flushing performed the day prior. No additional water was conveyed to the cell for constant head infiltration testing. Instead, a staff gauge was installed in the cell base and the falling head rate was measured for a duration of 4 hours and 10 minutes. | |

Additional Comments

A temporary staff gauge with a data logger was placed in the existing pond of cell 7 at 12:50 on Aug 22nd, pond dropped by 0.02' between 12:50 and 17:00. Staff gauge was left overnight. It rained over night. Staff gauge

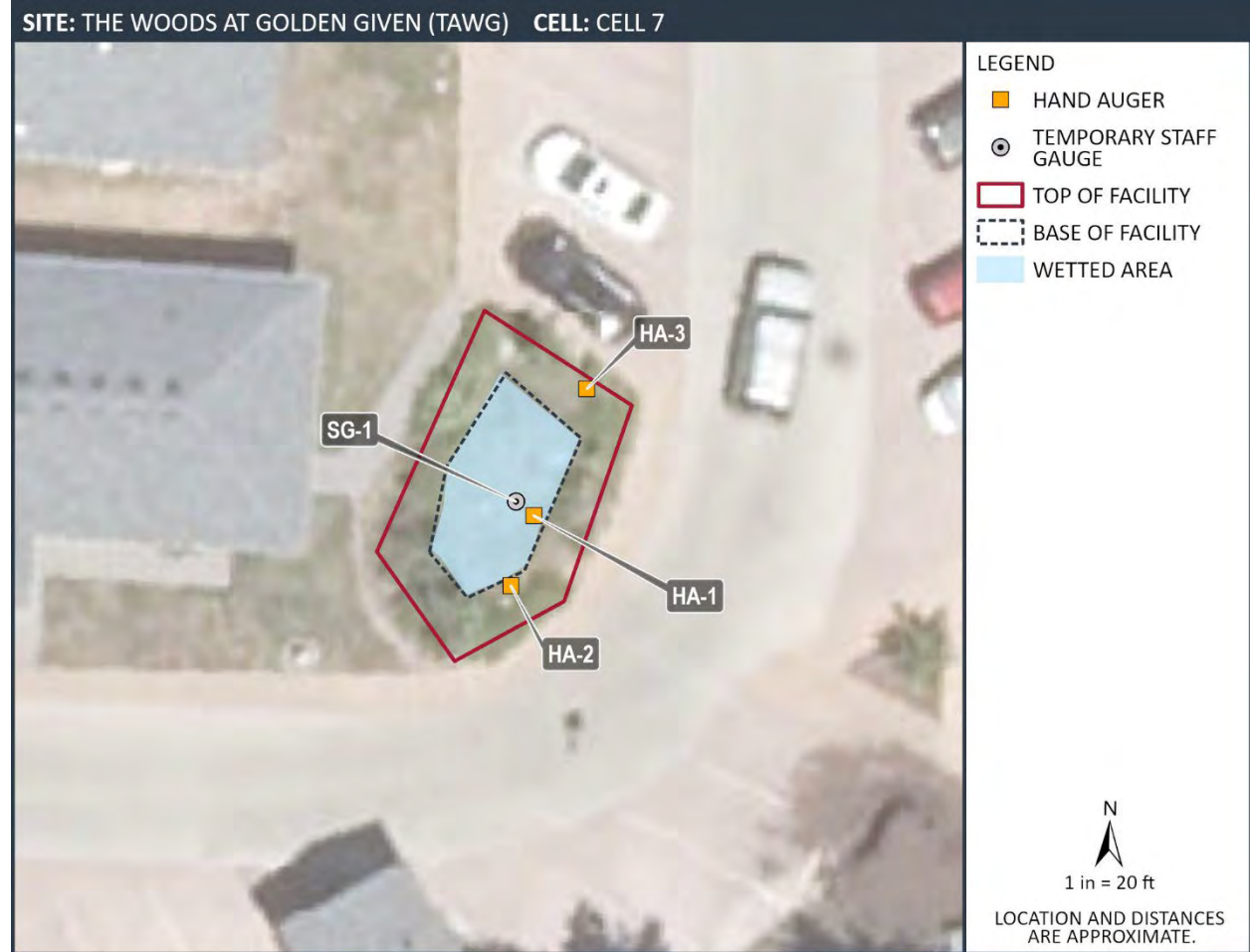
BIORETENTION CELL FIELD ASSESSMENT

Site: The Woods at Golden Given (TAWG)
Cell: Cell 7

Assessed On:
August 22, 2023



increased by 0.06' as measured at 09:02 August 23rd. The overnight rain (0.14inches) following the installation of the staff gauge impedes the infiltration rate calculation with overnight use and instead the rate measured form 12:50-17:00 on the 22nd is presented.





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Exploration Boring

TWGG-7-HA-1

Bioretention Hydrologic Performance Monitoring Study Sheet: 1 of 1

Multiple Locations

Start Date: 8/22/23

Logged By: CSI

20150387H008

Ending Date: 8/22/23

Approved By: JHS

Driller/Equipment: Hand Auger

Total Depth (ft): 0.7

Hammer Weight/Drop: N/A

Ground Surface Elevation (ft): 100

Hole Diameter (in): 4

Datum: Project Datum

Groundwater Depth ATD (ft): 0.1

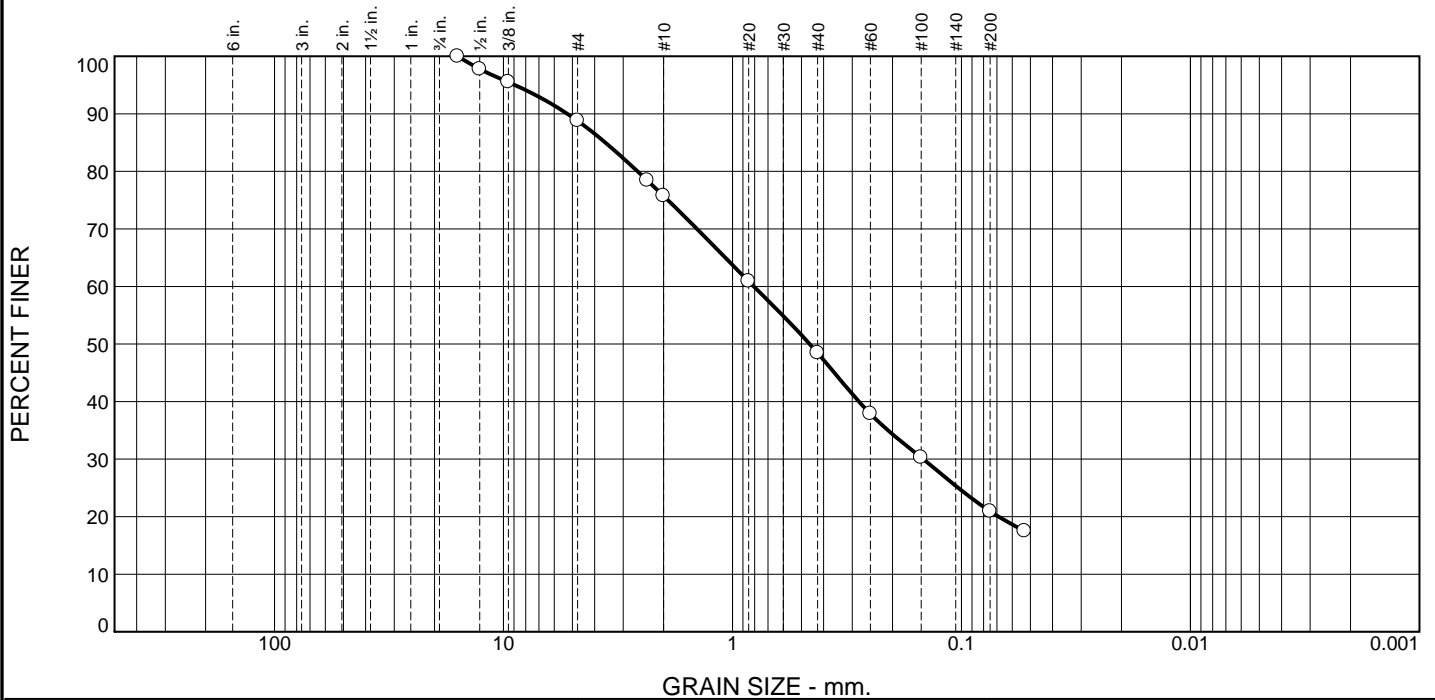
Groundwater Depth Post Drilling (ft) (Date): ()

| Depth (ft) | Sample Type | Sample | % Recovery | Graphic Symbol | Description | Water Level | Blows/6" | Blows/Foot | | | | | Other Tests |
|------------|-------------|--------|------------|----------------|--|-------------|----------|------------|----|----|----|-----|-------------|
| | | | | | | | | 10 | 20 | 30 | 40 | 50+ | |
| 0 | | | | | Slightly dense, wet, dark brown, silty, fine to medium SAND, some gravel; organic rich (SM). | ▼ | | | | | | | |
| 1 | | | | | Groundwater encountered at 0.1 feet ATD. Stopped exploration due to heavy caving and subsurface water. Soils information from adjacent hand auger explorations are described in the Site Assessment Field Report. | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | |

1/24/2024

20150387H008

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 11.2 | 13.1 | 27.2 | 27.6 | 20.9 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 5/8" | 100.0 | | |
| 1/2" | 97.8 | | |
| 3/8" | 95.5 | | |
| #4 | 88.8 | | |
| #8 | 78.5 | | |
| #10 | 75.7 | | |
| #20 | 60.9 | | |
| #40 | 48.5 | | |
| #60 | 37.9 | | |
| #100 | 30.3 | | |
| #200 | 20.9 | | |
| #270 | 17.5 | | |

* (no specification provided)

Material Description

BSM
silty SAND, some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-1-b

Coefficients

D₉₀= 5.2569 D₈₅= 3.5915 D₆₀= 0.8065
D₅₀= 0.4599 D₃₀= 0.1469 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8/22/2023 Date Tested: 10/10/2023

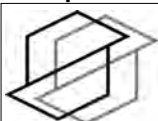
Tested By: FEW

Checked By: APJ/JHS

Title: _____

Location: Onsite - TWGG Cell 7
Sample Number: HA-1 Depth: 0-0.5'

Date Sampled: 8/22/2023



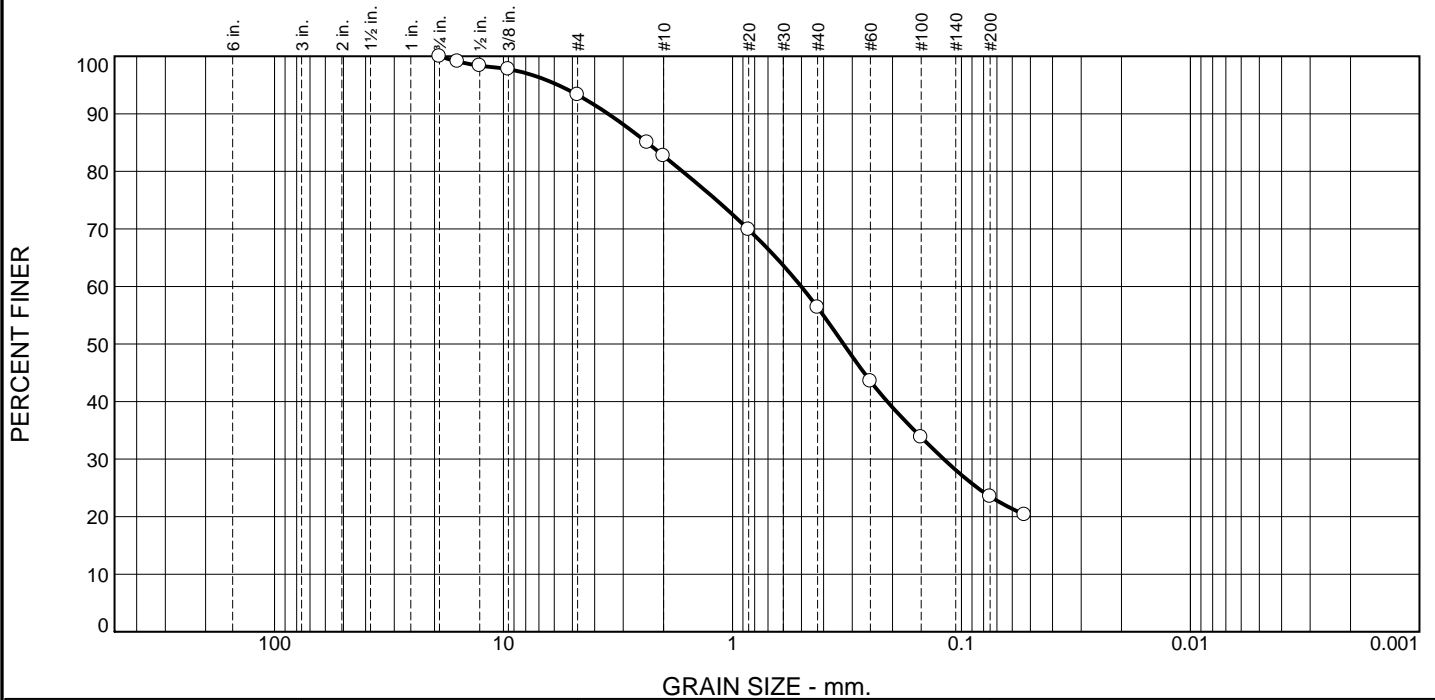
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earth sciences
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Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure

Particle Size Distribution Report



| % +3" | % Gravel | | % Sand | | | % Fines | |
|-------|----------|------|--------|--------|------|---------|------|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0.0 | 0.0 | 6.7 | 10.6 | 26.3 | 32.9 | 23.5 | |

| TEST RESULTS | | | |
|--------------|---------------|------------------|----------------|
| Opening Size | Percent Finer | Spec.* (Percent) | Pass? (X=Fail) |
| 3/4" | 100.0 | | |
| 5/8" | 99.1 | | |
| 1/2" | 98.4 | | |
| 3/8" | 97.8 | | |
| #4 | 93.3 | | |
| #8 | 85.0 | | |
| #10 | 82.7 | | |
| #20 | 69.9 | | |
| #40 | 56.4 | | |
| #60 | 43.6 | | |
| #100 | 33.8 | | |
| #200 | 23.5 | | |
| #270 | 20.3 | | |

* (no specification provided)

Material Description

BSM
silty SAND, some gravel

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI=

Classification

USCS (D 2487)= SM AASHTO (M 145)= A-2-4(0)

Coefficients

D₉₀= 3.4897 D₈₅= 2.3595 D₆₀= 0.5007
D₅₀= 0.3275 D₃₀= 0.1195 D₁₅=
D₁₀= C_u= C_c=

Remarks

Date Received: 8/22/2023 Date Tested: 10/10/2023

Tested By: FEW

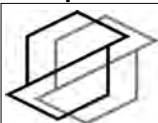
Checked By: APJ/JHS

Title: _____

Location: Onsite - TWGG Cell 7
Sample Number: HA-2

Depth: 0-0.7'

Date Sampled: 8/22/2023



a s s o c i a t e d
e a r t h s c i e n c e s
i n c o r p o r a t e d

Client: City of Olympia
Project: Bioretention Hydrologic Performance Monitoring Study

Project No: 20150387 H008

Figure



| | | | | |
|----------------------------------|---------------------------------|-------------------------------------|-------------------------|--|
| Date Sampled 8/22/2023 | Project BHPS - TAWG-7 | Project No. 20150387 H008 | | Soil Description Bioretention soil |
| Tested By FEW | Location Tacoma, WA | EB/EP No. TAWG-7-HA | Depth Various | |

Moisture Content

| Sample ID | HA-1 @ 0-0.5' | HA-2 @ 0-0.7' |
|--------------------|---------------|---------------|
| Wet Weight + Pan | 1021.34 | 1808.24 |
| Dry Weight + Pan | 824.96 | 1282.96 |
| Weight of Pan | 247.07 | 391.95 |
| Weight of Moisture | 196.38 | 525.28 |
| Dry Weight of Soil | 577.89 | 891.01 |
| % Moisture | 33.98 | 58.95 |

Organic Matter and Ash Content

| | | |
|-------------------------------|--------|---------|
| Dry Soil Before Burn + Pan | 824.96 | 1282.96 |
| Dry Soil After Burn + Pan | 785.19 | 1179.16 |
| Weight of Pan | 247.07 | 391.95 |
| Wt. Loss Due to Ignition | 39.77 | 103.80 |
| Actual Wt. Of Soil After Burn | 538.12 | 787.21 |
| % Organics | 6.88 | 11.65 |

ASSOCIATED EARTH SCIENCES, INC

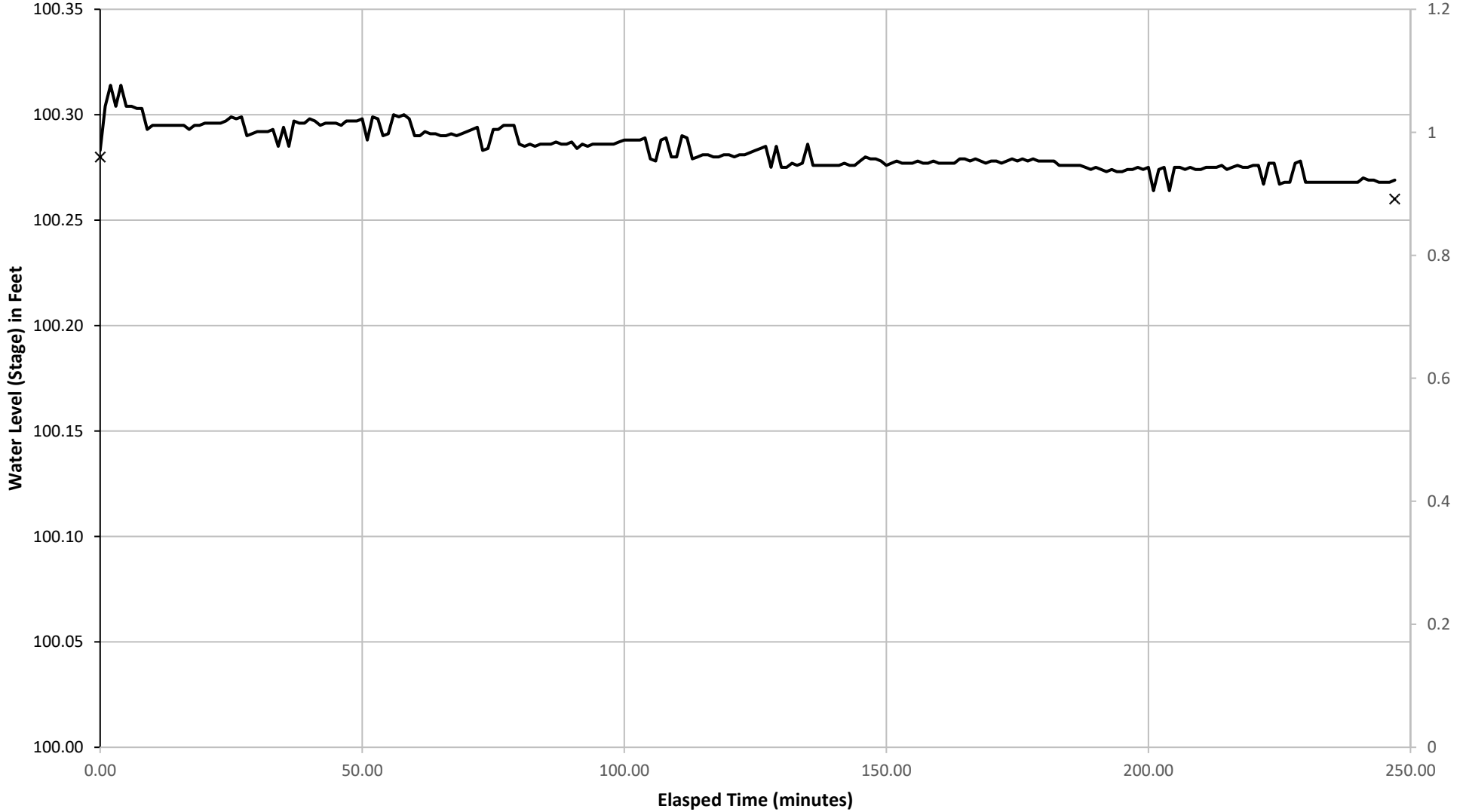
911 5th Ave., Suite 100 Kirkland, WA 98033 425-827-7701 FAX 425-827-5424

| | | | |
|------------------------|------------------------------|--------------------------------|-----------------------------|
| Project Name: | Woods at Golden Given Cell 7 | Water Source: | Rainfall / Hydrant Flushing |
| Project Number: | 20150387H008 | Meter: | N/A |
| Date: | 8/22/2023 | Wetted Area (sq. feet): | 244 |
| Weather: | Scattered showers | Underdrain: | No |
| Test No.: | IT-1 | Test Depth (feet): | 0.28 |
| Performed By: | SNCF / CSI | Receptor Soils: | Qvt |

| Time (24-hr) | Flow Rate (gpm) | Staff Gauge #1 (ft) | Totalizer (gallons) | Comments |
|-------------------------|------------------------|----------------------------|----------------------------|-----------------|
| 12:50 | 0 | 0.28 | 0 | Start Test |
| 17:00 | 0 | 0.26 | 0 | End Test |

| | |
|---|------|
| Average Infiltration Rate (in/hr) during last hour of inflow: | - |
| Average Infiltration Rate (in/hr) during falling head: | 0.06 |

Woods at Golden Given Cell 7 Infiltration Test
Stage (feet) on Left Axis; Flow Rate (gpm) on Right Axis vs Elapsed Time (minutes)



Notes: Elevations are not referenced and should be used as a relative reference. Elevation 100 represents ground surface. Standing water in cell, likely from hydrant flushing the day prior. Falling head observed from 12:50-17:00. Datalogger was not left in place overnight.

x Staff Gauge #1 Hand Data

— Staff Gauge #1 Logger