Attachment 16

Wellington Heights

Olympia, WA

Preliminary Drainage and Erosion Control Report

City of Olympia Project No. 17-4004
Olympic Engineering Project No. 17096

March 29, 2018
July 23, 2018 (Revised)

Prepared by:

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ENGINEERING

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REVISED CP&D
8/17/2018

PRELIMINARY DRAINAGE AND EROSION CONTROL REPORT

Wellington Heights

Olympia, Washington
March 29, 2018
July 23, 2018 (Revised)

Project Information

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Reviewing Agency

Jurisdiction: City of Olympia
Project Number: 17-4004
Contact: Paula Smith, Assistant Planner

References

City of Olympia Drainage Design and Erosion Control Manual, 2016 edition (DDECM)

Project Engineer

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7/23/18

“I hereby certify that this Preliminary Drainage and Erosion Control Report for the Wellington Heights project has been prepared by me or under my supervision and meets minimum standards of the City of Olympia and normal standards of engineering practice. I hereby acknowledge and agree that the jurisdiction does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me."

CHRISTOPHER M. MERRITT
37401

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SECTION 1 – PROPOSED PROJECT DESCRIPTION

Site Address: Unassigned Fern St. SW, Division St. SW, Cushing St. SW

Parcel Number(s): 59000200100, 59000200400,59000200600, 59000200900 59000300100, 59000400100 59000400600, 59000400800 59000500100, 59000600100 59000700100, 59000700300

Total Site Area: 9.40 Acres

Zoning: R 6-12

Section, Township, Range: Section 22, Township 18N, Range 2W, W.M.

Proposed Improvements

The proposal is to subdivide a 9.40-acre area (12 existing parcels) into 56 single-family residential lots with associated roadway, storm drainage, and public/private utility improvements. Fern St., Division St., and Cushing St. will be extended and looped through the project site.

Stormwater runoff from the proposed public roadways will be collected and routed to a catch basin with Baysaver Bayfilters for stormwater treatment and then to a below-grade infiltration trench consisting of StormTech chambers for storage and infiltration of 100% of the runoff from these areas. The two private access lanes and public sidewalks will be constructed of permeable pavement (BMP T5.15).

Stormwater runoff from future roof areas on Lots 38-56 will be routed directly to the infiltration trench mentioned above. Stormwater runoff from the remaining lots roof areas will be routed to individual lot downspouts infiltration trenches (BMP T5.10A) and/or conveyed to rain gardens (BMP T5.14A). Future individual lot driveways will be constructed of permeable pavement (BMP T5.15). Stormwater runoff from small walkways, patios, etc. on the lots will be sheet flow dispersed per BMP T5.12. All lot lawn/landscape areas will contain soils meeting the Post-Construction Soil Quality and Depth (BMP T5.13) requirements.

The lots will be served by:

City of Olympia	Water and Sanitary Sewer
Puget Sound Energy	Electricity and Natural Gas
Centurylink & Comast	Telecommunications
City of Olympia	Refuse & Recycling

The subject parcel is bordered by single-family residential parcels to the north and east and by developed commercial parcels to the south and west.

Applicable Core Requirements

The Core Requirements for stormwater management are listed in Section 2.4 of Volume I of the DDECM. Based on the thresholds given in this section, the proposed project must address or comment on Core Requirements #1 through #9 per Section 2.5 of Volume I of the DDECM. These Core Requirements have been addressed as follows:

Core Requirement #1 – Preparation of Drainage Control Plans:

A Stormwater Site Plan has been prepared (see Appendix for Preliminary Erosion Control and Drainage Plans).

Core Requirement #2 – Construction Stormwater Pollution Prevention Plan (SWPPP):

A Construction Stormwater Pollution Prevention Plan (SWPPP) has been prepared.

Core Requirement #3 – Source Control of Pollution:

A Pollution Source Control Program will be prepared and provided with the stormwater maintenance agreement and recorded prior to final project approval. Construction specific BMP's will be provided during construction (see SWPPP for reference).

Core Requirement #4 – Preservation of Natural Drainage Systems and Outfalls:

There are no known natural drainage systems or outfalls located on the subject parcel. Any natural drainage systems or outfalls that may be subsequently found will be preserved.

Core Requirement #5 – On-Site Stormwater Management:

This project is not required to meet the LID Performance Standard nor is it being proposed to be met (owner's option). Therefore, List #2 from Section 2.5.5 in Volume I of the DDECM is applicable.

The proposed Best Management Practice's (BMP's) are as follows:

Lawn and Landscape Areas:

- All disturbed areas not being covered with a hard surface and all new lawn and landscape areas will contain soils meeting the Post-Construction Soil Quality and Depth (BMP T5.13) requirements.

Roof Areas:

- Stormwater runoff from future roof areas on Lots 38-56 will be routed directly to the infiltration trench mentioned above. Stormwater runoff from the remaining lots roof areas will be routed to individual lot downspouts infiltration trenches (BMP T5.10A) and/or conveyed to rain gardens (BMP T5.14A) (these will be specified on the final plat map and/or at the time of building permit submittal for each lot).

    - Full Dispersion (BMP LID.11) is not feasible as a 65 to 10 ratio of forested or native vegetation area to impervious area cannot be achieved and the minimum native vegetation dispersion flow path distance requirement from all hard surface areas cannot be met.

Other Hard Surface Areas:

- Stormwater runoff from the new public roadways will be routed to a type 2 catch basin wtih Baysaver Bayfilters for stormwater treatment and then conveyed to a below-grade infiltration trench consisting of StormTech chambers for storage and infiltration of 100% of the runoff from these areas.

  BMP Infeasibility
    - Full Dispersion (BMP T5.30) is not feasible as a 65 to 10 ratio of forested or native vegetation area to impervious area cannot be achieved and the minimum native vegetation dispersion flow path distance requirement from all hard surface areas cannot be met.
    - Permeable Pavement (BMP T5.15) is not allowed for public roadways.
    - Bioretention facilities are not feasible as the width of roadside swales would not fit within a reasonable right-of-way width and the depth of a larger/common bioretention pond would not meet vertical separation requirements to the till layer.

- The private access lanes and public sidewalks will be constructed of permeable pavement (BMP T5.15) for storage, treatment, and infiltration of stormwater runoff from these areas.
- Future individual lot driveways will be constructed of permeable pavement (BMP T5.15) for storage, treatment, and infiltration of stormwater runoff from these areas. This will be specified on the final plat map and/or at the time of building permit submittal for each lot.

  BMP Infeasibility
    - Full Dispersion (BMP T5.30) is not feasible as a 65 to 10 ratio of forested or native vegetation area to impervious area cannot be achieved and the minimum native vegetation dispersion flow path distance requirement from all hard surface areas cannot be met.

- Stormwater runoff from small walkways, patios, etc. on the lots will be sheet flow dispersed per BMP T5.12. This will be specified on the final plat map and/or at the time of building permit submittal for each lot.

Core Requirement #6 – Runoff Treatment:

This project will create more than 5,000 square-feet of new total pollution-generating hard surface (PGHS) area; therefore, Runoff Treatment facilities are required.

Baysaver Bayfilter™ cartridges will provide treatment of stormwater runoff from pollution generating roadway areas. Per WWHM, this project is required to treat a 15-minute water quality flow rate of 0.2485 cfs (see Appendix).

0.2485 cfs / 0.067 cfs/cartridge = 3.7 (Use 4 cartridges)

> *The Washington State Department of Ecology issued a "General Use Level Designation for Basic (TSS) Treatment" for this filter when using a 30 gpm/cartridge design flow rate (see Appendix for GULD).*

Core Requirement #7 – Flow Control:

This project will create more than 10,000 square-feet of "effective" hard surface area; therefore, Flow Control is applicable.

There will be less than a 0.15-cfs increase from the pre- to post-developed runoff rate, less than ¾-acres of native vegetation will be converted to lawn/landscape, and no stormwater will be discharged into a fresh waterbody; therefore, additional Flow Control facilities (in addition to the proposed) are not warranted.

Treated stormwater runoff from the roadway areas will be conveyed to an underground infiltration trench system consisting of 60 MC-4500 StormTech chambers.

MTC recommends a 10.2"/hr long-term design infiltration rate for the infiltration trench be used – a 10"/hr design rate was used in WWHM. The 7' high infiltration trench will provide for 2.2' of freeboard, 1.2' more than the typical requirement of 1'. See Appendix for infiltration trench sizing.

At a maximum ponding depth of 4.8', the facility should draw down in 5.8 hours (4.8'x12")/10"/hr = 5.8 hours).

Stormwater Modeling Input/Assumptions

- All lawn/landscape areas that contain soils meeting the Post-Construction Soil Quality and Depth (BMP T5.13) requirements were entered into WWHM as "pasture". This includes all lot lawn/landscape areas, planter strip areas, and Open Space Tracts.
- For analyzing the difference between the pre- to post-developed 100-year runoff rate, the pre-developed land cover has been modeled as the current land cover.
- All areas being infiltrated (public roadway, permeable lanes/driveways, permeable sidewalks, and roof areas) are considered "ineffective" hard

surface areas and can be discounted from the model when analyzing the difference between the 100-year pre- to post-developed runoff rates.

- The Soil and Vegetation Protection Areas can be modeled as “forest” in the post-developed (mitigated) scenario when analyzing the difference between the 100-year pre- to post-developed runoff rates as these areas will become more forested over time.

Contingency Planning & Verification Testing

MTC used conservative correction factors (total factor of 0.22) in calculating the design infiltration rate. MTC will further evaluate the subgrade after storm facility excavation and the size of the facility may be adjusted (possibly reduced) based on the results.

The completed stormwater facility will be monitored through one full wet season (November 1 to March 30) to evaluate the performance of the facility. In the event the facility is not performing as designed, additional StormTech chambers can be added to increase capacity by approximately 33%.

Core Requirement #8 – Wetlands Protection:

There are no known wetlands located on-site or within the immediate vicinity of the site; therefore, this Core Requirement is not applicable.

Core Requirement #10 – Operation & Maintenance:

Maintenance of the storm drainage facilities (treatment and infiltration systems) will be the responsibility of the Homeowner’s Association (HOA). All improvements within the right-of-way will be maintained by the City of Olympia. A storm drainage operation and maintenance plan, including a pollution prevention plan, will be prepared and recorded prior to final project approval.

Project Areas

Parcel Area: 9.400 ac (409,486 sf)

Hard Surface Areas

Existing Hard Surface Areas:

Sidewalk:	95 sf
Roadway (cul-de-sacs):	20,268 sf
Gravel Sewer Access:	3,581 sf
Total:	23,944 sf

New/Replaced Hard Surface Area:

Roof:	100,800 sf*
Driveways on lots *(permeable)*:	29,120 sf*
Misc. (patios, etc. on lots):	28,000 sf*
Public Roadway:	39,317 sf
Private Access Lanes *(permeable)*:	4,756 sf
Sidewalks *(permeable)*:	10,594 sf
Driveways (w/in R/W):	14,927 sf
Total:	227,514 sf

Total Hard Surface Area after Project Completion:

Roof:	100,800 sf*
Driveways on lots *(permeable)*:	29,120 sf*
Misc. (patios, etc. on lots):	28,000 sf*
Public Roadway:	39,317 sf
Private Access Lanes *(permeable)*:	4,756 sf
Sidewalks *(permeable)*:	10,594 sf
Driveways (w/in R/W):	14,927 sf
Total:	227,514 sf (55.5% coverage)

* Based on anticipated building sizes and building setback requirements, it has been assumed that each lot will have, on average, 1,800 sf of roof area, 520 sf of driveway area, and 500 sf of patio/walkway/etc. area.

Pervious Surface Areas

Existing Pervious Surface Areas:

Forest:	15,557 sf
Pasture/Brush:	369,985 sf
Total:	385,542 sf (94%)

Pervious Areas after Project Completion:

Lawn/Landscape (on lots):	121,371 sf*
Roadway Planter Strips:	19,625 sf
Open Space Tracts:	18,459 sf
SVPA Tracts:	22,517 sf
Total:	181,972 sf (44.5%)

* Based on anticipated building sizes and driveway areas, it has been assumed that each lot will have, on average, 2,207 sf of lawn/landscape area.

Summary

Hard Surface Coverage:	227,514 sf
Pervious Surface Coverage:	181,972 sf
Total:	409,486 sf

SECTION 2 – EXISTING CONDITONS DESCRIPTION

On-Site Conditions/Description

The project site is currently undeveloped. The majority of the parcel was cleared approximately 14-years ago. Site vegetation consist of sparse conifer and deciduous trees with blackberry, Scotch broom, and field grass. Topography is rolling but generally slopes down at 1%-3% from the north to the south. A steep man-made slope, approximately 14-feet in height, borders the property along the south property line.

There are no known critical areas (wetlands, streams, etc.) on-site or within the immediate vicinity of the site. There is an off-site man-made steep slope bordering the south property line but it does not meet the city’s definition of a landslide hazard area.

An existing sanitary sewer main with an associated easement crosses the middle portion of the site and serves the Wellington West subdivisions to the north. This sewer main will remain and will be located within new right-of-way and/or an easement where needed.

The site and surrounding area is located within a Category II Critical Aquifer Recharge

Area as mapped by Thurston County. All stormwater runoff generated by the project will meet or exceed DDECM requirements.

Off-Site Drainage & Pass Through Drainage

Two storm pipes, a 30" diameter and an 18" diameter, daylight onto the north end of the subject parcel and are intended to convey metered stormwater release and bypass stormwater runoff from the Wellington West subdivisions and properties northerly of Wellington West, respectively. These pipes daylight into a drainage ditch (generally located just east and outside of an existing drainage easement) that runs southerly through the subject site.

Just south of the south property line of the subject parcel, the existing drainage ditch turns westerly and then southerly where it increases in size and depth and transitions into a small detention pond just north of Carriage St. Stormwater runoff from a portion of the commercial properties to the west of the subject site appears to be discharged to this ditch where it turns from west to south near the southwest corner of the subject parcel. Overflow from the small detention pond is conveyed westerly along Carriage St. and then southerly to Percival Creek through a series of storm pipes.

Based on multiple site visits, conversations with city staff, and information from neighbors, it is our understanding that the conveyance system that runs through the subject parcel has been operating sufficiently. However, there have been reports that the northern parking lot area associated with the Jeep dealership to the south has experienced temporary ponding/flooding during heavy rainfall events. The existing ditch along the north side of the Jeep dealership is undersized and needs to be improved to be able to convey the off-site flows. This issue is not related to the Wellington Heights project; however, the Wellington Heights owner/applicant, dealership owner, and the City of Olympia are currently working together to resolve this problem.

The portions of drainage ditch located on the subject parcel that are to remain will be improved (widened and deepened) to ensure they can convey the off-site flows through the site and the outfall point at the southern property line will remain at the same location (see Section 10 below).

The site does not appear to receive any noticeable stormwater surface run-on from adjacent properties which is likely due to the relatively flat topography of the area and decent porosity of the surface soils. Some stormwater runoff from the existing cul-de-sacs located on-site appears to sheet flow disperse to surrounding vegetation. The cul-de-sacs will be removed and replaced with roadway extensions and runoff from the new roadways will be collected in the proposed drainage system.

SECTION 3 – INFILTRATION RATES/SOILS REPORTS

The Natural Resource Conservation Service (NRCS) classifies the on-site soils as Alderwood Gravelly Sandy Loam.

A soils report prepared by Parnell Engineering (see Appendix) confirms the NRCS Alderwood classification. Based on this report, till was encountered at an average depth of 39-inches below-grade across twelve test pits and the till generally extended to depths of at least 13-feet below-grade in these pits. Parnell Engineering recommends a 4"/hr design infiltration rate in the surface soils which is adequate for individual lot downspout infiltration trenches, rain gardens, and permeable pavement.

Soil logs/data obtained from the Elis Estates project to the north and the Percival Creek Plaza project to the south of the subject site indicated a sand layer was encountered at depths of approximately 26-feet and 5-feet below-grade, respectively. This sand layer was targeted for stormwater infiltration for both projects. Based on this information, additional soils work was conducted by Materials Testing & Consulting (MTC) and this same sand layer was encountered on-site in three pits at depths of 5, 10, and 24-feet below-grade. MTC recommends a 10.2"/hr design infiltration rate in the sand horizon located at a depth of approximately 5 to 10-feet below-grade in the southwestern portion of the parcel or a 14"/hr rate at deeper depths. The proposed stormwater infiltration facility will target the sand layer where the sand was encountered by MTC at depths of 5 to 10-feet and a 10"/hr rate has been used in the design. MTC used conservative correction factors (total factor of 0.22) in calculating the design infiltration rate. MTC will further evaluate the subgrade after storm facility excavation and the size of the facility may be adjusted (possibly reduced) based on the results.

There are no known contaminated soils locate on-site or within the immediate vicinity of the site. Groundwater was encountered at a depth of 40-feet below-grade in BH#1 (see "Addendum #1 – Summary of Infiltration Evaluation" prepared by MTC).

SECTION 4 – WELLS AND SEPTIC SYSTEMS

There are no known wells or septic systems on-site or within 100-feet of the subject parcel per a site visit and review of WSDOE well log records.

SECTION 5 – FUEL TANKS

No fuel tanks were located during our site inspection. Olympic Engineering reviewed the latest "LUST" list (Leaking Underground Storage Tank) and found no listing for the subject site. If any tanks are found, they will be abandoned per applicable regulations.

SECTION 6 – SUB-BASIN DESCRIPTION

The parcel and surrounding areas are located within the Budd/Deschutes Watershed in the Percival Creek Basin.

See Sections 2 and 10 for information regarding off-site flows.

The majority of stormwater runoff generated by the new improvements will be infiltrated on-site.

SECTION 7 – FLOODPLAIN ANALYSIS

Per FEMA FIRM Map Panel #53067C0166E, the site is located within Zone X. The Zone X designation signifies areas that are outside the 0.2% annual chance floodplain. There are no known flooding issues on the subject parcel or within the immediate vicinity of the site.

SECTION 8 – AESTHETIC CONSIDERATIONS FOR FACILITIES

The stormwater treatment and flow control facilities associated with the site improvements (roadway, etc.) will be located below-grade; therefore, aesthetic consideration is not applicable. Stormwater runoff from future roof areas may be conveyed to rain gardens (BMP T5.14A) which require specific vegetation and soils and these will be addressed at the building permit phase for each lot. The pass-through ditch in Open Space Tracts C & E will be hydroseeded and the surrounding areas will be landscaped.

SECTION 9 – FACILITY SELECTION AND SIZING

See Section 1 above and the Appendices for descriptions of facility selection and sizing.

SECTION 10 – CONVEYANCE SYSTEM ANALYSIS AND DESIGN

Per the Wellington West Drainage Report prepared by Howard Godat & Associates, dated April 1, 1998, the Wellington West projects had a designed 100-year storm metered release rate of 7.98-cfs and the pass-through flow rate from the properties northerly of Wellington West was determined to be 36-cfs (total of 44-cfs).

Approximately one-half of the existing overflow ditch will be retained and improved (deepened and widened as needed to ensure conveyance of the off-site flows) in Open Space Tracts C & E. Three 24” diam. culverts will convey overflow beneath the proposed 18th Ave. roadway. Alternatively, an aluminum box culvert may be proposed at the final design stage. Based on preliminary calculations, the improved ditch can convey up to 91-cfs with up to 1.6-feet of freeboard and the combined 24” diam. culverts can convey up to 73-cfs, both exceeding the 44-cfs inflow by at least 65%.

All main storm conveyance pipes in the public roadways will be a minimum 12” diameter and lateral pipes may be 8” diameter.

Detailed conveyance calculations will be provided with the final drainage report.

SECTION 11 – OFF-SITE ANAYLSIS & MITIGATION

Newly generated stormwater runoff from the site will not be directly discharged to a downstream conveyance system. Any stormwater overflow/bypass from the Wellington West development to the north will continue to pass through the site and will discharge from the project site at its current location. See Section 2 above for additional information.

No downstream impacts are anticipated as a result of this project; therefore, a quantitative downstream analysis is not warranted.

Per MTC, the proposed infiltration trench will not adversely impact the steep slope bordering the south property line. MTC recommends a minimum 15-foot setback from the crest of the slope to the stormwater infiltration facility. As currently designed, the top edge of the trench closest to the slope is approximately 17-feet from the top of slope.

SECTION 12 – UTILITIES

The lots will be served by City of Olympia water and sanitary sewer; gas and power will be provided by Puget Sound Energy; and telephone/cable TV will be provided by Comcast and/or CenturyLink. Minimum vertical and horizontal separations between utilities will be provided as required and will be addressed during the final design phase.

SECTION 13 – COVENANTS, DEDICATIONS, EASEMENTS, AGREEMENTS

Maintenance of the storm drainage facilities (treatment vault and infiltration trench will be the responsibility of the Homeowner's Association (HOA). The proposed storm drainage improvements (catch basins and storm pipe) within the city's right-of-way will be the responsibility of the city. A storm drainage operation and maintenance plan, including a pollution prevention plan, will be recorded at the county auditor's office prior to final project approval.

A new/relocated easement will be created for the Wellington West overflow swale through Open Space Tracts C & E. No other dedications or easements for storm drainage systems are proposed.

SECTION 14 – OTHER PERMITS OR CONDITIONS

Site development (grading), right-of-way encroachment, etc. permits will be needed to construct the proposed site improvements. Once the improvements have been accepted, final plat approval will be needed to create the new lots.

A stormwater permit (Notice of Intent) will be submitted to the Washington State Department of Ecology prior to construction start.

Appendix 1

Preliminary Drainage Plans

SCALE: 1"=40 FEET
0 20 40 80

BASIS OF BEARINGS: N 65°47'00" E FROM THE FOUND MONUMENT AT THE WEST ONE-QUARTER CORNER TO THE FOUND MONUMENT AT THE INTERSECTION OF DIVISION AND 16TH.
MEAS=666.78 CITY=666.84

VERTICAL DATUM
NAVD 88

CITY OF OLYMPIA BM NO. 1534: BRASS DISC TOP OF CURB WEST SIDE OF DECATUR STREET ON EXTENSION OF 15TH AVENUE CENTERLINE.
ELEVATION = 206.335' NAVD 88

INDIVIDUAL LOT DRAINAGE NOTE

INDIVIDUAL LOT STORMWATER BMP'S ADDRESSING RUNOFF FROM HARD SURFACES (ROOF, DRIVEWAY) AND YARD AREAS WILL BE SPECIFIED ON THE FINAL PLAT MAP OR IN THE INDIVIDUAL BUILDING PERMIT APPLICATIONS FOR EACH LOT. ROOF RUNOFF FROM LOTS 38–56 WILL BE TIGHTLINED TO THE INFILTRATION FACILITY LOCATED ON TRACT E.

GENERAL NOTES

1. THE PROPOSED STORM DRAINAGE SYSTEM INCLUDING CONVEYANCE, TREATMENT, AND INFILTRATION SYSTEMS WILL MEET CITY OF OLYMPIA STANDARDS.
2. THE PROPOSED STORM PIPE AND CATCH BASIN RIM AND INVERT ELEVATIONS SHOWN ARE APPROXIMATE AND WILL BE ADJUSTED DURING THE FINAL DESIGN PHASE OF THE PROJECT.

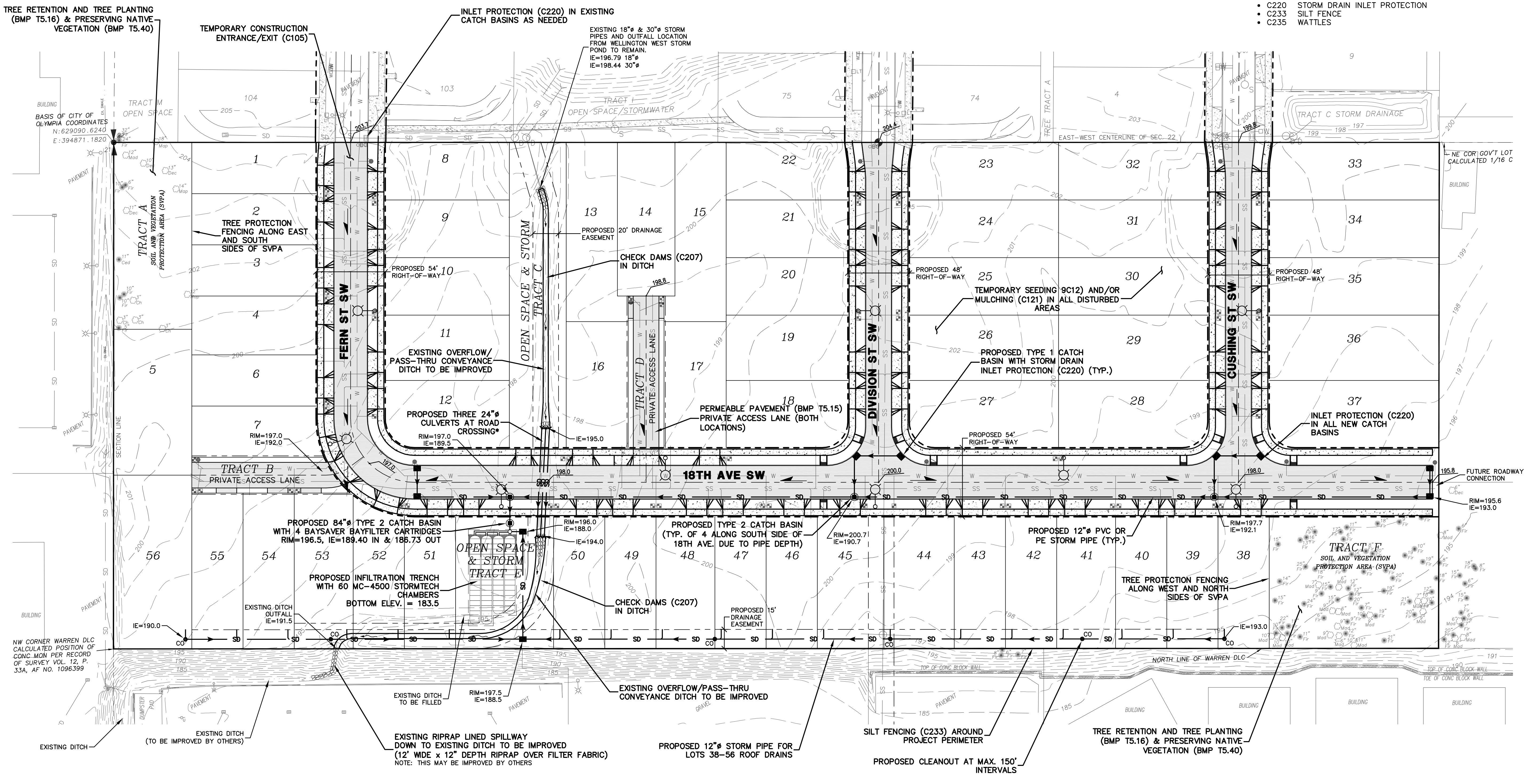
PROPOSED BEST MANAGEMENT PRACTICES (BMP'S)

THE FOLLOWING PERMANENT STORMWATER BEST MANAGEMENT PRACTICES (BMP'S) ARE PROPOSED FOR THIS PROJECT:

- T5.10A DOWNSPOUT INFILTRATION SYSTEMS (LOT ROOFS)
- T5.12 SHEET FLOW DISPERSION (LOT WALKWAYS/PATIOS)
- T5.13 POST-CONSTRUCTION SOIL QUALITY AND DEPTH (ALL DISTURBED, NEW LAWN/LANDSCAPE, AND STORMWATER DISPERSION AREAS)
- T5.14A RAIN GARDENS (LOT ROOFS)
- T5.15 PERMEABLE PAVEMENTS (PRIVATE ACCESS LANES, SIDEWALKS, AND INDIVIDUAL LOT DRIVEWAYS)
- T5.16 TREE RETENTION AND TREE PLANTING (SVPA TRACTS)
- T5.40 PRESERVING NATIVE VEGETATION (SVPA TRACTS)

THE FOLLOWING TEMPORARY CONSTRUCTION BEST MANAGEMENT PRACTICES (BMP'S) ARE PROPOSED FOR THIS PROJECT:

- C101 PRESERVING NATURAL VEGETATION
- C105 STABILIZED CONSTRUCTION ENTRANCE/EXIT
- C120 TEMPORARY AND PERMANENT SEEDING
- C121 MULCHING
- C123 PLASTIC COVERING
- C125 TOPSOILING/COMPOSTING
- C130 SURFACE ROUGHENING
- C140 DUST CONTROL
- C150 MATERIALS ON HAND
- C151 CONCRETE HANDLING
- C152 SAWCUTTING AND SURFACING POLLUTION PREVENTION
- C160 CONTRACTOR EROSION AND SPILL CONTROL LEAD
- C162 SCHEDULING
- C207 CHECK DAMS
- C209 OUTLET PROTECTION
- C220 STORM DRAIN INLET PROTECTION
- C233 SILT FENCE
- C235 WATTLES



*AN ALUMINUM BOX CULVERT MAY BE PROPOSED AT THE FINAL DESIGN STAGE IN LIEU OF THE THREE 24"ø CULVERTS.

NOTE:
SEE DETAILS ON SHEETS 4 & 5 FOR REFERENCE

NO.	DATE	REVISION
1	7/23/18	REVISIONS PER CITY 1ST REVIEW COMMENTS

WELLINGTON HEIGHTS
CITY OF OLYMPIA WA

PRELIMINARY EROSION CONTROL AND DRAINAGE PLAN

DESIGNED BY: CMM
DRAWN BY: CMM
CHECKED BY:
SCALE: 1" = 40'
DATE: 3/29/18

7/23/18
CHRISTOPHER M. MERRITT
37401

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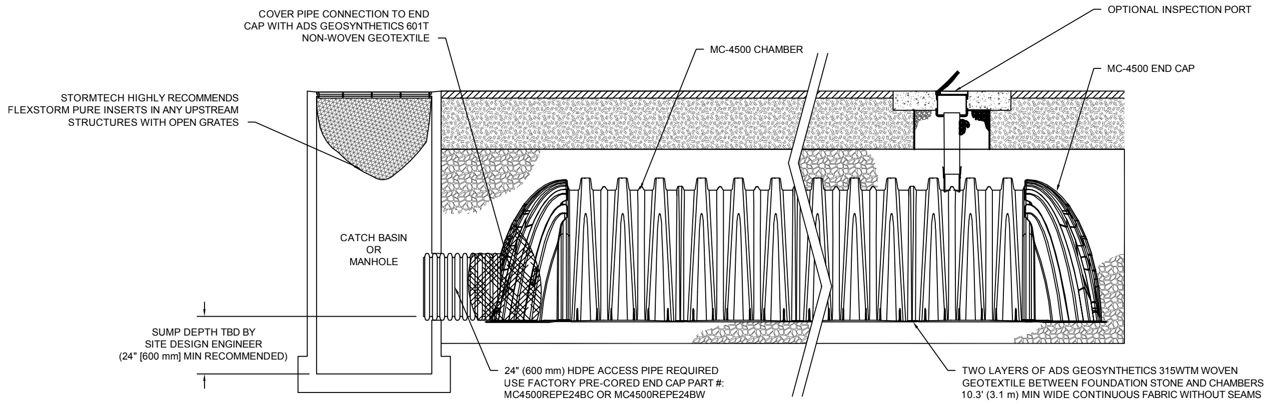
JOB NUMBER: 17096
DRAWING NAME: 17096_DRPL

SHEET: 2 OF 5



MC-4500 ISOLATOR ROW DETAIL

NTS

INSPECTION & MAINTENANCE

STEP 1) INSPECT ISOLATOR ROW FOR SEDIMENT
- A. INSPECTION PORTS (IF PRESENT)
  - A.1. REMOVE/OPEN LID ON NYLOPLAST INLINE DRAIN
  - A.2. REMOVE AND CLEAN FLEXSTORM FILTER IF INSTALLED
  - A.3. USING A FLASHLIGHT AND STADIA ROD, MEASURE DEPTH OF SEDIMENT AND RECORD ON MAINTENANCE LOG
  - A.4. LOWER A CAMERA INTO ISOLATOR ROW FOR VISUAL INSPECTION OF SEDIMENT LEVELS (OPTIONAL)
  - A.5. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.
- B. ALL ISOLATOR ROWS
  - B.1. REMOVE COVER FROM STRUCTURE AT UPSTREAM END OF ISOLATOR ROW
  - B.2. USING A FLASHLIGHT, INSPECT DOWN THE ISOLATOR ROW THROUGH OUTLET PIPE
    - i) MIRRORS ON POLES OR CAMERAS MAY BE USED TO AVOID A CONFINED SPACE ENTRY
    - ii) FOLLOW OSHA REGULATIONS FOR CONFINED SPACE ENTRY IF ENTERING MANHOLE
  - B.3. IF SEDIMENT IS AT, OR ABOVE, 3" (80 mm) PROCEED TO STEP 2. IF NOT, PROCEED TO STEP 3.

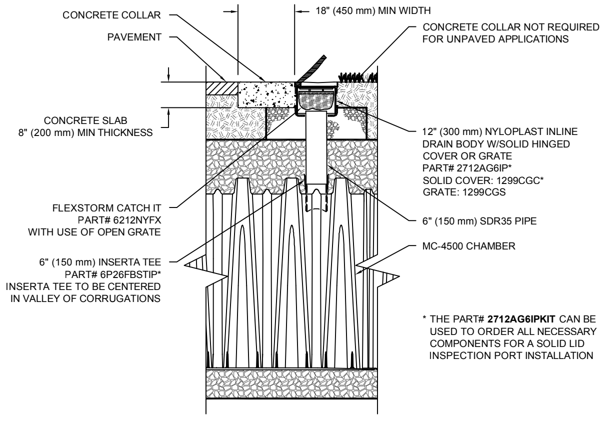
STEP 2) CLEAN OUT ISOLATOR ROW USING THE JETVAC PROCESS
- A. A FIXED CULVERT CLEANING NOZZLE WITH REAR FACING SPREAD OF 45" (1.1 m) OR MORE IS PREFERRED
- B. APPLY MULTIPLE PASSES OF JETVAC UNTIL BACKFLUSH WATER IS CLEAN
- C. VACUUM STRUCTURE SUMP AS REQUIRED

STEP 3) REPLACE ALL COVERS, GRATES, FILTERS, AND LIDS; RECORD OBSERVATIONS AND ACTIONS.

STEP 4) INSPECT AND CLEAN BASINS AND MANHOLES UPSTREAM OF THE STORMTECH SYSTEM.

NOTES

1. INSPECT EVERY 6 MONTHS DURING THE FIRST YEAR OF OPERATION. ADJUST THE INSPECTION INTERVAL BASED ON PREVIOUS OBSERVATIONS OF SEDIMENT ACCUMULATION AND HIGH WATER ELEVATIONS.
2. CONDUCT JETTING AND VACTORING ANNUALLY OR WHEN INSPECTION SHOWS THAT MAINTENANCE IS NECESSARY.



* THE PART# **2712AG6IPKIT** CAN BE USED TO ORDER ALL NECESSARY COMPONENTS FOR A SOLID LID INSPECTION PORT INSTALLATION

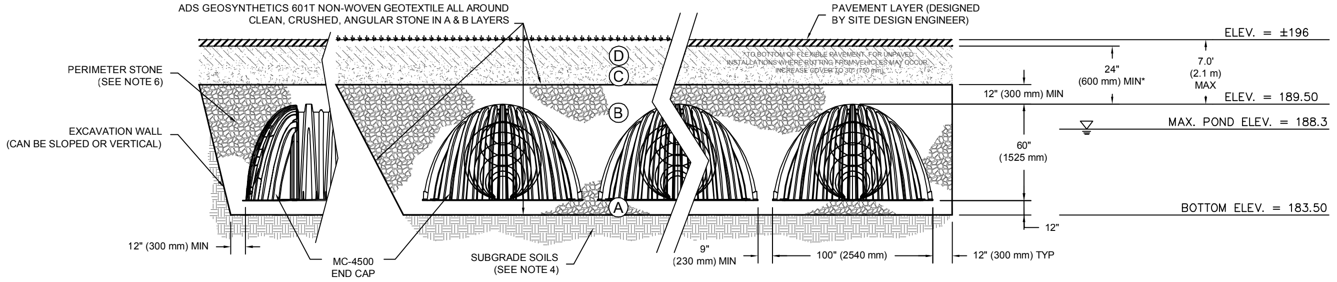
MC-4500 6" INSPECTION PORT DETAIL

NTS

ACCEPTABLE FILL MATERIALS: STORMTECH MC-4500 CHAMBER SYSTEMS

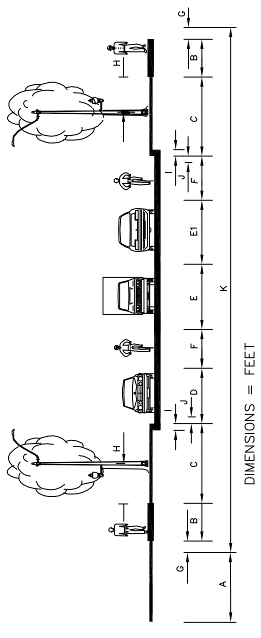
MATERIAL LOCATION		DESCRIPTION	AASHTO MATERIAL CLASSIFICATIONS	COMPACTION / DENSITY REQUIREMENT
D	**FINAL FILL:** FILL MATERIAL FOR LAYER 'D' STARTS FROM THE TOP OF THE 'C' LAYER TO THE BOTTOM OF FLEXIBLE PAVEMENT OR UNPAVED FINISHED GRADE ABOVE. NOTE THAT PAVEMENT SUBBASE MAY BE PART OF THE 'D' LAYER	ANY SOIL/ROCK MATERIALS, NATIVE SOILS, OR PER ENGINEER'S PLANS. CHECK PLANS FOR PAVEMENT SUBGRADE REQUIREMENTS.	N/A	PREPARE PER SITE DESIGN ENGINEER'S PLANS. PAVED INSTALLATIONS MAY HAVE STRINGENT MATERIAL AND PREPARATION REQUIREMENTS.
C	**INITIAL FILL:** FILL MATERIAL FOR LAYER 'C' STARTS FROM THE TOP OF THE EMBEDMENT STONE ('B' LAYER) TO 24" (600 mm) ABOVE THE TOP OF THE CHAMBER. NOTE THAT PAVEMENT SUBBASE MAY BE A PART OF THE 'C' LAYER.	GRANULAR WELL-GRADED SOIL/AGGREGATE MIXTURES, <35% FINES OR PROCESSED AGGREGATE. MOST PAVEMENT SUBBASE MATERIALS CAN BE USED IN LIEU OF THIS LAYER.	AASHTO M145[1] A-1, A-2-4, A-3 OR AASHTO M43[1] 3, 357, 4, 467, 5, 56, 57, 6, 67, 68, 7, 78, 8, 89, 9, 10	BEGIN COMPACTIONS AFTER 24" (600 mm) OF MATERIAL OVER THE CHAMBERS IS REACHED. COMPACT ADDITIONAL LAYERS IN 12" (300 mm) MAX LIFTS TO A MIN. 95% PROCTOR DENSITY FOR WELL GRADED MATERIAL AND 95% RELATIVE DENSITY FOR PROCESSED AGGREGATE MATERIALS.
B	**EMBEDMENT STONE:** FILL SURROUNDING THE CHAMBERS FROM THE FOUNDATION STONE ('A' LAYER) TO THE 'C' LAYER ABOVE.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	NO COMPACTION REQUIRED.
A	**FOUNDATION STONE:** FILL BELOW CHAMBERS FROM THE SUBGRADE UP TO THE FOOT (BOTTOM) OF THE CHAMBER.	CLEAN, CRUSHED, ANGULAR STONE	AASHTO M43[1] 3, 4	PLATE COMPACT OR ROLL TO ACHIEVE A FLAT SURFACE. [2] [3]

PLEASE NOTE:
1. THE LISTED AASHTO DESIGNATIONS ARE FOR GRADATIONS ONLY. THE STONE MUST ALSO BE CLEAN, CRUSHED, ANGULAR. FOR EXAMPLE, A SPECIFICATION FOR #4 STONE WOULD STATE: "CLEAN, CRUSHED, ANGULAR NO. 4 (AASHTO M43) STONE".
2. STORMTECH COMPACTION REQUIREMENTS ARE MET FOR 'A' LOCATION MATERIALS WHEN PLACED AND COMPACTED IN 9" (230 mm) (MAX) LIFTS USING TWO FULL COVERAGES WITH A VIBRATORY COMPACTOR.
3. WHERE INFILTRATION SURFACES MAY BE COMPROMISED BY COMPACTION, FOR STANDARD DESIGN LOAD CONDITIONS, A FLAT SURFACE MAY BE ACHIEVED BY RAKING OR DRAGGING WITHOUT COMPACTION EQUIPMENT. FOR SPECIAL LOAD DESIGNS, CONTACT STORMTECH FOR COMPACTION REQUIREMENTS.



NOTES:

1. MC-4500 CHAMBERS SHALL CONFORM TO THE REQUIREMENTS OF ASTM F2418 "STANDARD SPECIFICATION FOR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
2. MC-4500 CHAMBERS SHALL BE DESIGNED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS".
3. "ACCEPTABLE FILL MATERIALS" TABLE ABOVE PROVIDES MATERIAL LOCATIONS, DESCRIPTIONS, GRADATIONS, AND COMPACTION REQUIREMENTS FOR FOUNDATION, EMBEDMENT, AND FILL MATERIALS.
4. THE SITE DESIGN ENGINEER IS RESPONSIBLE FOR ASSESSING THE BEARING RESISTANCE (ALLOWABLE BEARING CAPACITY) OF THE SUBGRADE SOILS AND THE DEPTH OF FOUNDATION STONE WITH CONSIDERATION FOR THE RANGE OF EXPECTED SOIL MOISTURE CONDITIONS.
5. PERIMETER STONE MUST BE EXTENDED HORIZONTALLY TO THE EXCAVATION WALL FOR BOTH VERTICAL AND SLOPED EXCAVATION WALLS.
6. ONCE LAYER 'C' IS PLACED, ANY SOIL/MATERIAL CAN BE PLACED IN LAYER 'D' UP TO THE FINISHED GRADE. MOST PAVEMENT SUBBASE SOILS CAN BE USED TO REPLACE THE MATERIAL REQUIREMENTS OF LAYER 'C' OR 'D' AT THE SITE DESIGN ENGINEER'S DISCRETION.



DIMENSIONS = FEET

NUMBER OF LANES	EASEMENT	SIDEWALK	PLANTING	PARKING	LANE	LANE	BIKE LANE	R/W BEHIND SIDEWALK	CLEAR ZONE	CURB	GUTTER*	RIGHT OF WAY
	A	B	C	D	E	E1	F	G	H	I	J	K
2 LANES	10	5	8	7	10	9	0	1	4	0.5	1	~~55~~ 54
~~2 LANES CLASS II*~~	~~10~~	~~5~~	~~8~~	~~7~~	~~10~~	~~10~~	~~5~~	~~1~~	~~4~~	~~0.5~~	~~1~~	~~65~~
~~2 LANES CLASS III*~~	~~10~~	~~5~~	~~8~~	~~7~~	~~14~~	~~14~~	~~0~~	~~2~~	~~4~~	~~0.5~~	~~1~~	~~65~~

A= PRIVATE UTILITY EASEMENT

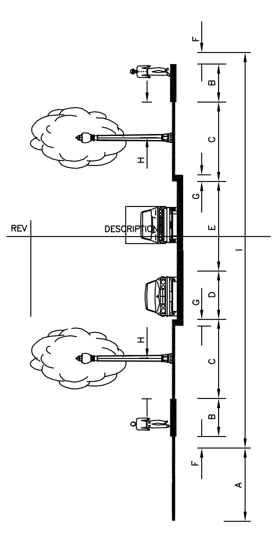
*GUTTER NOT ALLOWED NEXT TO BIKE FACILITY

SEE STANDARD DRAWING 4-6A FOR MINIMUM STRUCTURAL DESIGN AND STREET CROSS SLOPE DESIGN

SEE MINIMUM STREET DESIGN STANDARDS TABLE FOR ADDITIONAL DESIGN ELEMENTS

ADT
500–3,000

APPROVED BY	REVISED DATE	CITY OF OLYMPIA	STD. DWG. NO.
FRAN R. EIDE, PE CITY ENGINEER	8/10/2015	NEIGHBORHOOD COLLECTOR STREET	4–2I



DIMENSIONS = FEET

NUMBER OF LANES	EASEMENT	SIDEWALK	PLANTING	PARKING	LANE	R/W BEHIND SIDEWALK	CURB	CLEAR ZONE	RIGHT OF WAY
	A	B	C	D	E	F	G	H	I
1 LANE	10	5	8	7	13	1	0.5	4	48

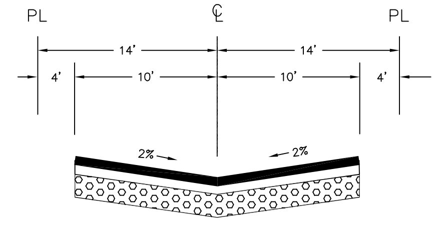
A= PRIVATE UTILITY EASEMENT

SEE STANDARD DRAWING 4-6A FOR MINIMUM STRUCTURAL DESIGN AND STREET CROSS SLOPE DESIGN

SEE MINIMUM STREET DESIGN STANDARDS TABLE FOR ADDITIONAL DESIGN ELEMENTS

ADT
0–500

APPROVED BY	REVISED DATE	CITY OF OLYMPIA	STD. DWG. NO.
FRAN R. EIDE, PE CITY ENGINEER	8/10/2015	LOCAL ACCESS STREET BLOCK SPACING < 350 FT	4–2K



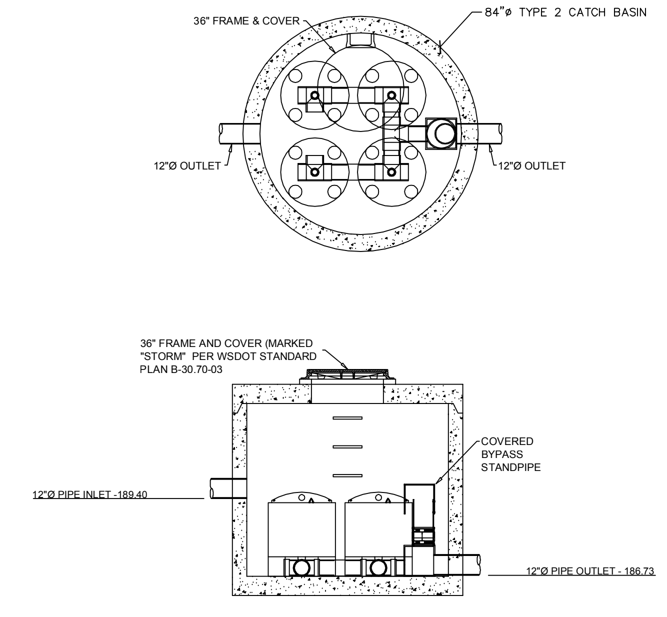
PRIVATE ACCESS LANE

****MODIFIED BY OLYMPIC ENGINEERING TO DEPICT INVERTED CROWN WITH NO PERIMETER CURBS**

NOTES:
1. PROVIDE DRIVEWAY APPROACH TO ACCESS LANE PER STANDARD DRAWING 4–7.
2. SIGN "NO OUTLET" PER STANDARD DRAWING 4–45.
3. STRUCTURAL SECTION PER PAVEMENT DESIGN STANDARD DRAWING 4–6A.

APPROVED BY	REVISED DATE	CITY OF OLYMPIA	STD. DWG. NO.
FRAN R. EIDE, PE CITY ENGINEER	9/1/2015	PRIVATE ACCESS LANE	4–46

NOTE:
SEE WSDOT STANDARD PLANS B-10.20-01
B-30.90-01 FOR ACCESS AND STEP/LADDER
LOCATION/ ORIENTATION AND DETAILS.



BAYSAVER – BAYFILTER DETAIL

N.T.S.

NO.	DATE	REVISION
1	7/23/18	REVISIONS PER CITY 1ST REVIEW COMMENTS

WELLINGTON HEIGHTS

CITY OF OLYMPIA WA

PRELIMINARY DETAILS

DESIGNED BY: CMM
DRAWN BY: CMM
CHECKED BY:
SCALE: 1" = 40'
DATE: 3/29/18

7/23/18
CHRISTOPHER M. MERRITT
37401

OLYMPIC ENGINEERING
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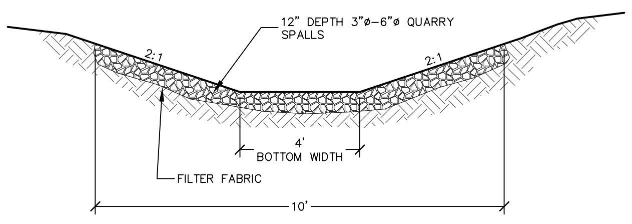
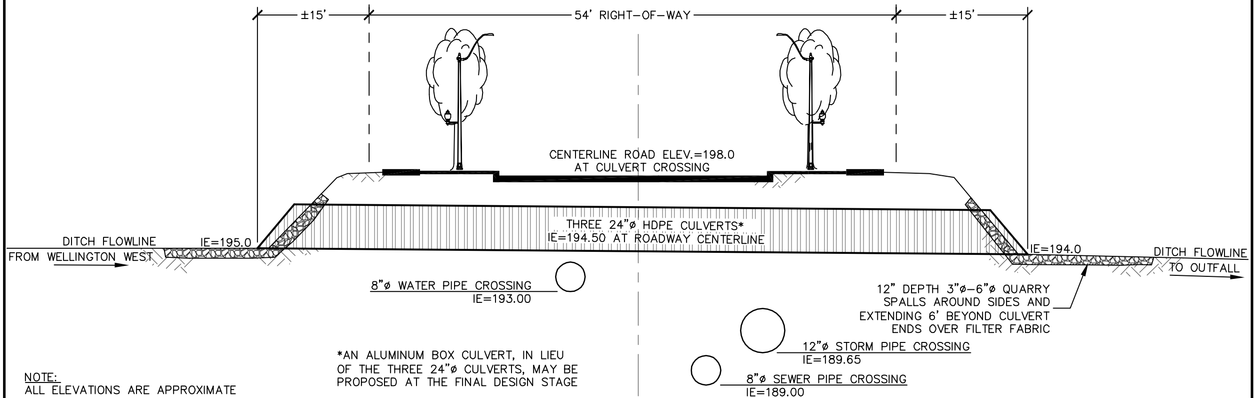
Olympia, WA 98508
360.705.2474
www.olyeng.com
Civil Engineering • Land Planning • Project Management

JOB NUMBER: 17096
DRAWING NAME: 17096_DETL1
SHEET: 4 OF 5



SPILLWAY DETAIL

N.T.S.

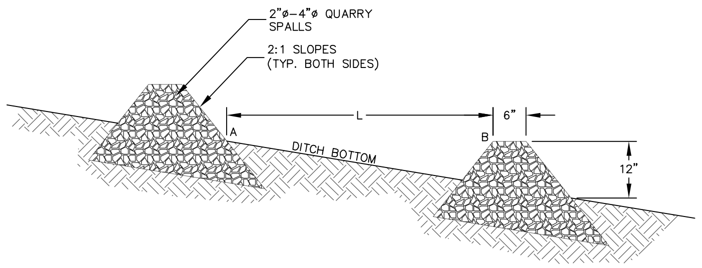


*AN ALUMINUM BOX CULVERT, IN LIEU OF THE THREE 24"ø CULVERTS, MAY BE PROPOSED AT THE FINAL DESIGN STAGE

NOTE:
ALL ELEVATIONS ARE APPROXIMATE AND WILL BE FINALIZED DURING THE CONSTRUCTION DOCUMENT/FINAL DESIGN PHASE

24"ø CULVERT CROSSING DETAIL

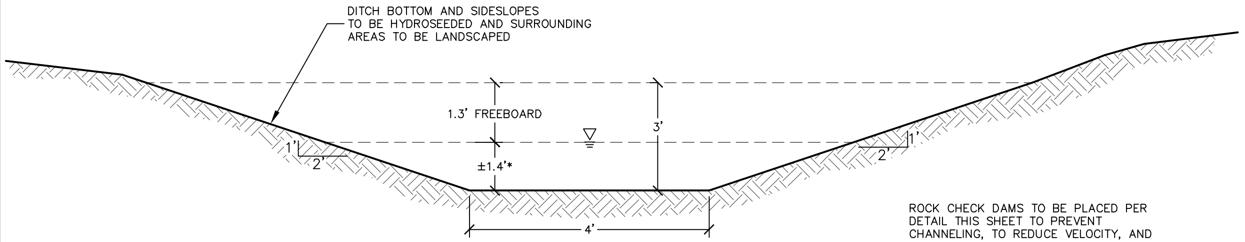
N.T.S.



NOTES:
1. L = THE DISTANCE SUCH THAT POINTS A AND B ARE OF EQUAL ELEVATION
2. CHECK DAMS ARE REQUIRED WHEN THE DITCH LONGITUDINAL SLOPE EXCEEDS 4%.

CHECK DAM DETAIL

N.T.S.

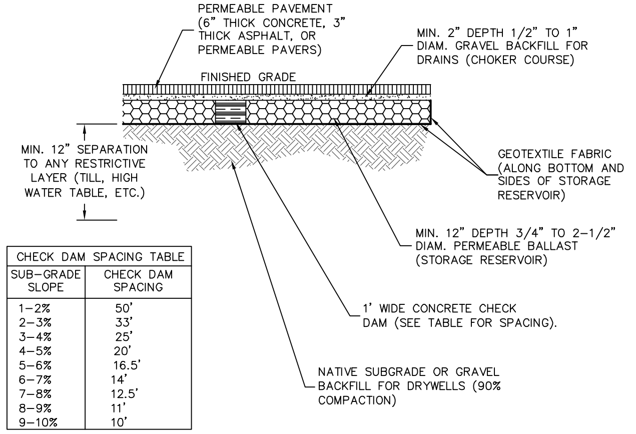


ROCK CHECK DAMS TO BE PLACED PER DETAIL THIS SHEET TO PREVENT CHANNELING, TO REDUCE VELOCITY, AND TO PROMOTE SOME INFILTRATION.

*MAX. WATER DEPTH BASED ON 44–CFS 100–YEAR STORM EVENT (MAX. PASS–THROUGH FLOW RATE PER WELLINGTON WEST DRAINAGE REPORT PREPARED BY HOWARD GODAT & ASSOCIATES, DATED APRIL 1, 1998)

PASS–THROUGH CONVEYANCE DITCH DETAIL

N.T.S.



CHECK DAM SPACING TABLE

SUB–GRADE SLOPE	CHECK DAM SPACING
1–2%	50'
2–3%	33'
3–4%	25'
4–5%	20'
5–6%	16.5'
6–7%	14'
7–8%	12.5'
8–9%	11'
9–10%	10'

NOTES:
1. ALL THICKNESSES ARE COMPACTED DEPTHS.
2. MAXIMUM PAVING SLOPES SHALL BE 5% FOR PERMEABLE ASPHALT, 6% FOR PERMEABLE CONCRETE, 10% FOR INTERLOCKING PAVERS, AND 6% FOR GRID/LATTICE SYSTEMS.
3. SLOPE PAVEMENT SURFACE TO DRAIN TO ADJACENT LAWN/LANDSCAPING AREAS OR CONVEY OVERFLOW TO DRYWELL TO PROVIDE FOR EMERGENCY OVERFLOW IN CASE OF PAVING SECTION FAILURE.
4. EXCAVATE TO GRADE WITH LIGHT EQUIPMENT WITH RUBBER TIRES. MINIMIZE DISTURBANCE OF THE SUBGRADE SOILS TO THE EXTENT PRACTICAL.
5. WASHED AGGREGATES SHALL MEET THE WSDOT SPECIFICATIONS FOR GRAVEL BACKFILL FOR DRAINS 9–03.12(4) AND PERMEABLE BALLAST 9–03.9(2).
6. GEOTEXTILE FABRIC SHALL BE MIRAFI 160N OR EQUAL.
7. PROVIDE CONCRETE CHECK DAMS PERPENDICULAR TO THE PAVEMENT SLOPE TO PREVENT WATER FROM FLOWING LATERALLY WITHIN THE STORAGE RESERVOIR SECTION.
8. ANY FILL NEEDED TO BRING THE PERMEABLE PAVEMENT SECTION UP TO GRADE SHALL CONSIST OF "PERMEABLE BALLAST PER WSDOT 9–03.9(2)".

PERMEABLE PAVEMENT (BMP T5.15) SECTION

N.T.S.

NO.	DATE	REVISION
1	7/23/18	REVISIONS PER CITY 1ST REVIEW COMMENTS

WELLINGTON HEIGHTS

CITY OF OLYMPIA WA

PRELIMINARY DETAILS

DESIGNED BY: CMM
DRAWN BY: CMM
CHECKED BY:
SCALE: 1" = 40'
DATE: 3/29/18

7/23/18
CHRISTOPHER M. MERRITT
37401

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JOB NUMBER: 17096
DRAWING NAME: 17096_DETL2

SHEET: 5 OF 5

Appendix 2
Drainage Calculations

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

January 2016

GENERAL USE LEVEL DESIGNATON FOR BASIC TREATMENT

CONDITIONAL USE LEVEL DESIGNATION FOR ENHANCED, AND PHOSPHORUS TREATMENT

For

BaySaver Technologies, LLC BayFilter™

Ecology's Decision:

1. **Based on BaySaver Technologies' application submissions, Ecology hereby issues a Basic Treatment General Use Level Designation (GULD) for the BayFilter™.**
    - **As a stormwater treatment device for Basic treatment (TSS) removal.**
    - **The Basic Treatment GULD is for both the BayFilter Cartridge (BFC) and Enhanced Media Cartridge (EMC) and limited to the following maximum flow rates:**
        a. **BFC Cartridge maximum flow rate of 0.70 gpm/sq ft**
            - **30 gpm (0.067 cfs) per cartridge (example dimensions: 26-inches in diameter, 29-inches tall (43 sq ft filter area))**
                - **Canisters that provide 0.70 gpm per sq ft filter area, regardless of dimensions meet this requirement**
            - **Media Blend of Silica Sand, Perlite, and Activated Alumina**

        b. **EMC Cartridge maximum flow rate of 0.50 gpm/sq ft**
            - **45 gpm (0.10 cfs) per cartridge (example dimensions 30-inch diameter, 30-inches tall (90 sq ft filter area))**
                - **Canisters that provide 0.50 gpm per sq ft filter area, regardless of dimensions meet this requirement**
            - **75 gpm (0.167 cfs) per cartridge (example dimensions 39-inch diameter, 30-inches tall) (150 sq ft filter area))**
                - **Canisters that provide 0.50 gpm per sq ft filter area, regardless of dimensions meet this requirement**
            - **Media Blend of Zeolite, Perlite, and Activated Alumina**

2. Based on BaySaver Technologies' application submissions, Ecology hereby issues a Enhanced and Phosphorus Conditional Use Level Designation (CULD) for the BayFilter™ cartridges.

- **As a stormwater treatment device for Enhanced treatment (dissolved Cu and dissolved Zn removal) and Phosphorus treatment.**
- **Sized at a design rates no greater than those listed above (GULD (Basic) Flow rates).**

3. Ecology approves use of BayFilter™ Cartridges for treatment at the above flow rates per cartridge. Designers shall calculate the water quality design flow rates using the following procedures:

- **Western Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using the latest version of the Western Washington Hydrology Model or other Ecology-approved continuous runoff model.**
- **Eastern Washington: For treatment installed upstream of detention or retention, the water quality design flow rate is the peak 15-minute flow rate as calculated using one of the three methods described in Chapter 2.2.5 of the Stormwater Management Manual for Eastern Washington (SWMMEW) or local manual.**
- **Entire State: For treatment installed downstream of detention, the water quality design flow rate is the full 2-year release rate of the detention facility.**

4. The CULDs expire on December 31, 2016 unless extended by Ecology, and are subject to the conditions specified below.

5. The GULD has no expiration date, but it may be amended or revoked by Ecology, and is subject to the conditions specified below.

Ecology's Conditions of Use:

BayFilter™ units shall comply with these conditions:

1. Design, assemble, install, operate, and maintain BayFilter™ units in accordance with BaySaver Technologies' applicable manuals and documents and the Ecology Decision.

2. Maintenance: The required inspection/maintenance interval for stormwater treatment devices is often dependent upon the efficiency of the device and the degree of pollutant loading from a particular drainage basin. Therefore, Ecology does not endorse or recommend a "one size fits all" maintenance cycle for a particular model/size of manufactured filter treatment device.

- **BaySaver recommends that the following be considered during the design application of the BayFilter Cartridge systems:**
    - **Water Quality Flow Rate**
    - **Anticipated Pollutant Load**
    - **Maintenance Frequency**

- **A BayFilter System tested adjacent to construction activity required maintenance after 4-months of operation. Monitoring personnel observed construction washout in the device during the testing period; the construction activity may have resulted in a shorter maintenance interval.**

- **Ecology has found that pre-treatment device prior to the BayFilter system can provide a reduction in pollutant loads on these systems, thereby extending the maintenance interval.**

- **Test results provided to Ecology from other BayFilter Systems, including the above mentioned system that was evaluated again after construction activities had been completed, have indicated the BayFilter System typically has longer maintenance intervals, sometimes exceeding 12-months.**

- **The BayFilter system contains filter fabric that is highly oleophilic (oil absorptive). When sufficient quantities of oils are present in the runoff, the oil and subsequent sediment particles may become attached to the fabric. As a result, it may compromise the maintenance interval of the BayFilter system. Oil control BMP's should be installed upstream of BayFilter installations if warranted, and/or the BayFilter system should be inspected after any known oil spill or release.**

- **Owners/operators must inspect BayFilter systems for a minimum of twelve months from the start of post-construction operation to determine site-specific inspection/maintenance schedules and requirements. Owners/operators must conduct inspections monthly during the wet season, and every other month during the dry season. (According to the SWMMWW, the wet season in western Washington is October 1 to April 30. According to SWMMEW, the wet season in eastern Washington is October 1 to June 30.) After the first year of operation, owners/operators must conduct inspections based on the findings during the first year of inspections or the manufacturer's anticipated maintenance interval, whichever is more frequent.**

- **Conduct inspections by qualified personnel, follow manufacturer's guidelines, and must use methods capable of determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.**

3. **When inspections are performed, the following findings typically serve as maintenance triggers:**
   - **Accumulated vault sediment depths exceed an average of 2 inches, or**
   - **Accumulated sediment depths on the tops of the cartridges exceed an average of 0.5 inches, or**
   - **Standing water remains in the vault between rain events.**
   - **Bypass during storms smaller than the design storm.**
   - **Note: If excessive floatables (trash and debris) are present, perform minor maintenance consisting of gross solids removal, not cartridge replacement.**

4. **BaySaver Technologies Inc. commits to submitting a QAPP for Ecology approval by February 1, 2015 that meets the TAPE requirements for attaining a GULD for enhanced and phosphorus treatment. The monitoring site(s) chosen should be reflective of the product's treatment intent. BaySaver shall monitor sites prior to installation of the canister to ensure concentrations of the monitored constituents are within TAPE guidelines.**

5. **BaySaver Technologies Inc. shall complete all required testing and submit a TER for enhanced and phosphorus treatment for Ecology review by April 30, 2015.**

6. **BaySaver Technologies Inc. may request Ecology to grant deadline or expiration date extensions, upon showing cause for such extensions.**

7. **Discharges from the BayFilter™ units shall not cause or contribute to water quality standards violations in receiving waters.**

Applicant: Advanced Drainage Systems - BaySaver
Applicant's Address: 4640 Trueman Blvd
Hilliard, Ohio 43065

Application Documents:

- *Technical Evaluation Report BayFilter System, Grandview Place Apartments*, Vancouver, Washington and Appendices A through O (May 18, 2011)
- *Washington State Department of Ecology Technology Assessment Protocol – Environmental BayFilter™ Conditional Use Designation Application* (March 2007)
- *BaySaver Technologies, Inc. BayFilter™ System Washington State Technical and Design Manual, Version 1.1* (December 2006)
- *Efficiency Assessment of BaySeparator and Bay filter Systems in the Richard Montgomery High School* January 6.2009.
- *Evaluation of MASWRC Sample Collection, Sample Analysis, and Data Analysis*, December 27, 2008
- Letter from Mid-Atlantic Stormwater Research Center to BaySaver Technologies, In. dated October 22, 2009.

- Letter from Mid-Atlantic Stormwater Research Center to BaySaver Technologies, In. dated November 5, 2009.
- Maryland Department of the Environment letter to BaySaver Technologies dated Jan. 13, 2008 regarding approval of BayFilter as a standalone BMP for Stormwater treatment.
- NJCAT letter to BaySaver Technologies dated June 18, 2009 regarding Interim Certification.

Applicant's Use Level Request:

- General use level designation as a basic, enhanced, and phosphorus treatment device in accordance with Ecology's Stormwater Management Manual for Western Washington.

Applicant's Performance Claims:

- Removes and retains 80% of TSS based on laboratory testing using Sil-Co-Sil 106 as a laboratory stimulant.
- Removes 42% of dissolved Copper and 38% of dissolved Zinc.
- Expected to remove 50% of the influent phosphorus load.

Ecology's Recommendations:

Ecology finds that:

- Ecology should provide BaySaver Technologies, Inc. with the opportunity to demonstrate, through additional laboratory and field-testing, whether the BayFilter™ system (as a single treatment facility) can attain Ecology's Enhanced Treatment and Phosphorus removal goals.

Findings of Fact:

- Based on field testing in Vancouver, WA, at a flow rate less than or equal to 30 gpm per canister, the BayFilter™ system demonstrated a total suspended solids removal efficiency of greater than 80% for influent concentrations between 100 and 200 mg/l and an effluent concentration < 20 mg/l for influent concentration < 100 mg/l.

- Based on laboratory testing, at a flowrate of 30 GPM per filter, the BayFilter™ system demonstrated a total suspended solids removal efficiency of 81.5% using Sil-Co-Sil 106 with an average influent concentration of 268 mg/L and zero initial sediment loading.

- Based on laboratory testing, at a flowrate of 30 GPM per filter, the BayFilter™ system demonstrated a dissolved phosphorus removal efficiency of 55% using data from the Richard Montgomery High School field-testing. The average influent concentration was 0.31 mg/L phosphorus and zero initial sediment loading.

- Based on data from field-testing at Richard Montgomery High School in Rockville, MD the BayFilter system demonstrated a Cu removal efficiency of 51% and 41% for total and dissolved Cu respectively. Average influent concentrations are 41.6 µg/l total and 17.5 µg/l dissolved.

- Based on data from field-testing at Richard Montgomery High School in Rockville, MD the BayFilter system demonstrated a Zn removal efficiency of 45% and 38% for total and dissolved Cu, respectively. Average influent concentrations are 354 µg/l total and 251 µg/l dissolved, respectively.

Other BayFilter™ Related Issues to be Addressed By the Company:

1. The Washington State field test results submitted in the TER do not yet show whether the BayFilter™ system can reliably attain 30% removal of dissolved Cu, 60% removal of dissolved Zn, or 50% removal of Total Phosphorus found on local highways, parking lots, and other high-use areas at the design operating rate.
2. BaySaver Technologies, Inc. should test a variety of operating rates to establish conservative design flow rates.
3. The manufacturer should continue to monitor the system to measure bypass and to calculate if the system treats 91% of the volume of the total annual runoff volume.
4. The manufacturer should test the system under normal operating conditions, with a partially pollutant filled settling basin. Results obtained for "clean" systems may not be representative of typical performance.
5. Conduct field-testing at sites that are indicative of the treatment goals.
6. BaySaver should continue monitoring the system for a longer period to help establish a maintenance period and to obtain data from additional qualified storms. Conduct testing to obtain information about maintenance requirements in order to come up with a maintenance cycle.
7. Conduct loading tests on the filter to determine maximum treatment life of the system.
8. Conduct testing to determine if oils and grease affect the treatment ability of the filter. This should include a determination of how oil and grease may affect the ion-exchange capacity of the system if BaySaver wishes to make claims for phosphorus removal.
9. BaySaver should develop easy-to-implement methods of determining when a BayFilter system requires maintenance (cleaning and filter replacement).
10. BaySaver must update their O&M documents to include information and instructions on the "24-hour draw-down" method to determine if cartridges need replacing.

Technology Description: Download at www.BaySaver.com

Contact Information:

Applicant:

Daniel Figola
Advanced Drainage Systems - BaySaver
4640 Trueman Blvd
Hilliard, Ohio 43065
(614) 658-0265
dfigola@ads-pipe.com

Applicant website: www.BaySaver.com

Ecology web link: http://www.ecy.wa.gov/programs/wq/stormwater/newtech/index.html

Ecology:

Douglas C. Howie, P.E.
Department of Ecology
Water Quality Program
(360) 407-6444
douglas.howie@ecy.wa.gov

Revision History

Date	**Revision**
April 2008	Original use-level-designation document
February 2010	Revision
August 2011	GULD awarded for Basic Treatment
April 2012	Maintenance requirements updated.
August 2012	Revised design storm criteria
December 2012	Revised contact information and document formatting
December 2013	Revised expiration and submittal dates
December 2014	Revised Inspection/maintenance discussion, Updated cartridge descriptions
January 2015	Revised discussion for flow rate controls
December 2015	Revised Expiration date
January 2016	Revised Manufacturer Contact Information and expiration date

Project: **Wellington Heights**

Chamber Model -	MC-4500	
Units -	**Imperial**	
Number of Chambers -	60	
Number of End Caps -	6	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	183.50	ft
Amount of Stone Above Chambers -	12	in
Amount of Stone Below Chambers -	12	in
Area of system -	2676	sf Min. Area - 2388 sf min. area

☑ Include Perimeter Stone in Calculations

StormTech MC-4500 Cumulative Storage Volumes

Height of System *(inches)*	Incremental Single Chamber *(cubic feet)*	Incremental Single End Cap *(cubic feet)*	Incremental Chambers *(cubic feet)*	Incremental End Cap *(cubic feet)*	Incremental Stone *(cubic feet)*	Incremental Ch, EC and Stone *(cubic feet)*	Cumulative System (cubic feet)	Elevation (feet)
84	0.00	0.00	0.00	0.00	89.20	89.20	11455.59	190.50
83	0.00	0.00	0.00	0.00	89.20	89.20	11366.39	190.42
82	0.00	0.00	0.00	0.00	89.20	89.20	11277.19	190.33
81	0.00	0.00	0.00	0.00	89.20	89.20	11187.99	190.25
80	0.00	0.00	0.00	0.00	89.20	89.20	11098.79	190.17
79	0.00	0.00	0.00	0.00	89.20	89.20	11009.59	190.08
78	0.00	0.00	0.00	0.00	89.20	89.20	10920.39	190.00
77	0.00	0.00	0.00	0.00	89.20	89.20	10831.19	189.92
76	0.00	0.00	0.00	0.00	89.20	89.20	10741.99	189.83
75	0.00	0.00	0.00	0.00	89.20	89.20	10652.79	189.75
74	0.00	0.00	0.00	0.00	89.20	89.20	10563.59	189.67
73	0.00	0.00	0.00	0.00	89.20	89.20	10474.39	189.58
72	0.04	0.00	2.46	0.00	88.22	90.67	10385.19	189.50
71	0.12	0.01	6.97	0.06	86.39	93.42	10294.51	189.42
70	0.16	0.03	9.88	0.16	85.18	95.23	10201.10	189.33
69	0.21	0.05	12.52	0.29	84.08	96.89	10105.87	189.25
68	0.27	0.07	16.10	0.41	82.60	99.10	10008.99	189.17
67	0.45	0.09	27.17	0.53	78.12	105.82	9909.88	189.08
66	0.67	0.11	39.92	0.68	72.96	113.56	9804.07	189.00
65	0.80	0.14	47.94	0.85	69.68	118.47	9690.51	188.92
64	0.91	0.17	54.49	1.01	67.00	122.50	9572.04	188.83
63	1.00	0.19	60.17	1.15	64.67	125.99	9449.54	188.75
62	1.09	0.22	65.24	1.29	62.59	129.12	9323.55	188.67
61	1.16	0.24	69.81	1.45	60.70	131.95	9194.43	188.58
60	1.23	0.27	74.04	1.62	58.94	134.60	9062.47	188.50
59	1.30	0.30	77.98	1.79	57.29	137.06	8927.88	188.42
58	1.36	0.32	81.66	1.94	55.76	139.36	8790.82	188.33
57	1.42	0.35	85.12	2.09	54.32	141.53	8651.46	188.25
56	1.47	0.37	88.40	2.23	52.95	143.58	8509.93	188.17
55	1.53	0.39	91.51	2.36	51.65	145.52	8366.35	188.08
54	1.57	0.42	94.47	2.50	50.41	147.38	8220.83	188.00
53	1.62	0.44	97.28	2.64	49.23	149.15	8073.45	187.92
52	1.67	0.46	99.97	2.78	48.10	150.85	7924.29	187.83
51	1.71	0.48	102.55	2.90	47.02	152.47	7773.44	187.75

50	1.75	0.50	105.01	3.03	45.99	154.02	7620.97	187.67
49	1.79	0.53	107.36	3.15	45.00	155.51	7466.95	187.58
48	1.83	0.55	109.63	3.27	44.04	156.94	7311.44	187.50
47	1.86	0.56	111.81	3.39	43.12	158.32	7154.50	187.42
46	1.90	0.58	113.90	3.50	42.24	159.64	6996.19	187.33
45	1.93	0.60	115.91	3.61	41.39	160.91	6836.55	187.25
44	1.96	0.62	117.84	3.72	40.57	162.14	6675.64	187.17
43	2.00	0.64	119.71	3.83	39.79	163.32	6513.50	187.08
42	2.03	0.66	121.50	3.93	39.03	164.46	6350.18	187.00
41	2.05	0.67	123.23	4.04	38.29	165.56	6185.72	186.92
40	2.08	0.69	124.89	4.14	37.59	166.62	6020.16	186.83
39	2.11	0.71	126.48	4.24	36.91	167.64	5853.54	186.75
38	2.13	0.72	128.03	4.34	36.25	168.62	5685.90	186.67
37	2.16	0.74	129.52	4.44	35.62	169.58	5517.27	186.58
36	2.18	0.76	130.95	4.54	35.00	170.49	5347.70	186.50
35	2.21	0.77	132.33	4.63	34.42	171.38	5177.21	186.42
34	2.23	0.79	133.66	4.72	33.85	172.23	5005.83	186.33
33	2.25	0.80	134.93	4.81	33.30	173.05	4833.60	186.25
32	2.27	0.82	136.16	4.92	32.77	173.85	4660.55	186.17
31	2.29	0.84	137.34	5.04	32.25	174.63	4486.70	186.08
30	2.31	0.85	138.47	5.08	31.78	175.33	4312.07	186.00
29	2.33	0.86	139.56	5.15	31.32	176.03	4136.75	185.92
28	2.34	0.87	140.60	5.23	30.87	176.70	3960.72	185.83
27	2.36	0.89	141.59	5.31	30.44	177.34	3784.02	185.75
26	2.38	0.90	142.55	5.39	30.03	177.96	3606.68	185.67
25	2.39	0.91	143.46	5.46	29.63	178.55	3428.72	185.58
24	2.41	0.92	144.33	5.53	29.26	179.12	3250.16	185.50
23	2.42	0.93	145.16	5.61	28.90	179.66	3071.05	185.42
22	2.43	0.95	145.94	5.67	28.55	180.17	2891.39	185.33
21	2.44	0.96	146.69	5.74	28.23	180.66	2711.22	185.25
20	2.46	0.97	147.40	5.80	27.92	181.12	2530.56	185.17
19	2.47	0.98	148.07	5.87	27.63	181.56	2349.44	185.08
18	2.48	0.99	148.70	5.93	27.35	181.97	2167.88	185.00
17	2.49	1.00	149.30	5.99	27.09	182.37	1985.91	184.92
16	2.50	1.01	149.86	6.04	26.84	182.74	1803.54	184.83
15	2.51	1.02	150.39	6.10	26.61	183.09	1620.80	184.75
14	2.51	1.02	150.88	6.15	26.39	183.42	1437.70	184.67
13	2.53	1.03	151.62	6.20	26.08	183.89	1254.29	184.58
12	0.00	0.00	0.00	0.00	89.20	89.20	1070.40	184.50
11	0.00	0.00	0.00	0.00	89.20	89.20	981.20	184.42
10	0.00	0.00	0.00	0.00	89.20	89.20	892.00	184.33
9	0.00	0.00	0.00	0.00	89.20	89.20	802.80	184.25
8	0.00	0.00	0.00	0.00	89.20	89.20	713.60	184.17
7	0.00	0.00	0.00	0.00	89.20	89.20	624.40	184.08
6	0.00	0.00	0.00	0.00	89.20	89.20	535.20	184.00
5	0.00	0.00	0.00	0.00	89.20	89.20	446.00	183.92
4	0.00	0.00	0.00	0.00	89.20	89.20	356.80	183.83
3	0.00	0.00	0.00	0.00	89.20	89.20	267.60	183.75
2	0.00	0.00	0.00	0.00	89.20	89.20	178.40	183.67
1	0.00	0.00	0.00	0.00	89.20	89.20	89.20	183.58

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	17096_071718
Site Name:	Wellington Heights
Site Address:	18th Ave SW
City:	Olympia
Report Date:	7/22/2018
Gage:	Courthouse
Data Start:	1955/10/01
Data End:	2011/09/30
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2017/07/05
Version:	4.2.13

POC Thresholds

Low Flow Threshold for POC1:	50 Percent of the 2 Year
High Flow Threshold for POC1:	50 Year
Low Flow Threshold for POC2:	50 Percent of the 2 Year
High Flow Threshold for POC2:	50 Year
Low Flow Threshold for POC3:	50 Percent of the 2 Year
High Flow Threshold for POC3:	50 Year

Landuse Basin Data

Predeveloped Land Use

Pre to Post Analysis

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	0.357
A B, Pasture, Flat	8.494
Pervious Total	8.851
Impervious Land Use	acre
ROADS FLAT	0.465
DRIVEWAYS FLAT	0.082
SIDEWALKS FLAT	0.002
Impervious Total	0.549
Basin Total	9.4

For analyzing the difference in the pre- to post-developed runoff rate

Element Flows To:

Surface	Interflow	Groundwater

Water Quality Dummy

Bypass: No

GroundWater: No

Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	0.903
DRIVEWAYS FLAT	0.343
Impervious Total	1.246
Basin Total	1.246

"Dummy" basin to enable model to work - for determining Water Quality Flow rate

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Infiltration Trench

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	0.903
ROOF TOPS FLAT	0.785
DRIVEWAYS FLAT	0.343
Impervious Total	2.031
Basin Total	2.031

Public roadways

Lots 38-55 roof area

Driveways within the right-of-way

Element Flows To:

Surface		Interflow		Groundwater
SSD Table	Infil Trench	SSD Table	Infil Trench	

Water Quality

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS FLAT	0.903
DRIVEWAYS FLAT	0.343
Impervious Total	1.246
Basin Total	1.246

For determining Water Quality Flow rate

Public roadways

Driveways within the right-of-way

Element Flows To:

Surface	Interflow	Groundwater

Pre to Post Analysis

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Pasture, Flat	3.661
A B, Forest, Flat	0.517
Pervious Total	4.178
Impervious Land Use	acre
Impervious Total	0
Basin Total	4.178

For analyzing the difference in the pre- to post-developed runoff rate

Planter strips, open space, & lawn/ landscape areas

SVPA areas

Excludes infiltrated hard surface areas (roof, driveway, roadway)

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements

Predeveloped Routing

Mitigated Routing

SSD Table Infil Trench

Depth: 7 ft.
Discharge Structure: 1
Riser Height: 6 ft.
Riser Diameter: 12 in.
Element Flows To:
Outlet 1 Outlet 2

2,676 sf infiltration bottom surface area of facility

Values may appear to be incorrect due to rounding

Per StormTech SC-740 Cumulative Storage Volume Table

10"/hr over a 2,676 sf infiltration surface area

SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	Infilt (cfs)	NotUsed	NotUsed	NotUsed
0.000	0.061	0.000	0.000	0.619	0.000	0.000	0.000
0.083	0.061	0.002	0.000	0.619	0.000	0.000	0.000
0.167	0.061	0.004	0.000	0.619	0.000	0.000	0.000
0.250	0.061	0.006	0.000	0.619	0.000	0.000	0.000
0.333	0.061	0.008	0.000	0.619	0.000	0.000	0.000
0.417	0.061	0.010	0.000	0.619	0.000	0.000	0.000
0.500	0.061	0.012	0.000	0.619	0.000	0.000	0.000
0.583	0.061	0.014	0.000	0.619	0.000	0.000	0.000
0.667	0.061	0.016	0.000	0.619	0.000	0.000	0.000
0.750	0.061	0.018	0.000	0.619	0.000	0.000	0.000
0.833	0.061	0.020	0.000	0.619	0.000	0.000	0.000
0.917	0.061	0.023	0.000	0.619	0.000	0.000	0.000
1.000	0.061	0.025	0.000	0.619	0.000	0.000	0.000
1.083	0.061	0.029	0.000	0.619	0.000	0.000	0.000
1.167	0.061	0.033	0.000	0.619	0.000	0.000	0.000
1.250	0.061	0.037	0.000	0.619	0.000	0.000	0.000
1.333	0.061	0.041	0.000	0.619	0.000	0.000	0.000
1.417	0.061	0.046	0.000	0.619	0.000	0.000	0.000
1.500	0.061	0.050	0.000	0.619	0.000	0.000	0.000
1.583	0.061	0.054	0.000	0.619	0.000	0.000	0.000
1.667	0.061	0.058	0.000	0.619	0.000	0.000	0.000
1.750	0.061	0.062	0.000	0.619	0.000	0.000	0.000
1.833	0.061	0.066	0.000	0.619	0.000	0.000	0.000
1.917	0.061	0.071	0.000	0.619	0.000	0.000	0.000
2.000	0.061	0.075	0.000	0.619	0.000	0.000	0.000
2.083	0.061	0.079	0.000	0.619	0.000	0.000	0.000
2.167	0.061	0.083	0.000	0.619	0.000	0.000	0.000
2.250	0.061	0.087	0.000	0.619	0.000	0.000	0.000
2.333	0.061	0.091	0.000	0.619	0.000	0.000	0.000
2.417	0.061	0.095	0.000	0.619	0.000	0.000	0.000
2.500	0.061	0.099	0.000	0.619	0.000	0.000	0.000
2.583	0.061	0.103	0.000	0.619	0.000	0.000	0.000
2.667	0.061	0.107	0.000	0.619	0.000	0.000	0.000
2.750	0.061	0.111	0.000	0.619	0.000	0.000	0.000
2.833	0.061	0.115	0.000	0.619	0.000	0.000	0.000
2.917	0.061	0.119	0.000	0.619	0.000	0.000	0.000
3.000	0.061	0.123	0.000	0.619	0.000	0.000	0.000
3.083	0.061	0.127	0.000	0.619	0.000	0.000	0.000
3.167	0.061	0.131	0.000	0.619	0.000	0.000	0.000
3.250	0.061	0.134	0.000	0.619	0.000	0.000	0.000
3.333	0.061	0.138	0.000	0.619	0.000	0.000	0.000
3.417	0.061	0.142	0.000	0.619	0.000	0.000	0.000

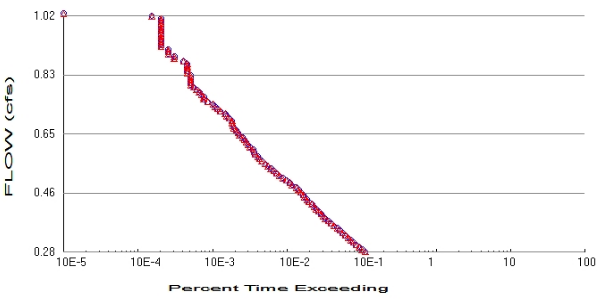
3.500	0.061	0.146	0.000	0.619	0.000	0.000	0.000
3.583	0.061	0.150	0.000	0.619	0.000	0.000	0.000
3.667	0.061	0.153	0.000	0.619	0.000	0.000	0.000
3.750	0.061	0.157	0.000	0.619	0.000	0.000	0.000
3.833	0.061	0.161	0.000	0.619	0.000	0.000	0.000
3.917	0.061	0.164	0.000	0.619	0.000	0.000	0.000
4.000	0.061	0.168	0.000	0.619	0.000	0.000	0.000
4.083	0.061	0.171	0.000	0.619	0.000	0.000	0.000
4.167	0.061	0.175	0.000	0.619	0.000	0.000	0.000
4.250	0.061	0.178	0.000	0.619	0.000	0.000	0.000
4.333	0.061	0.182	0.000	0.619	0.000	0.000	0.000
4.417	0.061	0.185	0.000	0.619	0.000	0.000	0.000
4.500	0.061	0.189	0.000	0.619	0.000	0.000	0.000
4.583	0.061	0.192	0.000	0.619	0.000	0.000	0.000
4.667	0.061	0.195	0.000	0.619	0.000	0.000	0.000
4.750	0.061	0.199	0.000	0.619	0.000	0.000	0.000
4.833	0.061	0.202	0.000	0.619	0.000	0.000	0.000
4.917	0.061	0.205	0.000	0.619	0.000	0.000	0.000
5.000	0.061	0.208	0.000	0.619	0.000	0.000	0.000
5.083	0.061	0.211	0.000	0.619	0.000	0.000	0.000
5.167	0.061	0.214	0.000	0.619	0.000	0.000	0.000
5.250	0.061	0.217	0.000	0.619	0.000	0.000	0.000
5.333	0.061	0.220	0.000	0.619	0.000	0.000	0.000
5.417	0.061	0.222	0.000	0.619	0.000	0.000	0.000
5.500	0.061	0.225	0.000	0.619	0.000	0.000	0.000
5.583	0.061	0.227	0.000	0.619	0.000	0.000	0.000
5.667	0.061	0.230	0.000	0.619	0.000	0.000	0.000
5.750	0.061	0.232	0.000	0.619	0.000	0.000	0.000
5.833	0.061	0.234	0.000	0.619	0.000	0.000	0.000
5.917	0.061	0.236	0.000	0.619	0.000	0.000	0.000
6.000	0.061	0.238	0.000	0.619	0.000	0.000	0.000
6.083	0.061	0.240	0.254	0.619	0.000	0.000	0.000
6.167	0.061	0.243	0.703	0.619	0.000	0.000	0.000
6.250	0.061	0.245	1.218	0.619	0.000	0.000	0.000
6.333	0.061	0.247	1.683	0.619	0.000	0.000	0.000
6.417	0.061	0.249	2.013	0.619	0.000	0.000	0.000
6.500	0.061	0.251	2.203	0.619	0.000	0.000	0.000
6.583	0.061	0.253	2.406	0.619	0.000	0.000	0.000
6.667	0.061	0.255	2.572	0.619	0.000	0.000	0.000
6.750	0.061	0.257	2.728	0.619	0.000	0.000	0.000
6.833	0.061	0.259	2.875	0.619	0.000	0.000	0.000
6.917	0.061	0.261	3.016	0.619	0.000	0.000	0.000
7.000	0.061	0.263	3.150	0.619	0.000	0.000	0.000

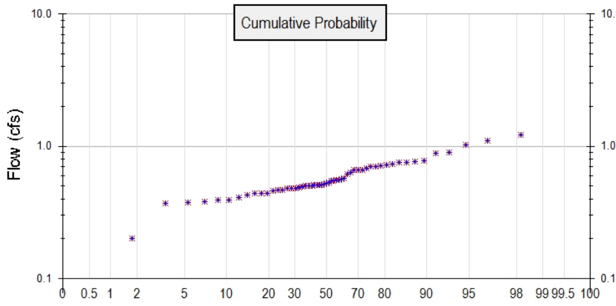
Analysis Results

POC 1

POC #1 was not reported because POC must exist in both scenarios and both scenarios must have been run.

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2

Total Pervious Area:	0
Total Impervious Area:	1.246

Mitigated Landuse Totals for POC #2

Total Pervious Area:	0
Total Impervious Area:	1.246

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.559405
5 year	0.730563
10 year	0.829745
25 year	0.941925
50 year	1.017458
100 year	1.087152

Not applicable

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.559405
5 year	0.730563
10 year	0.829745
25 year	0.941925
50 year	1.017458
100 year	1.087152

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1956	0.438	0.438
1957	0.774	0.774
1958	0.507	0.507
1959	0.529	0.529
1960	1.098	1.098
1961	0.409	0.409
1962	0.438	0.438
1963	0.879	0.879
1964	0.556	0.556
1965	0.506	0.506
1966	0.391	0.391

1967	0.754	0.754
1968	0.439	0.439
1969	0.382	0.382
1970	0.374	0.374
1971	0.427	0.427
1972	0.700	0.700
1973	0.485	0.485
1974	0.665	0.665
1975	0.483	0.483
1976	0.481	0.481
1977	0.750	0.750
1978	0.544	0.544
1979	0.665	0.665
1980	0.480	0.480
1981	0.678	0.678
1982	0.702	0.702
1983	1.023	1.023
1984	0.708	0.708
1985	0.658	0.658
1986	0.514	0.514
1987	0.465	0.465
1988	0.389	0.389
1989	0.369	0.369
1990	0.719	0.719
1991	0.766	0.766
1992	0.552	0.552
1993	0.459	0.459
1994	0.493	0.493
1995	0.510	0.510
1996	0.736	0.736
1997	0.186	0.186
1998	0.200	0.200
1999	0.551	0.551
2000	0.619	0.619
2001	0.501	0.501
2002	0.568	0.568
2003	0.503	0.503
2004	1.213	1.213
2005	0.468	0.468
2006	0.525	0.525
2007	0.634	0.634
2008	0.562	0.562
2009	0.897	0.897
2010	0.500	0.500
2011	0.508	0.508

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	1.2127	1.2127
2	1.0980	1.0980
3	1.0228	1.0228
4	0.8967	0.8967
5	0.8795	0.8795
6	0.7743	0.7743
7	0.7664	0.7664
8	0.7545	0.7545
9	0.7501	0.7501

10	0.7359	0.7359
11	0.7187	0.7187
12	0.7083	0.7083
13	0.7022	0.7022
14	0.6995	0.6995
15	0.6781	0.6781
16	0.6655	0.6655
17	0.6653	0.6653
18	0.6580	0.6580
19	0.6343	0.6343
20	0.6186	0.6186
21	0.5682	0.5682
22	0.5622	0.5622
23	0.5563	0.5563
24	0.5515	0.5515
25	0.5512	0.5512
26	0.5441	0.5441
27	0.5289	0.5289
28	0.5246	0.5246
29	0.5138	0.5138
30	0.5096	0.5096
31	0.5080	0.5080
32	0.5075	0.5075
33	0.5063	0.5063
34	0.5029	0.5029
35	0.5010	0.5010
36	0.4999	0.4999
37	0.4934	0.4934
38	0.4849	0.4849
39	0.4834	0.4834
40	0.4809	0.4809
41	0.4804	0.4804
42	0.4678	0.4678
43	0.4650	0.4650
44	0.4586	0.4586
45	0.4389	0.4389
46	0.4380	0.4380
47	0.4376	0.4376
48	0.4274	0.4274
49	0.4094	0.4094
50	0.3913	0.3913
51	0.3895	0.3895
52	0.3817	0.3817
53	0.3738	0.3738
54	0.3693	0.3693
55	0.2002	0.2002
56	0.1856	0.1856

Duration Flows

The Facility PASSED

Flow(cfs)	**Predev**	**Mit**	**Percentage**	**Pass/Fail**
0.2797	2207	2207	100	Pass
0.2872	1993	1993	100	Pass
0.2946	1833	1833	100	Pass
0.3021	1647	1647	100	Pass
0.3095	1527	1527	100	Pass
0.3170	1399	1399	100	Pass
0.3244	1298	1298	100	Pass
0.3319	1193	1193	100	Pass
0.3393	1093	1093	100	Pass
0.3468	1013	1013	100	Pass
0.3542	929	929	100	Pass
0.3617	839	839	100	Pass
0.3691	767	767	100	Pass
0.3766	702	702	100	Pass
0.3840	639	639	100	Pass
0.3915	594	594	100	Pass
0.3989	565	565	100	Pass
0.4064	523	523	100	Pass
0.4138	483	483	100	Pass
0.4213	454	454	100	Pass
0.4287	424	424	100	Pass
0.4362	383	383	100	Pass
0.4436	361	361	100	Pass
0.4511	335	335	100	Pass
0.4586	325	325	100	Pass
0.4660	301	301	100	Pass
0.4735	280	280	100	Pass
0.4809	262	262	100	Pass
0.4884	229	229	100	Pass
0.4958	214	214	100	Pass
0.5033	193	193	100	Pass
0.5107	171	171	100	Pass
0.5182	155	155	100	Pass
0.5256	143	143	100	Pass
0.5331	130	130	100	Pass
0.5405	119	119	100	Pass
0.5480	109	109	100	Pass
0.5554	100	100	100	Pass
0.5629	90	90	100	Pass
0.5703	84	84	100	Pass
0.5778	79	79	100	Pass
0.5852	73	73	100	Pass
0.5927	71	71	100	Pass
0.6001	69	69	100	Pass
0.6076	62	62	100	Pass
0.6150	59	59	100	Pass
0.6225	56	56	100	Pass
0.6300	53	53	100	Pass
0.6374	50	50	100	Pass
0.6449	45	45	100	Pass
0.6523	43	43	100	Pass
0.6598	41	41	100	Pass
0.6672	38	38	100	Pass

Not applicable

0.6747	37	37	100	Pass
0.6821	36	36	100	Pass
0.6896	36	36	100	Pass
0.6970	33	33	100	Pass
0.7045	30	30	100	Pass
0.7119	29	29	100	Pass
0.7194	25	25	100	Pass
0.7268	23	23	100	Pass
0.7343	21	21	100	Pass
0.7417	20	20	100	Pass
0.7492	17	17	100	Pass
0.7566	15	15	100	Pass
0.7641	15	15	100	Pass
0.7715	14	14	100	Pass
0.7790	13	13	100	Pass
0.7864	12	12	100	Pass
0.7939	11	11	100	Pass
0.8013	10	10	100	Pass
0.8088	10	10	100	Pass
0.8163	10	10	100	Pass
0.8237	10	10	100	Pass
0.8312	10	10	100	Pass
0.8386	9	9	100	Pass
0.8461	9	9	100	Pass
0.8535	9	9	100	Pass
0.8610	9	9	100	Pass
0.8684	9	9	100	Pass
0.8759	8	8	100	Pass
0.8833	6	6	100	Pass
0.8908	6	6	100	Pass
0.8982	5	5	100	Pass
0.9057	5	5	100	Pass
0.9131	5	5	100	Pass
0.9206	4	4	100	Pass
0.9280	4	4	100	Pass
0.9355	4	4	100	Pass
0.9429	4	4	100	Pass
0.9504	4	4	100	Pass
0.9578	4	4	100	Pass
0.9653	4	4	100	Pass
0.9727	4	4	100	Pass
0.9802	4	4	100	Pass
0.9876	4	4	100	Pass
0.9951	4	4	100	Pass
1.0026	4	4	100	Pass
1.0100	4	4	100	Pass
1.0175	3	3	100	Pass

Not applicable

Water Quality

Water Quality BMP Flow and Volume for POC #2
On-line facility volume: 0.2065 acre-feet
On-line facility target flow: 0.2485 cfs.
Adjusted for 15 min: 0.2485 cfs.
Off-line facility target flow: 0.1398 cfs.
Adjusted for 15 min: 0.1398 cfs.

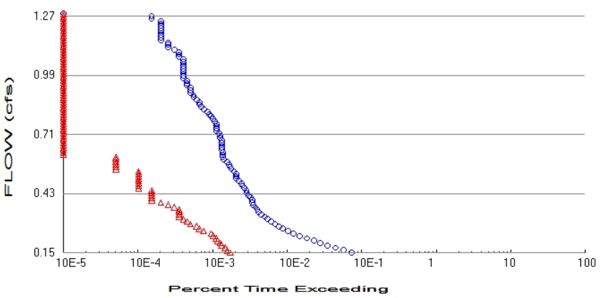
Water Quality flow rate

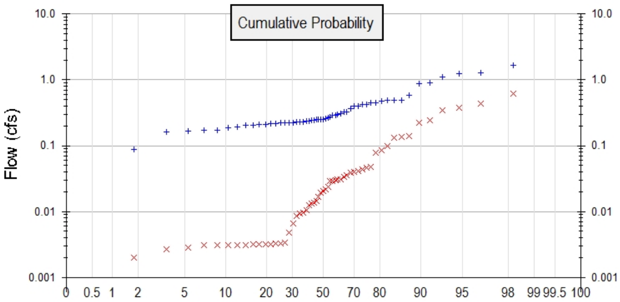
LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Not applicable

POC 3





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3
Total Pervious Area: 8.851
Total Impervious Area: 0.549

Mitigated Landuse Totals for POC #3
Total Pervious Area: 4.178
Total Impervious Area: 0

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	0.290076
5 year	0.498256
10 year	0.685026
25 year	0.989124
50 year	1.273824
100 year	1.61644

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**
2 year	0.017942
5 year	0.071704
10 year	0.152543
25 year	0.349315
50 year	0.604398
100 year	0.998413

Less than 0.15-cfs from pre- to post-developed condition (no additional flow control facilities needed

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1956	0.213	0.022
1957	0.423	0.040
1958	0.423	0.087
1959	0.233	0.019
1960	0.486	0.046
1961	0.260	0.036
1962	0.193	0.003
1963	0.906	0.225
1964	0.245	0.031
1965	0.452	0.100
1966	0.173	0.005

1967	0.877	0.245
1968	0.494	0.141
1969	0.168	0.003
1970	0.190	0.014
1971	0.251	0.042
1972	1.284	0.441
1973	0.238	0.011
1974	0.491	0.135
1975	0.213	0.013
1976	0.234	0.029
1977	0.331	0.003
1978	0.269	0.034
1979	0.293	0.003
1980	0.215	0.010
1981	0.366	0.029
1982	0.310	0.021
1983	0.451	0.030
1984	0.481	0.080
1985	0.290	0.003
1986	0.326	0.048
1987	0.295	0.044
1988	0.172	0.003
1989	0.163	0.003
1990	0.406	0.039
1991	1.117	0.351
1992	0.252	0.007
1993	0.205	0.030
1994	0.218	0.003
1995	0.225	0.009
1996	1.684	0.612
1997	0.082	0.001
1998	0.088	0.002
1999	0.247	0.015
2000	0.278	0.003
2001	0.221	0.003
2002	0.251	0.017
2003	0.224	0.009
2004	1.252	0.382
2005	0.206	0.003
2006	0.231	0.013
2007	0.580	0.133
2008	0.248	0.003
2009	0.401	0.003
2010	0.225	0.003
2011	0.229	0.024

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	Predeveloped	Mitigated
1	1.6841	0.6116
2	1.2842	0.4410
3	1.2523	0.3820
4	1.1169	0.3508
5	0.9057	0.2446
6	0.8772	0.2251
7	0.5802	0.1414
8	0.4941	0.1350
9	0.4906	0.1334

10	0.4863	0.1005
11	0.4815	0.0867
12	0.4521	0.0796
13	0.4511	0.0481
14	0.4231	0.0461
15	0.4230	0.0442
16	0.4057	0.0415
17	0.4015	0.0398
18	0.3665	0.0389
19	0.3314	0.0357
20	0.3259	0.0341
21	0.3097	0.0312
22	0.2951	0.0304
23	0.2933	0.0300
24	0.2903	0.0292
25	0.2780	0.0290
26	0.2687	0.0239
27	0.2598	0.0219
28	0.2524	0.0206
29	0.2515	0.0192
30	0.2505	0.0169
31	0.2478	0.0146
32	0.2472	0.0138
33	0.2454	0.0132
34	0.2381	0.0125
35	0.2344	0.0106
36	0.2334	0.0097
37	0.2313	0.0095
38	0.2294	0.0085
39	0.2248	0.0066
40	0.2248	0.0048
41	0.2245	0.0034
42	0.2209	0.0033
43	0.2175	0.0032
44	0.2153	0.0032
45	0.2132	0.0032
46	0.2130	0.0032
47	0.2063	0.0031
48	0.2049	0.0031
49	0.1933	0.0031
50	0.1901	0.0031
51	0.1725	0.0031
52	0.1718	0.0031
53	0.1684	0.0029
54	0.1628	0.0026
55	0.0883	0.0020
56	0.0823	0.0011

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1450	1431	34	2	Pass
0.1564	1125	31	2	Pass
0.1678	882	29	3	Pass
0.1792	691	26	3	Pass
0.1906	553	25	4	Pass
0.2020	449	23	5	Pass
0.2134	359	22	6	Pass
0.2249	292	20	6	Pass
0.2363	237	19	8	Pass
0.2477	204	15	7	Pass
0.2591	173	13	7	Pass
0.2705	152	12	7	Pass
0.2819	136	10	7	Pass
0.2933	121	9	7	Pass
0.3047	107	8	7	Pass
0.3161	99	7	7	Pass
0.3275	89	7	7	Pass
0.3389	82	7	8	Pass
0.3503	78	7	8	Pass
0.3617	74	6	8	Pass
0.3731	69	5	7	Pass
0.3845	67	4	5	Pass
0.3959	67	3	4	Pass
0.4073	63	3	4	Pass
0.4187	60	3	5	Pass
0.4301	56	3	5	Pass
0.4415	56	3	5	Pass
0.4529	52	2	3	Pass
0.4643	50	2	4	Pass
0.4757	48	2	4	Pass
0.4871	44	2	4	Pass
0.4985	41	2	4	Pass
0.5099	41	2	4	Pass
0.5213	41	2	4	Pass
0.5327	38	2	5	Pass
0.5441	35	1	2	Pass
0.5555	34	1	2	Pass
0.5669	33	1	3	Pass
0.5783	31	1	3	Pass
0.5897	28	1	3	Pass
0.6011	27	1	3	Pass
0.6125	27	0	0	Pass
0.6239	27	0	0	Pass
0.6353	26	0	0	Pass
0.6467	26	0	0	Pass
0.6581	26	0	0	Pass
0.6695	26	0	0	Pass
0.6809	26	0	0	Pass
0.6923	25	0	0	Pass
0.7037	25	0	0	Pass
0.7151	24	0	0	Pass
0.7265	22	0	0	Pass
0.7379	22	0	0	Pass

0.7493	22	0	0	Pass
0.7607	22	0	0	Pass
0.7721	21	0	0	Pass
0.7835	20	0	0	Pass
0.7949	19	0	0	Pass
0.8063	18	0	0	Pass
0.8177	17	0	0	Pass
0.8292	15	0	0	Pass
0.8406	14	0	0	Pass
0.8520	13	0	0	Pass
0.8634	13	0	0	Pass
0.8748	12	0	0	Pass
0.8862	11	0	0	Pass
0.8976	11	0	0	Pass
0.9090	10	0	0	Pass
0.9204	10	0	0	Pass
0.9318	10	0	0	Pass
0.9432	9	0	0	Pass
0.9546	9	0	0	Pass
0.9660	9	0	0	Pass
0.9774	8	0	0	Pass
0.9888	8	0	0	Pass
1.0002	8	0	0	Pass
1.0116	8	0	0	Pass
1.0230	8	0	0	Pass
1.0344	8	0	0	Pass
1.0458	8	0	0	Pass
1.0572	8	0	0	Pass
1.0686	8	0	0	Pass
1.0800	7	0	0	Pass
1.0914	7	0	0	Pass
1.1028	7	0	0	Pass
1.1142	6	0	0	Pass
1.1256	5	0	0	Pass
1.1370	5	0	0	Pass
1.1484	5	0	0	Pass
1.1598	4	0	0	Pass
1.1712	4	0	0	Pass
1.1826	4	0	0	Pass
1.1940	4	0	0	Pass
1.2054	4	0	0	Pass
1.2168	4	0	0	Pass
1.2282	4	0	0	Pass
1.2396	4	0	0	Pass
1.2510	4	0	0	Pass
1.2624	3	0	0	Pass
1.2738	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #3

On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

Not applicable

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Total Volume Infiltrated		0.00	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Not applicable

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

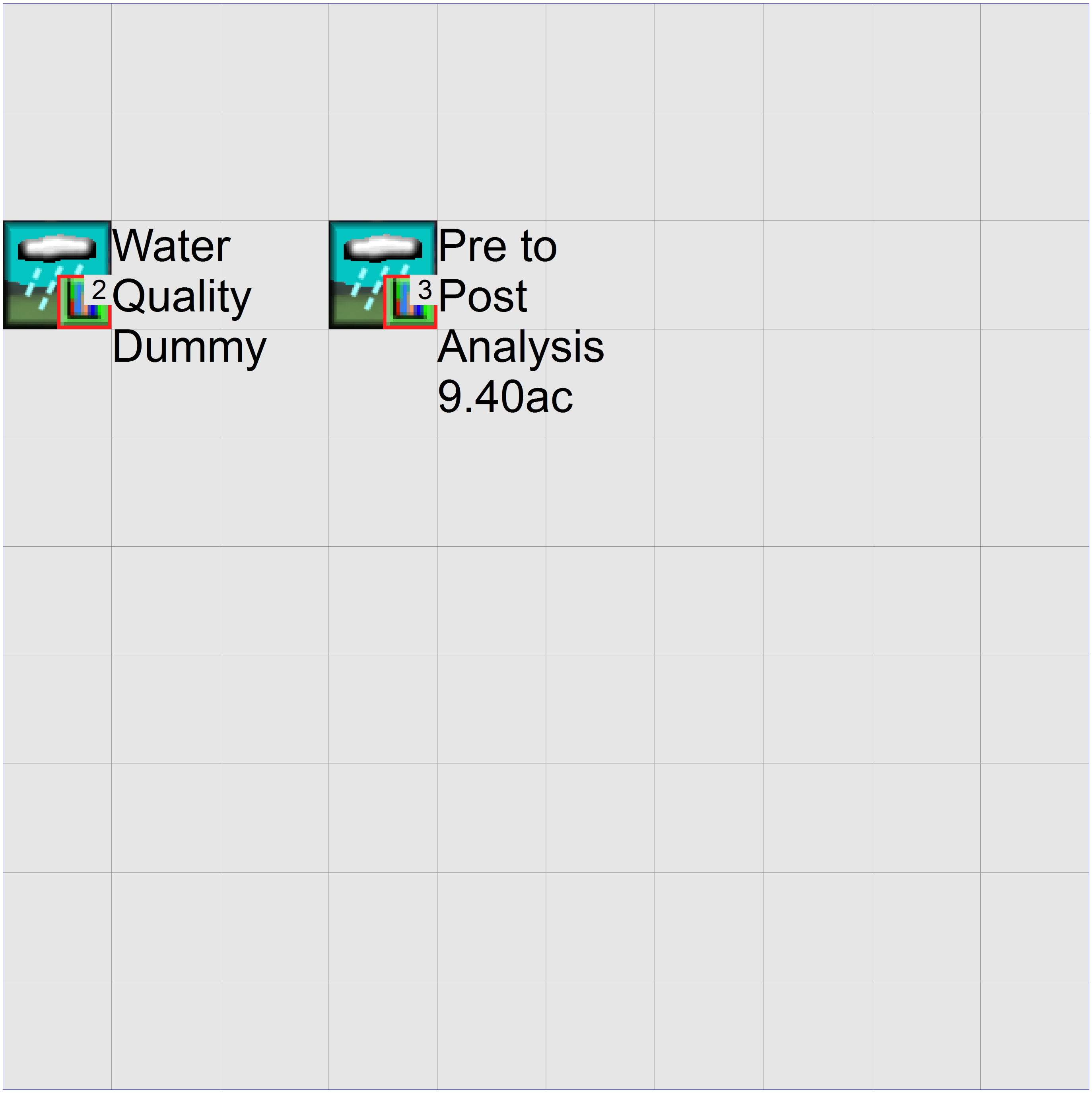
No PERLND changes have been made.

IMPLND Changes

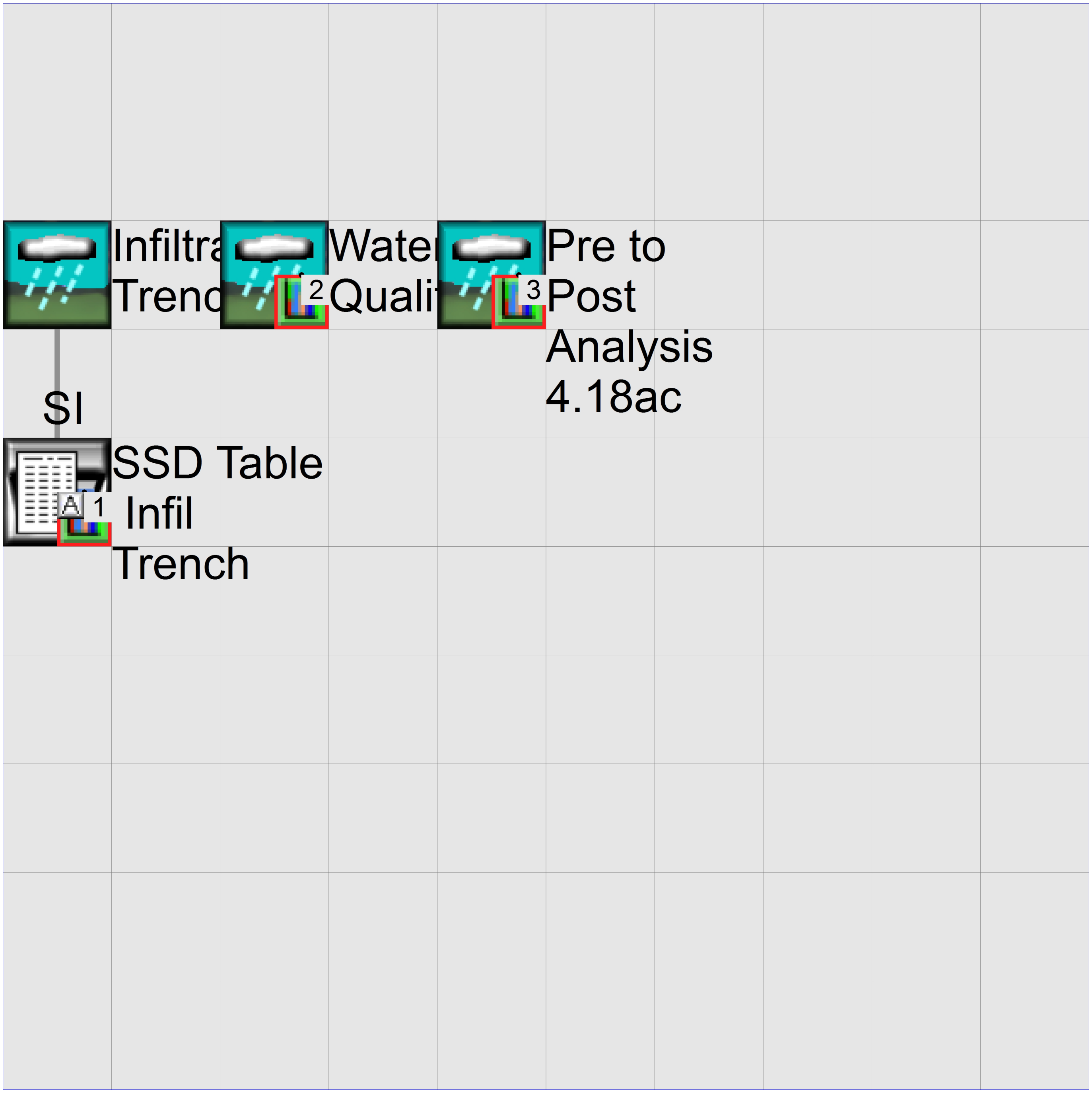
No IMPLND changes have been made.

Appendix

Predeveloped Schematic



Mitigated Schematic



Appendix 3A
Soils Report (Parnell Engineering)

Wellington Heights

Soils Report For Stormwater Drainage Design Purposes

Site Address: Immediately south of Fern St SW, Division St SW and Division St. SW, Olympia, WA 98502
TPN: 59000400100, 59000400600, 59000400800, 59000500100, 59000300100, 59000600100, 59000200100, 59000200400, 59000200600, 59000200900, 59000700100, 59000700300

Prepared For: ABS Investment LLC
PO Box 6130
Olympia, WA 98507
Contact: Alex Vo
(360) 481-3086

Prepared By: Parnell Engineering, LLC
10623 Hunters Lane S.E.
Olympia, WA 98513
(360) 491-3243
Contact: William Parnell, P.E.

PE
PARNELL ENGINEERING, LLC

SOIL EVALUATION REPORT
FORM 1: GENERAL SITE INFORMATION

PROJECT TITLE: Wellington Heights
SHEET: 1 OF 2
PE PROJECT NO.:17128
DATE: 1/5/18
PREPARED BY: William Parnell, P.E.

1. SITE ADDRESS: Immediately south of Fern St SW, Division St SW and Division St. SW, Olympia, WA 98502
TPN: 59000400100, 59000400600, 59000400800, 59000500100, 59000300100, 59000600100, 59000200100, 59000200400, 59000200600, 59000200900, 59000700100, 59000700300

2. PROJECT DESCRIPTION: Residential Plat

3. SITE DESCRIPTION: The rectangular shaped 9.4 ± acre project site is currently unoccupied. Topography is slightly rolling with a general overall slope of 1% - 3% from north to south. Elevations range from 200 ft. at the northwest corner to 192 ft. at the southeast corner of the site. Vegetation consists of sparsely located conifer and deciduous trees with blackberry, scotch bloom and field grass ground cover. A small conifer tree grove of moderate density is present on the southeast corner of the site. Site distinguishing features include a 40' wide stormwater easement located on the western third of the site that traverses the entire site from north to south. Within the confines of the easement is a broad stormwater overflow swale that services a stormwater pond located adjacent to and immediately north of the project site. Existing access to the site is off Fern St. SW, Division St. SW and Cushing St. SW. The parcel is bounded by developed residential property to the north and east and developed commercial property to the west and south. Onsite soils are generally an Alderwood series formed in glacial outwash over dense glaciomarine deposits with isolated pockets of Everett type series soils formed in glacial outwash also over dense glaciomarine deposits.

4. SUMMARY OF SOILS WORK PERFORMED: Twelve test pits were excavated by backhoe to a maximum depth of 156" below the existing grade. Soils were inspected by entering and visually logging each test pit to a depth of four feet. Soils beyond four feet were inspected by examining backhoe tailings. Soil samples were taken from test pits #8, #9, #11 and #12 at 12" below the existing grade and test pit #10 at 15". An ASTM grain size distribution test was completed on each sample. Test pit soil log data sheets and grain size gradation test results with **Ksat** calculations are included in this report.

5. ADDITIONAL SOILS WORK RECOMMENDED: Additional soils work should not be necessary unless drainage infiltration facilities are located outside the general area encompassed by the soil test pits.

6. FINDINGS: The Natural Resource Conservation Service soil survey for Thurston County mapped the on-site soils as an Alderwood gravelly sandy loam (1). Most test pits generally confirmed the Alderwood series designation profiling sandy loam stratum soils underlain by indurated and cemented very gravelly loamy fine sand (Till) substratum soils. Winter water table was present in the form of sidewall seepage in numerous test pits.

ASTM grain size distribution tests completed on samples taken from test pits revealed sandy loam type soils. By method 2 – soil grain size analysis method, the initial saturated hydraulic conductivity (**Ksat**) was determined. The calculated **Ksat** value was then adjusted by safety factors for field measurements resulting in a maximum design infiltration rate **Idesign**. **Idesign** values for the tested soil samples are as follows: test pit #8 at 12" - **Idesign** ≤ 4.55 in/hr, test pit #9 at 12" - **Idesign** ≤ 5.24 in/hr, test pit #10 at 15" - **Idesign** ≤ 2.43 in/hr, test pit #11 at 12" - **Idesign** ≤ 3.44 in/hr, test pit #12 at 12" - **Idesign** ≤ 4.92 in/hr, All **Idesign** calculations assumed a 1' separation to winter water table, an infiltration facility width of 3', a reduction for testing by a 0.4 multiplier and a reduction for soil plugging by a 0.7 multiplier. Please refer to the attached soil gradation test results with **Ksat**, **Idesign** calculations.

7. RECOMMENDATIONS: The Alderwood soil series is a moderately well drained soil that formed on till plains in sandy glacial drift. Infiltration rates are generally moderately rapid in the

soils above the till horizon. The Everett soil series is a very well drained soil that formed on outwash plains in glacial outwash. Infiltration rates are generally rapid. Test pits with Everett series characteristics were also underlain by a till horizon.

It is recommended that the I_{design} values calculated for the five test pit soil samples be averaged resulting in an $I_{design(ave)} \leq 4.12$ in/hr. This value is to be used in the design for the 3' wide roadside infiltration swale with a minimum of 1' of separation to a restrictive/impervious horizon as indicated in the soil log data sheets. This value should be suitable for all roadside swales on the project site.

During construction, care must be taken to prevent the erosion of exposed soils. Stormwater drainage facility infiltration surfaces must be properly protected from contamination by the fine-grained upper horizon soils and from compaction by construction site activities. Soils not properly protected will cause drainage infiltration facilities to prematurely fail.

I hereby certify that I prepared this report, and conducted or supervised the performance of related work. I certify that I am qualified to do this work. I represent my work to be complete an accurate within the bounds of uncertainty inherent to the practice of soils science, and to be suitable for its intended use.

SIGNED: William Parnell

DATE: 1/5/18

WILLIAM W. PARNELL
[illegible]

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights
PROJECT NO.: 17128
PREPARED BY: William Parnell, PE

SHEET: 1 OF 12
DATE: 12/18/2017

SOIL LOG: #1
LOCATION: 420 ft. west and 60 ft. south of the northwest property corner.

1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: 75”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 45”	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: Heavy mottles were present at 45”-55”. Slight seepage was present at 75”+.

Soils Strata Description
Soil Log #1

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 9”	10YR2/2	GrSaLm	<12	<12	<25	1SBK	-	-	-	fm	2-6	4
Bw1	9”- 30”	10YR3/3	GrSaLm	<10	<6	<25	1SBK	-	-	-	fm	2-6	4.12
Bw2	30”- 45”	10YR4/4	GrLm	<18	-	<20	1SBK	-	-	-	ff	2-6	3
2Cqm1	45”- 65”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<40	Mas	M3P	Str	Mod	-	-	-
2C2	65”- 75”	2.5Y5/1	ExGrSa	<2	-	<85	Mas	-	Wk	-	-	>10	-
2Cqm3	75”-138”	2.5Y5/1	GrLmFiSa (Till)	<8	-	<35	Mas	-	Str	Str	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE	SHEET: 2 OF 12 DATE: 12/18/2017

SOIL LOG: #2
LOCATION: 350 ft. west and 60 ft. south of the northwest property corner.

1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: 96”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 60”	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: Weak mottles at 48” transitioning to heavy mottles at 60”- 62”. Slight seepage was present at 96”+.

Soils Strata Description
Soil Log #2

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 8”	10YR2/2	GrSaLm	<12	<12	<25	1SBK	-	-	-	fm	2-6	4
Bw1	8”- 21”	10YR3/3	GrSaLm	<10	<6	<25	1SBK	-	-	-	fm	2-6	4.12
Bw2	21”- 36”	10YR4/4	LmMSa	<8	-	<20	SG	-	-	-	fm	6-20	10
2Cqm1	60”-150”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<45	Mas	M3P	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE		SHEET: 3 OF 12 DATE: 12/18/2017		
SOIL LOG: #3 LOCATION: 40 ft. east and 200 ft. south of the northeast property corner.				
1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains		
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown		
7. CURRENT WATER DEPTH: 24”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 24”	9. MISCELLANEOUS: Slightly sloping		
10. POTENTIAL FOR:		EROSION	RUNOFF	PONDING
		Minimal	Slow	Minimal
11. SOIL STRATA DESCRIPTION: See Following chart				
12. SITE PERCOLATION RATE: See FSP				
13. FINDINGS & RECOMMENDATIONS: Heavy mottles were present at 24”- 34”. Moderate seepage was present at 24”+ transitioning to heavy seepage at 108”.				

Soils Strata Description
Soil Log #3

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 6”	10YR2/2	GrSaLm	<14	<12	<20	1SBK	-	-	-	fm	2-6	4
Bw	6”- 24”	10YR3/3	GrSaLm	<10	<6	<20	1SBK	-	-	-	fm	2-6	4.12
2Cqm1	24”- 41”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<40	Mas	M3P	Mod	Wk	-	-	-
2Cqm2	41”-132”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	F1F	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights
PROJECT NO.: 17128
PREPARED BY: William Parnell, PE

SHEET: 4 OF 12
DATE: 12/18/2017

SOIL LOG: #4
LOCATION: 90 ft. east and 200 ft. south of the northeast property corner.

1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: 60”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 24”	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: The 2Cqm1 horizon was broken and fractured. Heavy mottles were present at 24”- 34”. Moderate to heavy seepage was present at 60”+.

Soils Strata Description
Soil Log #4

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 6”	10YR2/2	GrSaLm	<14	<12	<20	1SBK	-	-	-	fm	2-6	4
Bw	6”- 24”	10YR4/4	VGrSaLm	<10	<6	<40	1SBK	-	-	-	fm	2-6	4.12
2Cqm1	24”- 30”	2.5Y5/2	VGrLmFiSa (Weathered Till)	<8	-	<40	Pl	M3P	Str	Mod	-	-	-
2Cqm2	30”-132”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<40	Mas	F1F	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE		SHEET: 5 OF 12 DATE: 12/18/2017		
SOIL LOG: #5 LOCATION: 60 ft. west and 20 ft. north of the southeast property corner.				
1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains		
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown		
7. CURRENT WATER DEPTH: 26”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 26”	9. MISCELLANEOUS: Slightly sloping		
10. POTENTIAL FOR:		EROSION	RUNOFF	PONDING
		Minimal	Slow	Minimal
11. SOIL STRATA DESCRIPTION: See Following chart				
12. SITE PERCOLATION RATE: See FSP				
13. FINDINGS & RECOMMENDATIONS: The 2Cqm1 horizon was broken and fractured. Heavy mottles were present at 26”- 34”. Moderate seepage was present at 26”+.				

Soils Strata Description
Soil Log #5

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 6”	10YR2/2	GrSaLm	<14	<12	<20	1SBK	-	-	-	fm	2-6	4
Bw	6”- 26”	10YR4/4	VGrSaLm	<10	<6	<40	1SBK	-	-	-	fm	2-6	4.12
2Cqm1	26”- 34”	2.5Y5/2	VGrLmFiSa (Weathered Till)	<8	-	<40	Pl	M3P	Str	Str	-	-	-
2Cqm2	34”- 86”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<40	Mas	F1F	Str	Str	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights
PROJECT NO.: 17128
PREPARED BY: William Parnell, PE

SHEET: 6 OF 12
DATE: 12/18/2017

SOIL LOG: #6
LOCATION: 240 ft. east and 40 ft. north of the southwest property corner.

1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Everett very gravelly sandy loam(32)	3. LAND FORM: Outwash Plains
4. DEPOSITION HISTORY: Glacial outwash over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: A	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: Greater than bottom of hole	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 72"	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: The C2 horizon was heavily stained. The C3 horizon was heavily mottled.

Soils Strata Description
Soil Log #6

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0"- 8"	10YR2/2	VGrSaLm	<12	<10	<45	1SBK	-	-	-	fm	2-6	6
Bw	8"- 24"	10YR4/4	VGrCSa	<2	-	<40	SG	-	-	-	fm	>20	>20
C1	24"- 40"	10YR5/1	VGrCSa	<2	-	<50	SG	-	-	-	ff	>20	>20
C2	40"- 53"	10YR5/6	ExGrCSa	<2	-	<90	SG	-	-	-	ff	>20	10
C3	53"- 72"	10YR5/2	Si	<10	-	<5	Mas	M3P	-	-	fm	.6-2.0	-
Cqm4	72"- 102"	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	F1F	Mod	Wk	-	-	-
Cqm5	102"- 152"	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	-	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE	SHEET: 7 OF 12 DATE: 12/18/2017

SOIL LOG: #7
LOCATION: 240 ft. east and 90 ft. north of the southwest property corner.

1. TYPES OF TEST DONE: None	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: Greater than bottom of hole	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 27”	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: The 2Cqm1 horizon was broken and fractured. Heavy mottles were present at 27”- 36”.

Soils Strata Description
Soil Log #7

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 7”	10YR2/2	GrSaLm	<14	<12	<20	1SBK	-	-	-	fm	2-6	4
Bw1	7”- 18”	10YR4/4	VGrSaLm	<10	<6	<40	1SBK	-	-	-	fm	2-6	4.12
Bw2	18”- 27”	10YR4/4	VGrLmSa	<8	-	<50	SG	-	-	-	fm	6-20	8
2Cqm1	27”- 36”	2.5Y5/6	VGrLmFiSa (Weathered Till)	<8	-	<40	Pl	M3P	Wk	Wk	-	-	-
2Cqm2	36”- 59”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	F1F	Str	Wk	-	-	-
2Cqm3	59”-108”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	-	Str	Str	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE	SHEET: 8 OF 12 DATE: 12/18/2017

SOIL LOG: #8
LOCATION: 180 ft. east and 130 ft. south of the northwest property corner.

1. TYPES OF TEST DONE: ASTM grain size distribution	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: 32”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 24”	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: The 2Cqm1 horizon was broken and fractured. Heavy mottles were present at 29”- 32”. Moderate seepage was present at 32”. An ASTM grain size distribution test was completed on a sample taken at 12” below the existing grade and revealed a sandy loam texture. **Ksat** value was calculated and then adjusted by safety factors for field measurements resulting in a maximum design infiltration rate, $I_{design} \leq 4.55$ in/hr in the Bw horizon soils.

Soils Strata Description
Soil Log #8

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 8”	10YR2/2	GrSaLm	<14	<12	<20	1SBK	-	-	-	fm	2-6	4
Bw	8”- 24”	10YR4/4	VGrSaLm	<10	<6	<45	1SBK	-	-	-	mm	2-6	4.12
2Cqm1	24”- 32”	2.5Y5/2	VGrLmFiSa (Weathered Till)	<8	-	<40	Pl	M3P	Wk	Wk	mm	-	-
2Cqm1	32”-108”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	F1F	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE	SHEET: 9 OF 12 DATE: 12/18/2017

SOIL LOG: #9
LOCATION: 440 ft. east and 120 ft. north of the southwest property corner.

1. TYPES OF TEST DONE: ASTM grain size distribution	2. SCS SOILS SERIES: Everett very gravelly sandy loam(32)	3. LAND FORM: Outwash Plains
4. DEPOSITION HISTORY: Glacial outwash over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: A	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: Greater than bottom of hole	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 54”	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: An ASTM grain size distribution test was completed on a sample taken at 12” below the existing grade and revealed a sandy loam texture. K_{sat} value was calculated and then adjusted by safety factors for field measurements resulting in a maximum design infiltration rate, $I_{design} \leq 5.24$ in/hr in the Bw horizon soils.

Soils Strata Description
Soil Log #9

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 5”	10YR2/2	VGrSaLm	<12	<10	<40	1SBK	-	-	-	ff	2-6	6
Bw	5”- 20”	10YR4/4	ExGrSaLm	<8	<5	<70	SG	-	-	-	ff	2-6	4.12
C1	20”- 54”	10YR5/1	ExGrCSa	<1	-	<90	SG	-	-	-	-	>20	>20
C2	54”- 60”	2.5Y5/2	ExGrLmFiSa (Till)	<8	-	<70	Mas	F1F	Str	Mod	-	-	-
C3	60”- 95”	2.5Y5/2	Si	<10	-	<5	Mas	C2D	-	-	-	.6-2.0	-
Cqm4	95”-156”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<55	Mas	F1F	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE	SHEET: 10 OF 12 DATE: 12/18/2017

SOIL LOG: #10
LOCATION: 590 ft. east and 160 ft. south of the northwest property corner.

1. TYPES OF TEST DONE: ASTM grain size distribution	2. SCS SOILS SERIES: Everett very gravelly sandy loam(32)	3. LAND FORM: Outwash Plains
4. DEPOSITION HISTORY: Glacial outwash over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: A	6. DEPTH OF SEASONAL HW: Unknown
7. CURRENT WATER DEPTH: Greater than bottom of hole	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 62"	9. MISCELLANEOUS: Slightly sloping

10. POTENTIAL FOR:	EROSION	RUNOFF	PONDING
	Minimal	Slow	Minimal

11. SOIL STRATA DESCRIPTION: See Following chart

12. SITE PERCOLATION RATE: See FSP

13. FINDINGS & RECOMMENDATIONS: The Cqm2 horizon was broken and fractured. Moderate mottles were present at 58"- 62". An ASTM grain size distribution test was completed on a sample taken at 15" below the existing grade and revealed a sandy loam texture. Ksat value was calculated and then adjusted by safety factors for field measurements resulting in a maximum design infiltration rate, Idesign ≤ 2.43 in/hr in the Bw horizon soils.

Soils Strata Description
Soil Log #10

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0"- 8"	10YR2/2	VGrSaLm	<12	<10	<30	1SBK	-	-	-	ff	2-6	4
Bw	8"- 30"	10YR4/4	VGrSaLm	<8	<5	<55	SG	-	-	-	ff	2-6	4.12
C1	30"- 62"	10YR5/1	ExGrCSa	<1	-	<95	SG	-	-	-	-	>20	>20
Cqm2	62"- 66"	2.5Y5/2	VGrLmFiSa (Weathered Till)	<8	-	<40	Pl	C2D	Wk	Wk	-	-	-
Cqm3	66"-156"	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<40	Mas	F1F	Str	Mod	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE		SHEET: 11 OF 12 DATE: 12/18/2017		
SOIL LOG: #11 LOCATION: 260 ft. west and 150 ft. north of the southeast property corner.				
1. TYPES OF TEST DONE: ASTM grain size distribution	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains		
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown		
7. CURRENT WATER DEPTH: 66”	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 29”	9. MISCELLANEOUS: Slightly sloping		
10. POTENTIAL FOR:		EROSION	RUNOFF	PONDING
		Minimal	Slow	Minimal
11. SOIL STRATA DESCRIPTION: See Following chart				
12. SITE PERCOLATION RATE: See FSP				
13. FINDINGS & RECOMMENDATIONS: Heavy seepage was present at 66”+. An ASTM grain size distribution test was completed on a sample taken at 12” below the existing grade and revealed a sandy loam texture. Ksat value was calculated and then adjusted by safety factors for field measurements resulting in a maximum design infiltration rate, Idesign ≤ 3.44 in/hr in the Bw horizon soils.				

Soils Strata Description
Soil Log #11

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0”- 6”	10YR2/2	VGrSaLm	<12	<10	<30	1SBK	-	-	-	fm	2-6	4
Bw	6”- 22”	10YR4/4	VGrSaLm	<8	<5	<55	SG	-	-	-	fm	2-6	4.12
C1	22”- 29”	10YR5/2	ExGrLmMSa	<4	-	<75	SG	-	-	-	fm	6-20	6
2Cqm2	29”-146”	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<60	Mas	C2D	Wk	Wk	-	-	-

SOIL EVALUATION REPORT
FORM 2: SOIL LOG INFORMATION

PROJECT TITLE: Wellington Heights PROJECT NO.: 17128 PREPARED BY: William Parnell, PE		SHEET: 12 OF 12 DATE: 12/18/2017		
SOIL LOG: #12 LOCATION: 160 ft. west and 230 ft. north of the southeast property corner.				
1. TYPES OF TEST DONE: ASTM grain size distribution	2. SCS SOILS SERIES: Alderwood gravelly sandy loam(1)	3. LAND FORM: Glacial Till Plains		
4. DEPOSITION HISTORY: Glacial drift over dense glaciomarine deposits	5. HYDROLOGIC SOIL GROUP: B	6. DEPTH OF SEASONAL HW: Unknown		
7. CURRENT WATER DEPTH: 60"	8. DEPTH TO IMPERVIOUS/RESTRICTIVE HORIZON: 27"	9. MISCELLANEOUS: Slightly sloping		
10. POTENTIAL FOR:		EROSION	RUNOFF	PONDING
		Minimal	Slow	Minimal
11. SOIL STRATA DESCRIPTION: See Following chart				
12. SITE PERCOLATION RATE: See FSP				
13. FINDINGS & RECOMMENDATIONS: Moderate seepage was present at 60"+. An ASTM grain size distribution test was completed on a sample taken at 12" below the existing grade and revealed a sandy loam texture. Ksat value was calculated and then adjusted by safety factors for field measurements resulting in a maximum design infiltration rate, Idesign ≤ 4.92 in/hr in the Bw horizon soils.				

Soils Strata Description
Soil Log #12

Horz	Depth	Color	Texture	%CL	%ORG	CF	STR	MOT	IND	CEM	ROO	<X>	FSP
A	0"- 5"	10YR2/2	VGrSaLm	<12	<10	<30	1SBK	-	-	-	fm	2-6	4
Bw	5"- 27"	10YR4/4	VGrSaLm	<8	<5	<55	SG	-	-	-	fm	2-6	4.12
2Cqm1	27"- 35"	2.5Y5/2	VGrLmFiSa (Weathered Till)	<8	-	<40	Pl	C2D	Wk	Wk	fm	-	-
2Cqm2	35"-156"	2.5Y5/2	VGrLmFiSa (Till)	<8	-	<60	Mas	C2D	Mod	Wk	-	-	-

Abbreviations

Textural Class (Texture)	Structure (STR)	Grades of Structure
Cobbled - Cob	Granular - Gr	Strong - 3
Stoney - St	Blocky - Blky	Moderate - 2
Gravelly - Gr	Platy - Pl	Weak - 1
Sandy - Sa	Massive - Mas	
Loamy - Lm	Single Grained - SG	
Silty - Si	Sub-Angular Blocky - SBK	
Clayey - Cl		
Coarse - C		
Very - V		
Extremely - Ex		
Fine - F		
Medium - M		

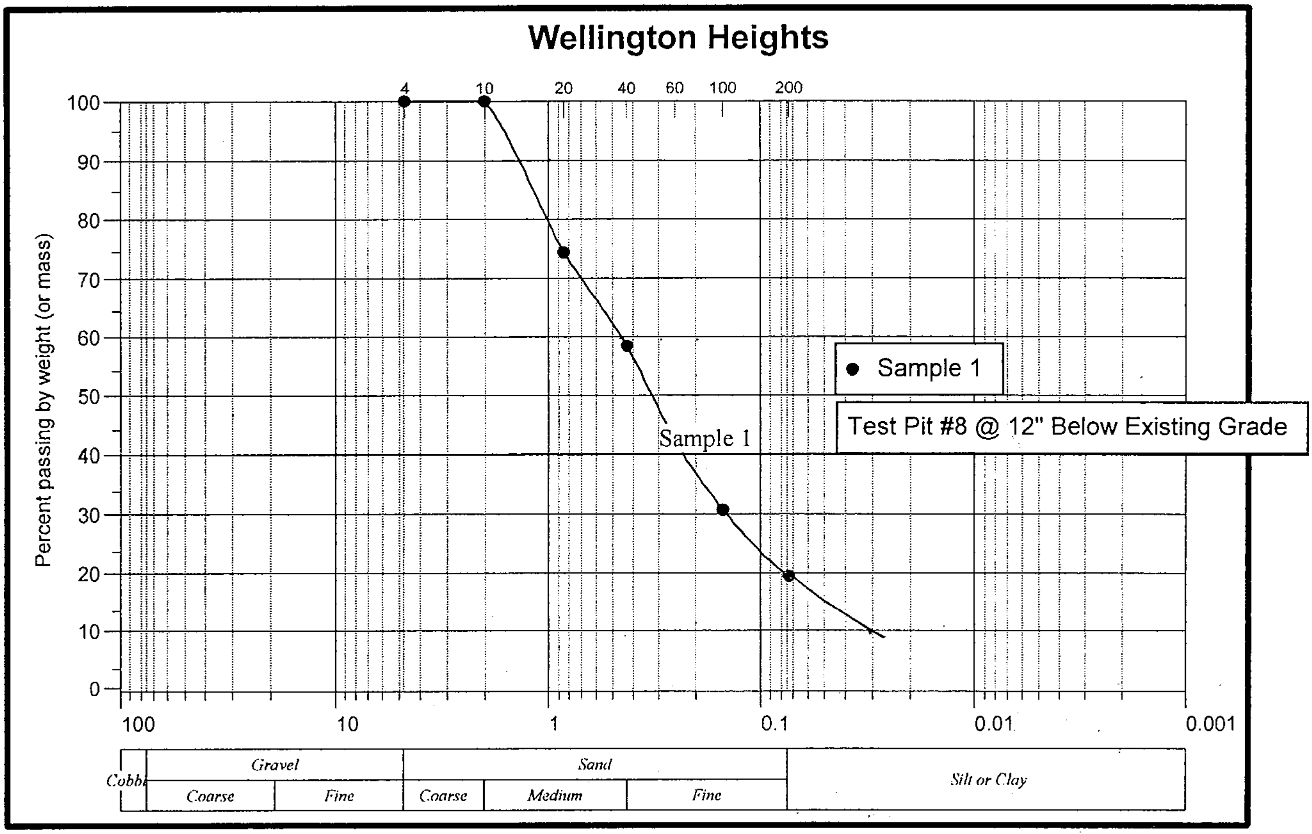
Induration & Cementation (IND) (CEM)
Weak - Wk
Moderate - Mod
Strong - Str

Mottles (MOT)		
1 Letter Abundance	**1st Number Size**	**2nd Letter Contrast**
Few - F	Fine - 1	Faint - F
Common - C	Medium - 2	Distinct - D
Many - M	Coarse - 3	Prominent - P

Roots (ROO)	
1st Letter Abundance	**2nd Letter Size**
Few - f	Fine - f
Common - c	Medium - m
Many - m	Coarse - c

<X> - Generalized range of infiltration rates from SCS soil survey (<X>)

FSP - Estimated **Design F**ield **S**aturated **P**ercolation rate based on horizon specific factors and specific test results.



$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$

$\log_{10}(K_{sat}) = -1.57 + 1.90(0.03) + 0.015(0.46) - 0.013(1.4) - 2.08(0.20)$

$K_{sat} = 0.0115$ cm/s = 16.26 in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial}$ X Safety Factors

$K_{sat\ initial} = 16.26$ in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial} \times F_{testing} \times F_{geometry} \times F_{plugging}$

$K_{sat\ initial} = 16.26$ in/hr $\qquad F_{testing} = 0.40$

$F_{geometry} = 4D/W + 0.05$ Where: D = Depth from the bottom of the proposed facility to the maximum wet season water table or nearest impervious layer, whichever is less. Assume D = 1.0 feet.

$0.25 \leq F_{geometry} \leq 1.0$

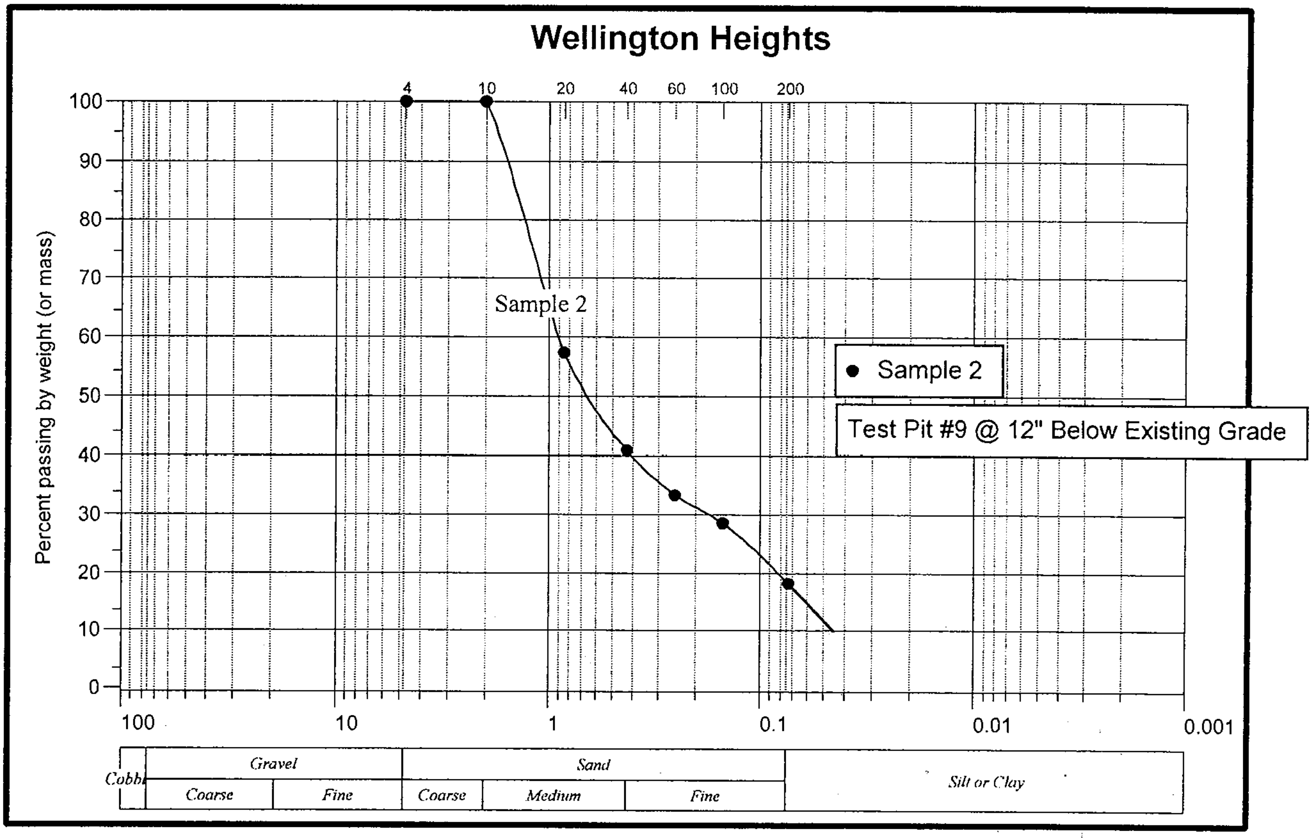
$F_{geometry} = 4(1/3) + 0.05$ W = Width of facility. Assume W = 3.0 feet

$F_{geometry} = 1.38$ Use $F_{geometry} = 1.00$

$F_{plugging} = 0.7$ for loams and sandy loams, 0.8 for loamy sands or fine sands, 0.9 for medium sands, 1.0 for coarse sands or cobbles or any soil type with infiltration facility preceded by a specific water quality facility. Use $F_{plugging} = 0.7$

$I_{design} = 16.26 \times 0.4 \times 1.00 \times 0.7 = 4.55$ in/hr

For stormwater facility design purposes, use an $I_{design} \leq$ **4.55 in/hr.**



$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$

$\log_{10}(K_{sat}) = -1.57 + 1.90(0.05) + 0.015(0.9) - 0.013(1.7) - 2.08(0.19)$

$K_{sat} = 0.013$ cm/s = 18.74 in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial}$ X Safety Factors

$K_{sat\ initial} = 18.74$ in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial} \times F_{testing} \times F_{geometry} \times F_{plugging}$

$K_{sat\ initial} = 18.74$ in/hr $F_{testing} = 0.40$

$F_{geometry} = 4D/W + 0.05$ Where: D = Depth from the bottom of the proposed facility to the

$0.25 \leq F_{geometry} \leq 1.0$ maximum wet season water table or nearest impervious layer, whichever is less. Assume D = 1.0 feet.

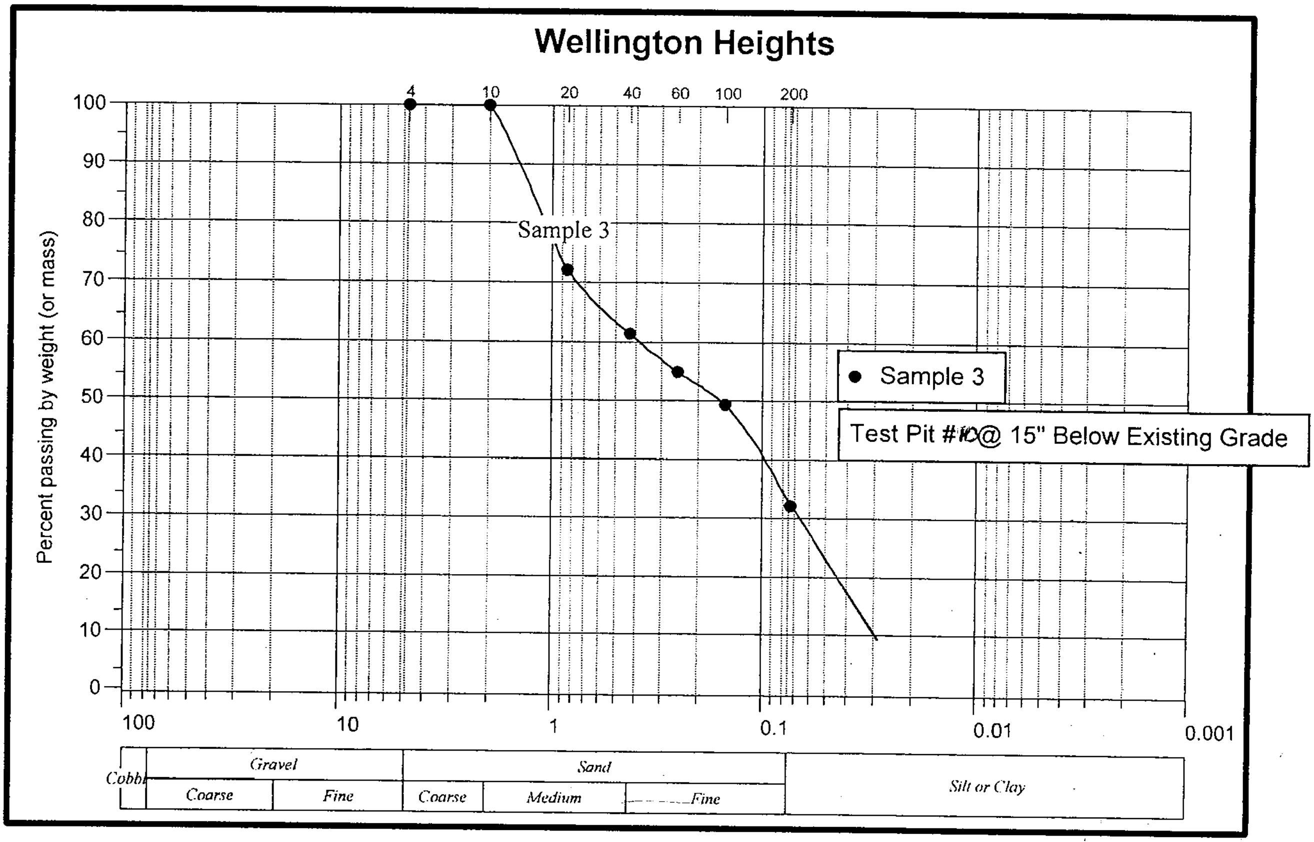
$F_{geometry} = 4(1/3) + 0.05$ W = Width of facility. Assume W = 3.0 feet

$F_{geometry} = 1.38$ Use $F_{geometry} = 1.00$

$F_{plugging} = 0.7$ for loams and sandy loams, 0.8 for loamy sands or fine sands, 0.9 for medium sands, 1.0 for coarse sands or cobbles or any soil type with infiltration facility preceded by a specific water quality facility. Use $F_{plugging} = 0.7$

$I_{design} = 18.74 \times 0.4 \times 1.00 \times 0.7 = 5.24$ in/hr

For stormwater facility design purposes, use an $I_{design} \leq$ **5.24 in/hr.**



$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$

$\log_{10}(K_{sat}) = -1.57 + 1.90(0.03) + 0.015(0.42) - 0.013(1.5) - 2.08(0.33)$

$K_{sat} = 0.03074$ cm/s = 43.57 in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial}$ X Safety Factors

$K_{sat\ initial} = 8.69$ in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial} \times F_{testing} \times F_{geometry} \times F_{plugging}$

$K_{sat\ initial} = 8.69$ in/hr $\quad F_{testing} = 0.40$

$F_{geometry} = 4D/W + 0.05$ Where: D = Depth from the bottom of the proposed facility to the maximum wet season water table or nearest impervious layer, whichever is less. Assume D = 1.0 feet.

$0.25 \leq F_{geometry} \leq 1.0$

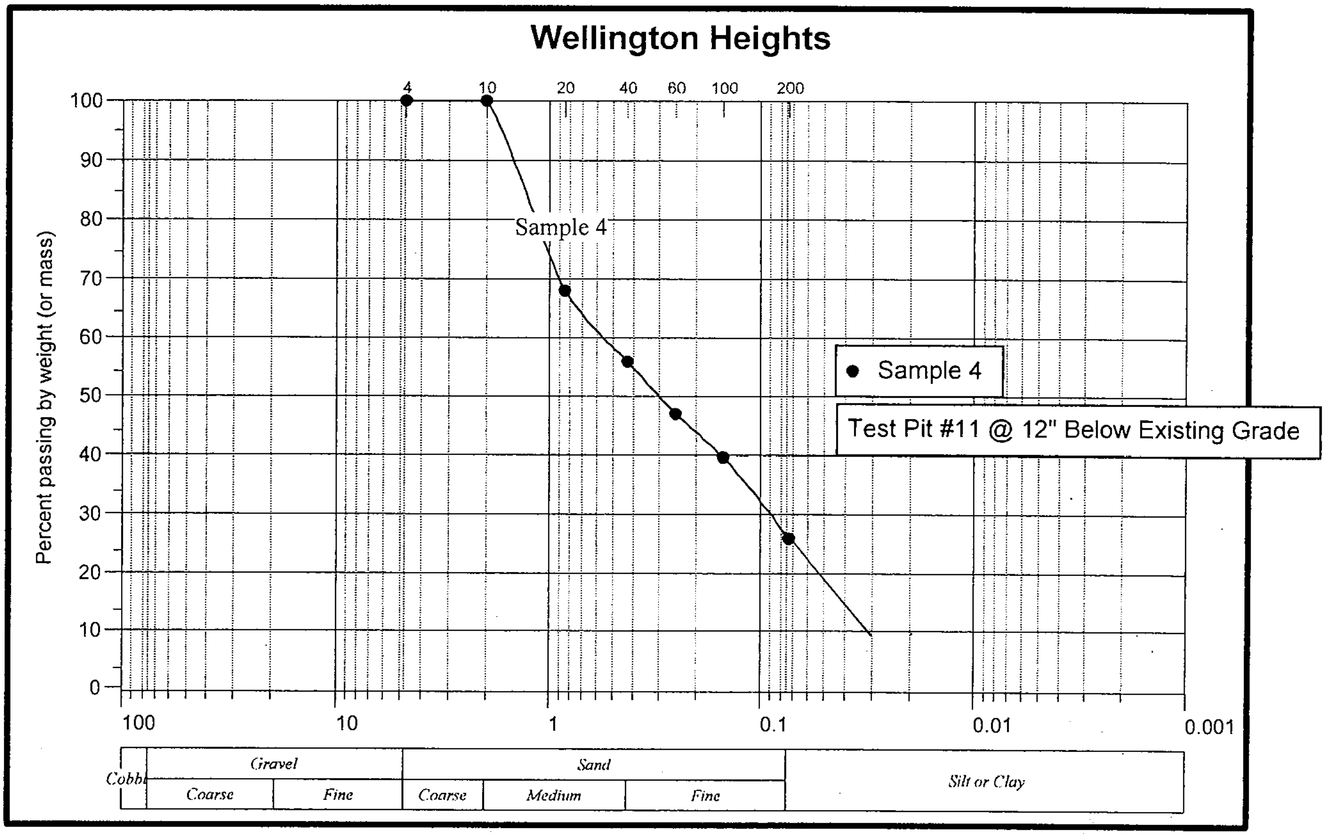
$F_{geometry} = 4(1/3) + 0.05$ W = Width of facility. Assume W = 3.0 feet

$F_{geometry} = 1.38$ Use $F_{geometry} = 1.00$

$F_{plugging} = 0.7$ for loams and sandy loams, 0.8 for loamy sands or fine sands, 0.9 for medium sands, 1.0 for coarse sands or cobbles or any soil type with infiltration facility preceded by a specific water quality facility. Use $F_{plugging} = 0.7$

$I_{design} = 8.69 \times 0.4 \times 1.00 \times 0.7 = 2.43$ in/hr

For stormwater facility design purposes, use an $I_{design} \leq$ **2.43 in/hr.**



$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$

$\log_{10}(K_{sat}) = -1.57 + 1.90(0.032) + 0.015(0.58) - 0.013(1.6) - 2.08(0.26)$

$K_{sat} = 0.0087$ cm/s = 12.28 in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial}$ X Safety Factors

$K_{sat\ initial} = 12.28$ in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial} \times F_{testing} \times F_{geometry} \times F_{plugging}$

$K_{sat\ initial} = 12.28$ in/hr $\quad F_{testing} = 0.40$

$F_{geometry} = 4D/W + 0.05$ Where: D = Depth from the bottom of the proposed facility to the maximum wet season water table or nearest impervious layer, whichever is less. Assume D = 1.0 feet.

$0.25 \leq F_{geometry} \leq 1.0$

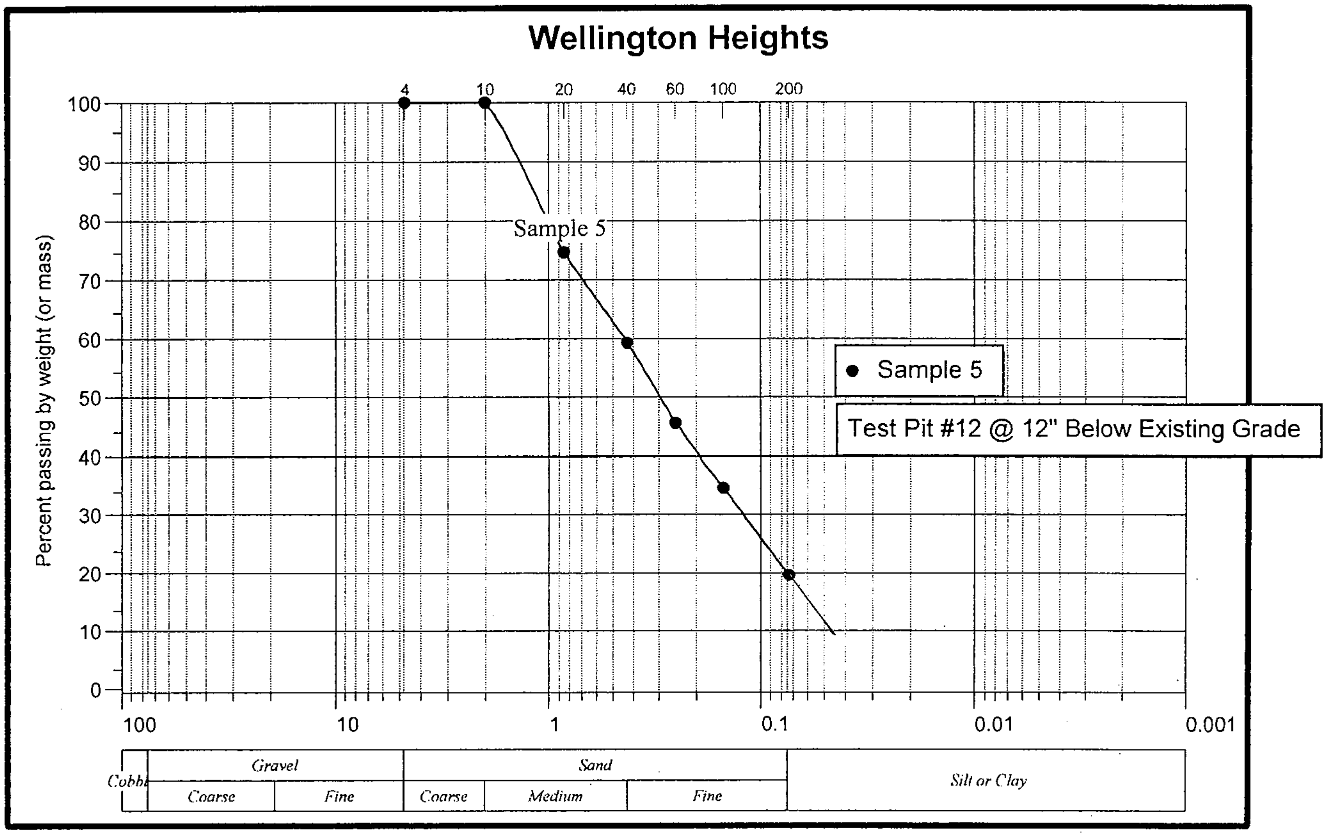
$F_{geometry} = 4(1/3) + 0.05$ W = Width of facility. Assume W = 3.0 feet

$F_{geometry} = 1.38$ Use $F_{geometry} = 1.00$

$F_{plugging} = 0.7$ for loams and sandy loams, 0.8 for loamy sands or fine sands, 0.9 for medium sands, 1.0 for coarse sands or cobbles or any soil type with infiltration facility preceded by a specific water quality facility. Use $F_{plugging} = 0.7$

$I_{design} = 12.28 \times 0.4 \times 1.00 \times 0.7 = 3.44$ in/hr

For stormwater facility design purposes, use an $I_{design} \leq$ **3.44 in/hr.**



$\log_{10}(K_{sat}) = -1.57 + 1.90D_{10} + 0.015D_{60} - 0.013D_{90} - 2.08f_{fines}$

$\log_{10}(K_{sat}) = -1.57 + 1.90(0.048) + 0.015(0.45) - 0.013(1.45) - 2.08(0.2)$

$K_{sat} = 0.0124$cm/s = 17.56 in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial}$ X Safety Factors

$K_{sat\ initial}$ = 17.56 in/hr

Design Infiltration Rate Calculation : I_{design}

$I_{design} = K_{sat\ initial} \times F_{testing} \times F_{geometry} \times F_{plugging}$

$K_{sat\ initial}$ = 17.56 in/hr $\quad F_{testing} = 0.40$

$F_{geometry} = 4D/W + 0.05$ Where: D = Depth from the bottom of the proposed facility to the maximum wet season water table or nearest impervious layer, whichever is less. Assume D = 1.0 feet.

$0.25 \leq F_{geometry} \leq 1.0$

$F_{geometry} = 4(1/3) + 0.05$ W = Width of facility. Assume W = 3.0 feet

$F_{geometry} = 1.38$ Use $F_{geometry} = 1.00$

$F_{plugging}$ = 0.7 for loams and sandy loams, 0.8 for loamy sands or fine sands, 0.9 for medium sands, 1.0 for coarse sands or cobbles or any soil type with infiltration facility preceded by a specific water quality facility. Use $F_{plugging} = 0.7$

I_{design} = 17.56 x 0.4 x 1.00 x 0.7 = 4.92 in/hr

For stormwater facility design purposes, use an $I_{design} \leq$ **4.92 in/hr.**

SOIL LOG TEST PIT LOCATION MAP

SCALE: 1"=80FEET

0 80

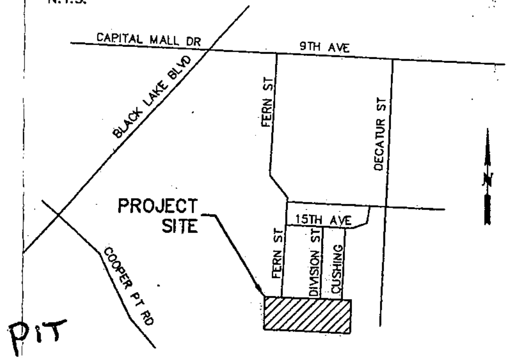
PROJECT INFORMATION

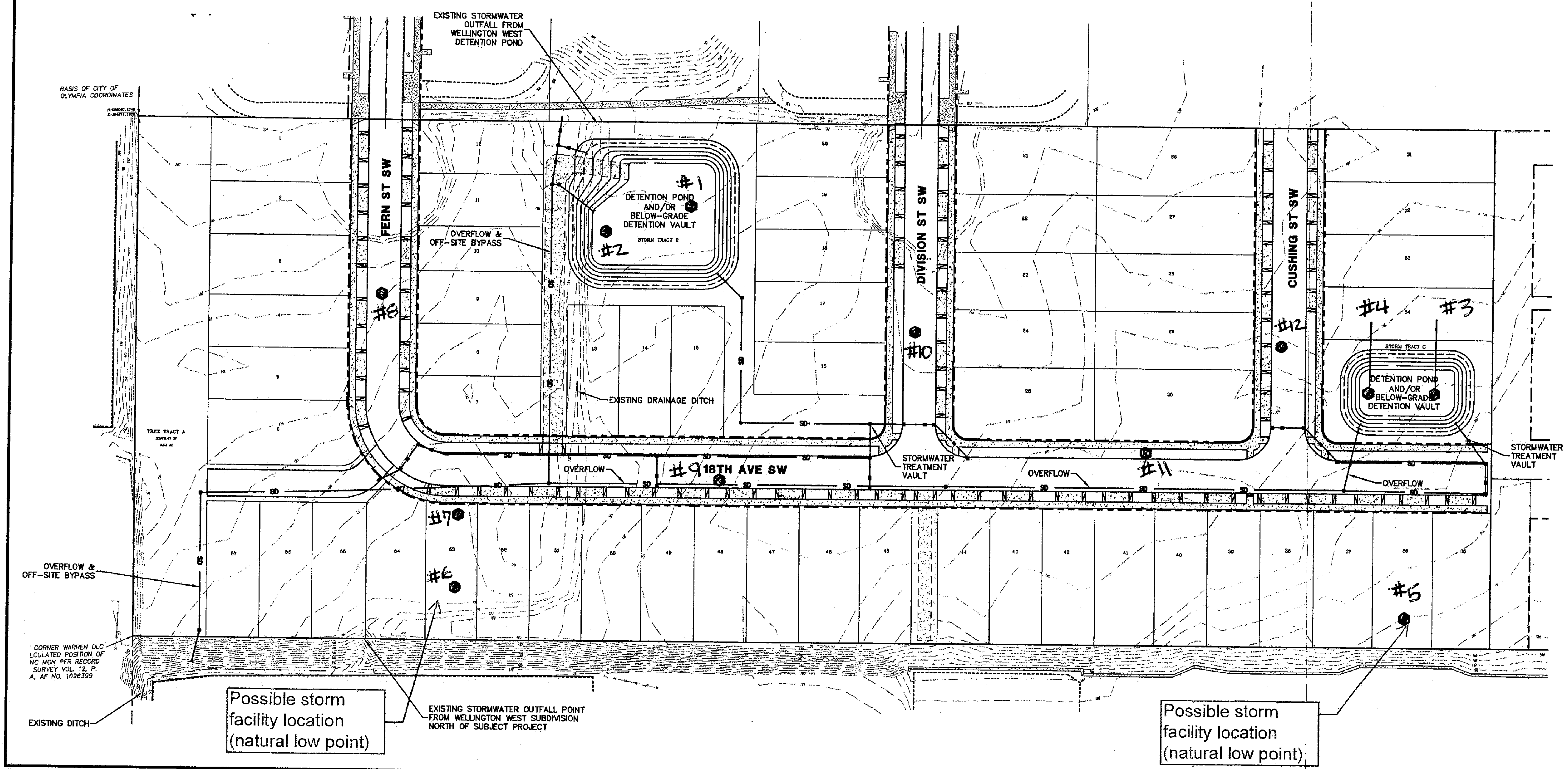
APPLICANT:	ABS INVESTMENT, LLC PO BOX 6130 OLYMPIA, WA 98507
PARCEL NO:	59000400600, 59000400100, 59000400800, 59000500100, 59000300100, 59000600100, 59000200100, 59000200600, 59000200900, 59000700300
SITE ADDRESS:	UNASSIGNED
ZONING:	R6-12
SITE AREA:	±9.40 ACRES
# LOTS:	57 SINGLE-FAMILY

● SOIL LOG TEST PIT

VICINITY MAP

N.T.S.





Possible storm facility location (natural low point)

Possible storm facility location (natural low point)

NO.	DATE	REVISION

WELLINGTON HEIGHTS

CITY OF OLYMPIA WA

DESIGNED BY:
DRAWN BY:
CHECKED BY:
SCALE:
DATE:

Appendix 3B

Soils Report (Materials Testing & Consulting)

Materials Testing & Consulting, Inc.
Geotechnical Engineering ● Materials Testing ● Special Inspection ● Environmental Consulting

March 5, 2018

Alex Vo
P.O. Box 6130
Olympia, WA 98507
(360) 481 - 3086
alexv@triwayenterprises.com

Subject: **Wellington Heights Infiltration – Limited Soils Exploration**
South of Division St SW & 16th Ave SW, Olympia, WA 98502
Geotechnical Engineering & Consulting Services

MTC Project No.: 18S053

Dear Mr. Vo:

At your request, Materials Testing & Consulting, Inc. (MTC) has performed a limited soils exploration of existing site conditions, including targeted explorations in support of a feasibility evaluation for an in-ground stormwater infiltration facility. MTC understands the client has not requested any geotechnical designs, recommendations, or site wide soil evaluation at this time.

MTC has performed this soils exploration in accordance with project discussions with the client and our Proposal for Geotechnical Services dated February 14, 2018. The following report presents the findings of our targeted site investigation, and results of our targeted infiltration rate calculations.

We appreciate the opportunity to provide our consultation services for this project and would be pleased to continue our role as your geotechnical engineering consultant during any future project planning and construction. We also have a keen interest in providing materials testing and special inspection during construction of this project if required. We will be pleased to meet with you at your convenience to discuss these, or future services.

Review of Geological Literature:

The *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington* (Walsh et al, 2003) published by the Washington Division of Geology and Earth Resources indicates the entirety of the project site is located within Vashon recessional outwash (Qgo), commonly described as stratified, poorly sorted, and comprised of sand and gravel, locally containing silt and clay. Vashon till (Qgt) is also mapped within 0.5 miles of the project area. Vashon till (Qgt) is commonly described as an unsorted and highly compacted mixture of clays, silts, sands, and gravels that are variably cemented. Maps of greater scale indicate the possible presence of till in local variation, and other areas where advanced and recessional outwash deposits are undifferentiated, if no intervening till horizon is present to identify the contact.

Shallow soils are mapped by the NRCS Web Soil Survey as *Alderwood gravelly sandy loam* (1), with 0 to 8 percent slopes. Alderwood gravelly sandy loam is described to have formed in hills and ridges as a derivative of recessional glacial outwash. The soil is described to be moderately well drained and typically consists of very gravelly sandy loam to depths beyond 59 inches. Depth to the restrictive feature or water table is described as 18 to 39 inches and can be noted by the presence of densic material.

Reconnaissance and General Site Conditions:

An MTC Staff Geologist visited the site on February 27, 2018 to complete the proposed explorations and observe the advancement of two (2) geotechnical test pits to evaluate existing site soil conditions for infiltration feasibility. Exploration locations were chosen by the client in consideration of underground utilities, area of development, and equipment accessibility. Exploration locations are shown in Figure 2 of Appendix B. Test pits were excavated to maximum practical depth limit of the machinery made available by the client.

Test pit TP-1 was advanced approximately 100 feet north and 80 feet west of the southeastern bound of the project area, and was terminated approximately 30.0 feet below present grade (BPG). Test pit TP-2 was advanced approximately 60 feet north and 360 feet east of the southwestern bound of the project area, and was terminated approximately 24.0 feet BPG.

During advancement of test pits, an MTC project geologist logged, visually classified, and sampled the encountered subsoils in accordance with the Unified Soil Classification System (USCS) as well as ASTM D2487. Representative soil samples were collected of each unit encountered, identified according to excavation location and depth, placed in plastic bags to protect against moisture loss, and transported to MTC laboratory for supplemental classification and analysis. Additional information pertaining to the field exploration activities can be found referring to the exploration logs included as an attachment to this report in Appendix B.

Results of Subsurface Exploration:

A general characterization of relevant on-site soil units encountered during our exploration is presented in this section. The exploration logs in Appendix B present details of the soils encountered at the exploration locations. The site soils appear to correlate with mapped soil units. The on-site soils are generally characterized as follows:

Weathered Glacial Deposits – Silty Sand to Silt (SM to ML):

- Beneath gravelly organic-rich topsoil deposits, native shallow soils consisting of alternating bands of variably thick silty sand and silt were encountered from approximately 3.0 to 10.0 feet BPG at exploration location TP-2. The material was typically moist, faintly mottled, medium brown, appeared loose/soft, and may be a combination of weathered recessional outwash and till. Minor weak seepage was noted at the base of this unit, appearing to be the result of a minor accumulation of recent stormwater.

Glacial Till – Silty Gravel with Sand (GM):

- Beneath gravelly topsoil deposits, native shallow soils consisting of silty gravel with sand were encountered approximately 3.0 feet BPG at exploration location TP-1. The till was not encountered in TP-2, possibly due to the till deposits tapering out towards the southernmost extent of the site. The material was typically cemented, moist, gray and very dense throughout. This unit was encountered to 24.0 feet BPG before transitioning to unconsolidated poorly graded sand with silt and gravel.

Advanced Glacial Outwash – Sand with Silty Clay and Gravel (SW-SC to SP):

- Beneath glacial till deposits at TP-1, and found directly beneath recessional outwash deposits at TP-2, native soil consisting of poorly graded sand with silt and gravel were encountered from 10.0 feet BPG to the termination depth of 24.0 feet BPG. This material was typically moist, gray, and appeared in a medium dense condition. Beneath glacial till deposits encountered at exploration location TP-1, native soil consisting of well graded sand with silty clay and gravel was encountered from 24.0 feet BPG to 30.0 feet BPG. This material was typically moist, gray, unconsolidated, and may be advanced outwash deposits.

No underlying confining units or evidence of a regional groundwater table was encountered within the lower sandy unit.

Infiltration Analysis Results

During test pit excavations for potential site infiltration feasibility, MTC collected representative samples of native soil deposits among potentially infiltrative strata and depths. We understand the project will be subject to infiltration design based on the Washington Department of Ecology

Stormwater Management Manual for Western Washington (DoE SMMWW), 2012 edition, as accepted by the City of Olympia. For initial site infiltration characterization within the scope of this study, laboratory gradation analyses were completed including sieve tests for stormwater design characterization and rate determination to supplement field observations. Results of laboratory testing in terms of rate calculation are summarized below.

Laboratory results were interpreted to recommended design inputs in accordance with methods of the 2012 DoE SMMWW. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

(1) $\log10(Ksat) = -1.57 + 1.90*D10 + 0.015*D60 - 0.013*D90 - 2.08*ff$

Table 1 reports for each sample the input laboratory values and calculated Ksat. Corrected Ksat values presented below are a product of the initial Ksat and correction factor CFT. For a generalized site-wide design situation, we have applied a conservative site variability factor of CFv = 0.6 along with typical values of CFt = 0.4 (for the Grain Size Method) and CFm = 0.9 (assuming standard influent control).

(2) $CFT = CFv \times CFt \times CFm = 0.6 \times 0.4 \times 0.9 = 0.22$

Table 1. Results of Massmann Analysis

TP #	**Sample Depth** *(ft BPG)*	**Unit Extent** *(ft)*	**Soil Type**	**D10**	**D60**	**D90**	**Ff** (%)	**Ksat** *(inches/hour)*	**Corrected Ksat** *(inches/hour)*
1	24	24 to 30	SW-SC	0.110	0.798	7.472	8.9	33.13	**7.3**
2	15	10 to 24+	SP-SM	0.192	4.978	15.483	7.3	46.54	**10.2**
2	24	10 to 24+	SP	0.223	1.344	11.565	3.4	63.72	**14.0**

Discussion and Recommendations

Infiltration appears most feasible within the southwestern portion of the site, directly within the vicinity of TP-2, where glacial till soils appeared to taper, and pinch out, so as to be absent from between the surface soils and outwash deposits. These conditions appeared generally correlative with available map data.

For application to initial design scenarios, if feasible, we recommend considering a corrected Ksat maximum value of ***10.2 inches/hour*** for an infiltration facility within the immediate vicinity of TP-2, below 10 feet. This rate considers the generally minimal variability noted in the lower soil unit, while also considering the irregular presence of till in the immediate vicinity. The higher rate of 14.0 inches per hour may be utilized below depths of 20 feet within this same vicinity. However, a final design application would most likely employ a further reduced rate in order to compensate for additional factors such as the minimal separation to seasonal water conditions and restrictive soils. It is the responsibility of the project designer to account for all reductions required. At this time, if infiltration is proposed to occur within the vicinity of TP-2, MTC does not feel any further extent of exploration is needed at this time unless greater infiltration rates than those determined in this investigation are desired. Methods to determine such higher rates would include in-field Pilot Infiltration Testing (PIT). This and other services can be provided by MTC if desired.

MTC recommends the facility designer review these results and stated assumptions per reference literature to ensure applicability with the proposed development, level of anticipated controls, and long-term maintenance plan. The designer may make reasonable adjustments to correction factors and the resulting design values based on these criteria to ensure design and operational intent is met.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. No other warranties, express or implied, are intended or made. We trust this letter satisfies your interests at this time.

We trust this correspondence will satisfy your needs. If you have further questions, please do not hesitate to call.

Respectfully Submitted;
Materials Testing and Consulting, Inc.

MEDHANIE GHEBRETENSAE TECLE
50966
03-05-2018

Luke P. Mc

Luke Preston McCann, G.I.T.
Project Geologist

Medhanie G. Tecle, P.E.
Engineering Manager

Kyle Hahn, G.I.T
Staff Geologist

Attached:
Limitations and Use of this Report
Appendix A – Site Location and Vicinity
Appendix A1 – Site Map with Exploration Locations
Appendix B – Exploration Logs
Appendix C – Laboratory Test Results

Limitations and Use of This Report

Recommendations contained in this report are based on MTC's understanding of the proposed development and construction activities, MTC's field observations and exploration and MTC's laboratory test results. It is possible that soil and groundwater conditions could vary and differ between or beyond the points explored. If soil or groundwater conditions are encountered during construction that vary or differ from those described herein, MTC shall be notified immediately in order that a review may be made and supplemental recommendations provided. If the scope of the proposed construction, including the proposed loads or structural locations, changes from that described in this report, MTC's recommendations shall also be reviewed.

MTC has prepared this report in substantial accordance with the generally accepted geotechnical engineering practice as it exists in the site area at the time of MTC's study. No warranty, expressed or implied, is made. The recommendations provided in this report are based on the assumption that an adequate program of tests and observations will be conducted by MTC during the construction phase in order to evaluate compliance with our recommendations. Other standards or documents referenced in any given standard cited in this report, or otherwise relied upon by the author of this report, are only mentioned in the given standard; they are not incorporated into it or "included by reference", as that latter term is used relative to contracts or other matters of law.

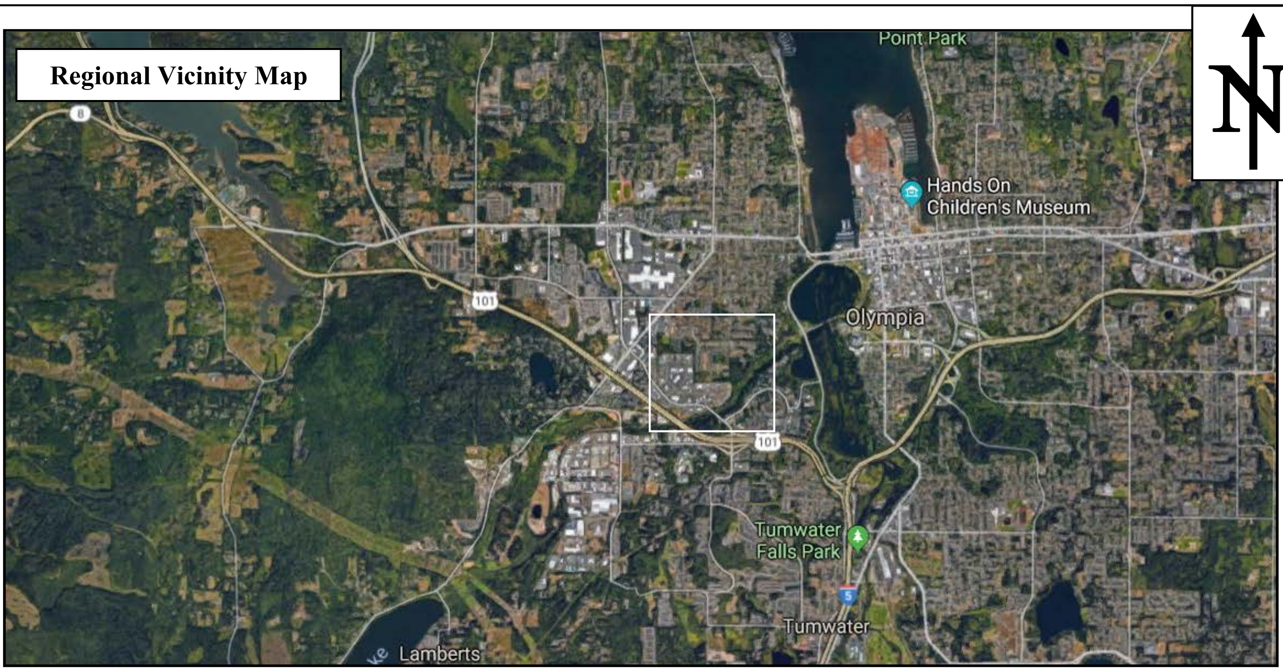
This report may be used only by Mr. Vo, the client, and their design consultants and only for the purposes stated within a reasonable time from its issuance, but in no event later than 18 months from the date of the report. Note that if another firm assumes Geotechnical Engineer of Record responsibilities they need to review this report and either concur with the findings, conclusions, and recommendations or provide alternate findings, conclusions and recommendation under the guidance of a professional engineer registered in the State of Washington. The recommendations of this report are based on the assumption that the Geotechnical Engineer of Record has reviewed and agrees with the findings, conclusion and recommendations of this report.

Land or facility use, on- and off-site conditions, regulations, or other factors may change over time, and additional work may be required with the passage of time. Based on the intended use of the report, MTC may recommend that additional work be performed and that an updated report be issued. Non-compliance with any of these requirements by Mr. Vo, the client, or anyone else will release MTC from any liability resulting from the use of this report by any unauthorized party and Mr. Vo agrees to defend, indemnify, and hold MTC harmless from any claim or liability associated with such unauthorized use or non-compliance. MTC recommends that we be given the opportunity to review the final project plans and specifications to evaluate if our recommendations have been properly interpreted. MTC assumes no responsibility for misinterpretation of our recommendations.

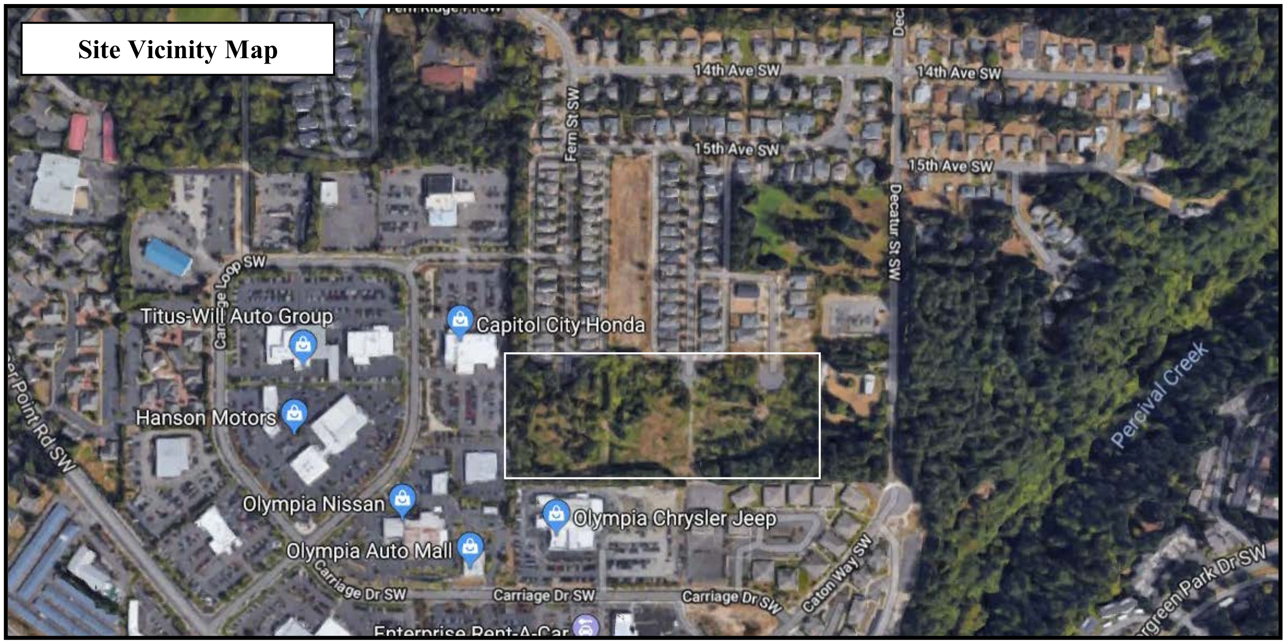
The scope of work for this subsurface exploration did not include geotechnical design, geotechnical recommendations, environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater at this site.

Appendix A. Site Location and Vicinity

Regional Vicinity Map



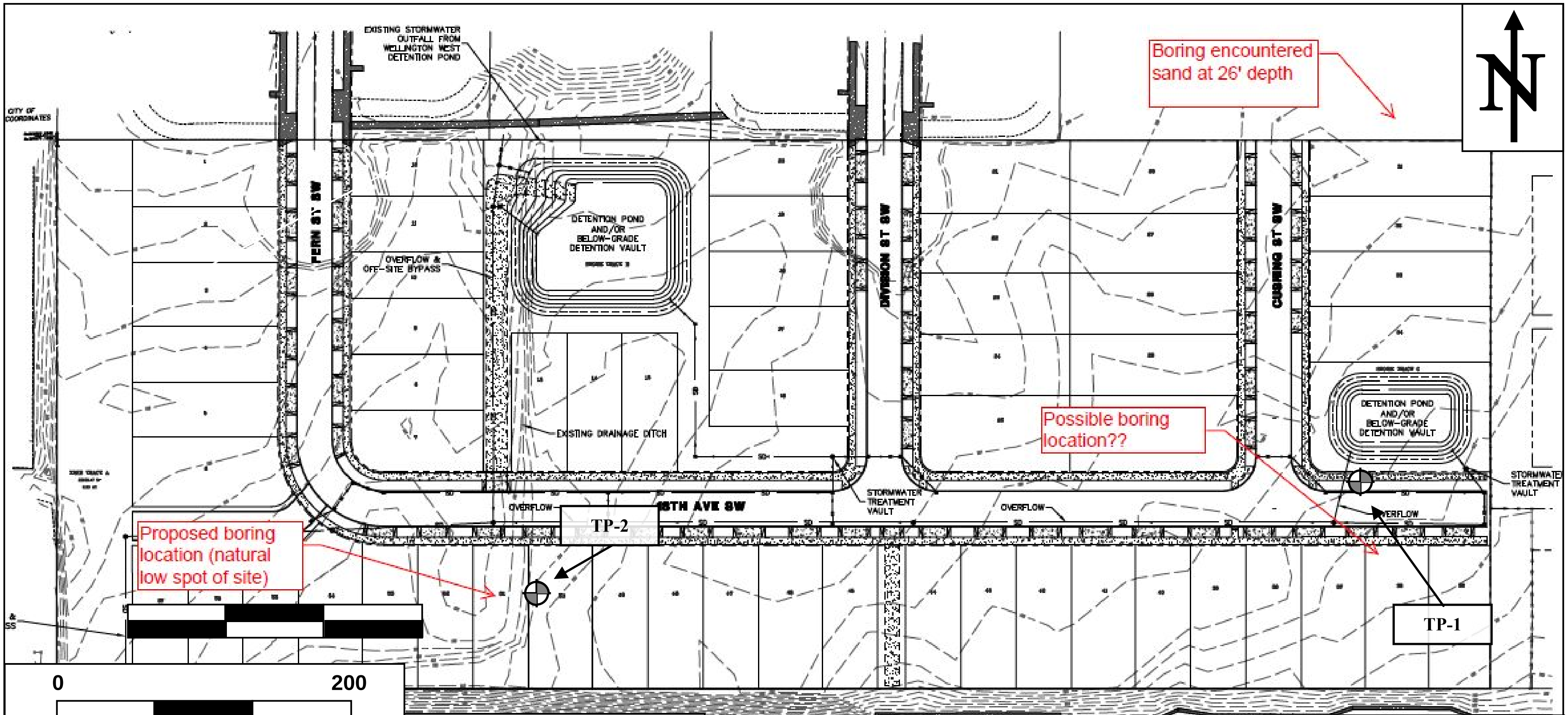
Site Vicinity Map



Locations are approximate ***Not for Construction***	Maps Source: Google Imagery 2018

Materials Testing & Consulting, Inc. 2118 Black Lake Blvd SW Olympia, WA 98512	**Regional & Site Vicinity Maps** South of intersection of Division St SW and 15th Ave SW Olympia, WA 98502	**FIGURE** **1**

Appendix A1. Site Map with Exploration Locations



Boring encountered sand at 26' depth

Possible boring location??

Proposed boring location (natural low spot of site)

SCALE IS APPROXIMATE
*** Not for Construction ***

Map Source: Olympic Engineering (11/20/17)

Materials Testing & Consulting, Inc.
2118 Black Lake Blvd SW
Olympia, WA 98512

Site Map with Exploration Locations
South of intersection of Division St SW
and 15th Ave SW
Olympia, WA 98502

FIGURE
2

Appendix B. Exploration Logs

Exploration logs from the excavated test pits are shown in full in this Appendix. Grab soil samples were collected from representative soil layers within the exploration locations by our field geologist during the excavation. The exploration was monitored by our field geologist who examined and classified the materials encountered in accordance with the Unified Soil Classification System (USCS), obtained representative soil samples, and recorded pertinent information including soil sample depths, stratigraphy, soil engineering characteristics, and groundwater occurrence. Upon completion, the pits were backfilled with the excavated soils. Soil samples collected during the field exploration were classified in accordance with ASTM D2487 and the Unified Soil Classification System (USCS). All samples were placed in plastic bags to limit moisture loss, labeled, and returned to our laboratory for further examination and testing.

The stratification lines shown on the boring logs represent the approximate boundaries between soil types; actual transitions may be either more gradual or more severe. The conditions depicted are for the date and location indicated only, and it should not necessarily be expected that they are representative of conditions at other locations and times.

Corporate • 777 Chrysler Drive • Burlington, WA 98233 • Phone 360.755.1990 • Fax 360.755.1980
SW Region • 2118 Black Lake Blvd. S.W.• Olympia, WA 98512 • Phone 360.534.9777 • Fax 360.534.9779
NW Region • 805 Dupont St, Suite 5 • Bellingham, WA 98226 • Phone 360.647.6061 • Fax 360.647.8111
Kitsap Region • 5451 N.W. Newberry Hill Road, Suite 101 • Silverdale, WA 98383 • Phone/Fax 360.698.6787

Visit our website: www.mtc-inc.net

Unified Soil Classification System Chart

Major Divisions			Graph	USCS	Typical Description
Coarse Grained Soils More Than 50% Retained On No. 200 Sieve	**Gravel** More Than 50% of Coarse Fraction Retained On No. 4 Sieve	Clean Gravels	○	GW	Well-graded Gravels, Gravel-Sand Mixtures
			●	GP	Poorly-Graded Gravels, Gravel-Sand Mixtures
		Gravels With Fines	▥	GM	Silty Gravels, Gravel-Sand-Silt Mixtures
			▨	GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand More Than 50% of Coarse Fraction Passing No. 4 Sieve	Clean Sands	░	SW	Well-graded Sands, Gravelly Sands
			░	SP	Poorly-Graded Sands, Gravelly Sands
		Sands With Fines	▥	SM	Silty Sands, Sand-Silt Mixtures
			▨	SC	Clayey Sands, Clay Mixtures
Fine Grained Soils More Than 50% Passing The No. 200 Sieve	**Silts & Clays**	Liquid Limit Less Than 50	▥	ML	Inorganic Silts, rock Flour, Clayey Silts With Low Plasticity
			▨	CL	Inorganic Clays of Low To Medium Plasticity
			▥	OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts & Clays	Liquid Limit Greater Than 50	▥	MH	Inorganic Silts of Moderate Plasticity
			▨	CH	Inorganic Clays of High Plasticity
			▨	OH	Organic Clays And Silts of Medium to High Plasticity
Highly Organic Soils			▤	PT	Peat, Humus, Soils with Predominantly Organic Content

Sampler Symbol Description

◪	Standard Penetration Test (SPT)
▥	Shelby Tube
☒	Grab or Bulk
⊟	California (3.0" O.D.)
■	Modified California (2.5" O.D.)

Stratigraphic Contact

——	Distinct Stratigraphic Contact Between Soil Strata
╲	Gradual Change Between Soil Strata
- - - -	Approximate location of stratagraphic change
▼	Groundwater observed at time of exploration
▽	Measured groundwater level in exploration, well, or piezometer
◆	Perched water observed at time of exploration

Modifiers

Description	%
Trace	>5
Some	5-12
With	>12

Soil Consistency

Granular Soils		Fine-grained Soils	
Density	***SPT Blowcount***	***Consistency***	***SPT Blowcount***
Very Loose	0-4	Very Soft	0-2
Loose	4-10	Soft	2-4
Medium Dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very Dense	> 50	Very Stiff	15-30
		Hard	> 30

Grain Size

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than a basketball
Cobbles		3 - 12"	3 - 12"	Fist to basketball
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb to fist
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea to thumb
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock salt to pea
	Medium	#40 - #10	0.017 - 0.079"	Sugar to rock salt
	Fine	#200 - #40	0.0029 - 0.017"	Flour to Sugar
Fines		Passing #200	< 0.0029"	Flour and smaller

Materials Testing & Consulting, Inc.
2118 Black Lake Blvd SW
Olympia, WA 98512

Exploration Log Key

FIGURE
3

Materials Testing & Consulting, Inc.

Geotechnical Engineering

Log of Test Pit TP-1

Wellington Heights
S of Division St & 15th Ave
Olympia, WA 98502

MTC Project No.: 18S053

Date Started : February 27, 2018
Date Completed : February 27, 2018
Sampling Method : Grab Samples
Location : 100' N, 80' W of SE Corner
Logged By : KH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level
0	GM		SILTY GRAVEL with SAND, loose, roots and organics, damp. Medium BROWN. *Approximately 58.0% Gravel, 26.0% Sand, 14.0% Fines* Minor seepage at 3.0 feet		
5 10 15 20	GM		SILTY GRAVEL with SAND, dense, damp, cemented, minor cobbles. Medium GRAY. **(Glacial Till)** *Approximately 54.0% Gravel, 29.0% Sand, 17.0% Fines*		
25 30	SW-SC		*Sample No. S18-0252: 15.9% Gravel, 75.2% Sand, 8.9% Fines* SAND with SILTY CLAY and GRAVEL, medium dense, damp, gravel up to 2.0 inch diameter. Medium GRAY. **(Suspected Advanced Glacial Outwash)**	☒	

Total Depth:30.0 feet
Test pit terminated at maximum equipment depth
No groundwater encountered

03-05-2018 C:\Documents and Settings\Luke McCann\Desktop\GeoGraphics logs\WellingtonInfiltration - TP-1 - KH.bor

Materials Testing & Consulting, Inc.

Geotechnical Engineering

Log of Test Pit TP-2

Wellington Heights
S of Division St & 15th Ave
Olympia, WA 98502

MTC Project No.: 18S053

Date Started : February 27, 2018
Date Completed : February 27, 2018
Sampling Method : Grab Samples
Location : 60' N, 360' E of SW Corner
Logged By : KH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level
0	GM		SILTY GRAVEL with SAND, loose, damp, TOPSOIL. Medium BROWN. *Approximately 55.0% Gravel, 25.0% Sand, 20.0% Fines*		
5	SM-ML		SILTY SAND with GRAVEL to SILT, loose to medium dense, damp, interbedded coarse-grained and fine-grainedhorizons 0.5 to 2.0 feet in thickness. Medium BROWN. **(Suspected Recessional Glacial Outwash)** *Silty Sand with Gravel: Approximately 21.0% Gravel, 65.0% Sand, 14.0% Fines* *Silt: Approximately 0.0% Gravel, 4.0% Sand, 96.0% Fines* Minor seepage at 10 feet		
10	SP-SM		SAND with SILT and GRAVEL, poorly graded, medium dense, damp, gravel up to 2.0 inches in diameter, minor cobbles. Medium GRAY-BROWN. **(Suspected Advanced Glacial Outwash)**		
15			*Sample No. S18-0250: 40.8% Gravel, 51.9% Sand, 7.3% Fines*	☒	
20			Soil becomes sandier with depth		
			Sample No. S18-025: 21.4% Gravel, 75.3% Sand, 3.4% Fines	☒	
25			Total Depth:24.0 feet Test pit terminated at maximum equipment depth No groundwater encountered		
30					

03-05-2018 C:\Documents and Settings\Luke McCann\Desktop\GeoGraphics logs\WellingtonInfiltration - TP-2 - KH.bor

Appendix C. Laboratory Test Results

Laboratory tests were conducted on several representative soil samples to better identify the soil classification of the units encountered and to evaluate the material's general physical properties and engineering characteristics. A brief description of the tests performed for this study is provided below. The results of laboratory tests performed on specific samples are provided at the appropriate sample depths on the individual boring logs. However, it is important to note that these test results may not accurately represent in situ soil conditions. All of our recommendations are based on our interpretation of these test results and their use in guiding our engineering judgment. MTC cannot be responsible for the interpretation of these data by others.

Soil samples for this project will be retained for a period of three months following completion of this report, unless we are otherwise directed in writing.

SOIL CLASSIFICATION

Soil samples were visually examined in the field by our representative at the time they were obtained. They were subsequently packaged and returned to our laboratory where they were reexamined and the original description checked and verified or modified. With the help of information obtained from the other classification tests, described below, the samples were described in general accordance with ASTM Standard D2487. The resulting descriptions are provided at the appropriate locations on the individual exploration logs, located in Appendix C, and are qualitative only.

GRAIN-SIZE DISTRIBUTION

Grain-size distribution analyses were conducted in general accordance with ASTM Standard D422 on representative soil samples to determine the grain-size distribution of the on-site soil. The information gained from these analyses allows us to provide a description and classification of the in-place materials. In turn, this information helps us to understand engineering properties of the soil and thus how the in-place materials will react to conditions such as heavy seepage, traffic action, loading, potential liquefaction, and so forth. The results are presented in this Appendix.

Sieve Report

Project: Wellington Infilltration
Project #: 18S053
Client: Tri Way Enterprises
Source: TP2 @ 15'
Sample#: S18-0250

Date Received: 27-Feb-18
Sampled By: KH
Date Tested: 28-Feb-18
Tested By: FP

ASTM D-2487 Unified Soils Classification System
SP-SM, Poorly graded Sand with Silt and Gravel
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

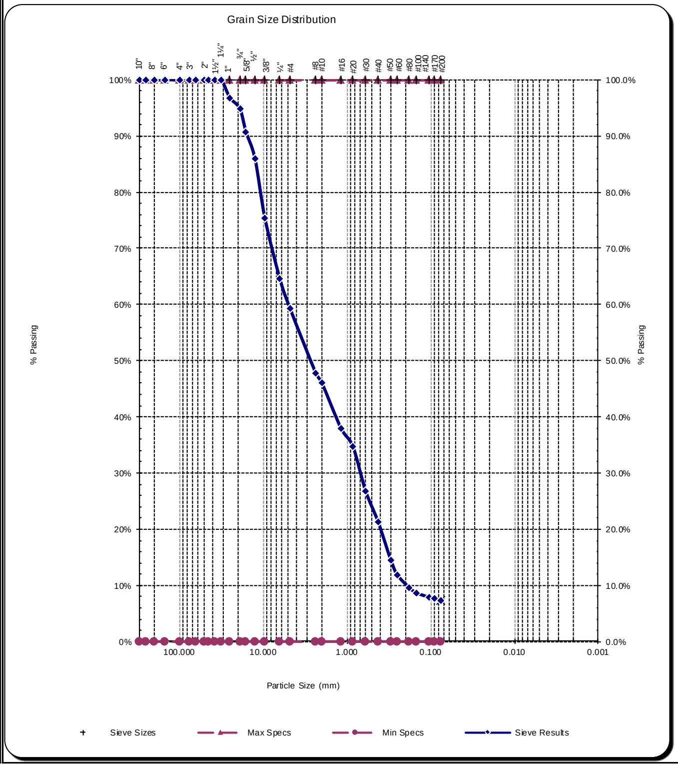
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.051 mm	% Gravel = 40.8%	Coeff. of Curvature, C_C = 0.51
$D_{(10)}$ = 0.192 mm	% Sand = 51.9%	Coeff. of Uniformity, C_U = 25.93
$D_{(15)}$ = 0.308 mm	% Silt & Clay = 7.3%	Fineness Modulus = 4.35
$D_{(30)}$ = 0.699 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 2.813 mm	Plasticity Index = n/a	Moisture %, as sampled = 7.4%
$D_{(60)}$ = 4.978 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 15.483 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 11/32	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50	100%	100%	100.0%	0.0%
1.00"	25.00	97%	97%	100.0%	0.0%
3/4"	19.00	95%	95%	100.0%	0.0%
5/8"	16.00	91%	91%	100.0%	0.0%
1/2"	12.50	86%	86%	100.0%	0.0%
3/8"	9.50	75%	75%	100.0%	0.0%
1/4"	6.30	65%	65%	100.0%	0.0%
#4	4.75	59%	59%	100.0%	0.0%
#8	2.36		48%	100.0%	0.0%
#10	2.00	46%	46%	100.0%	0.0%
#16	1.18		38%	100.0%	0.0%
#20	0.850	35%	35%	100.0%	0.0%
#30	0.600		27%	100.0%	0.0%
#40	0.425	21%	21%	100.0%	0.0%
#50	0.300		15%	100.0%	0.0%
#60	0.250	12%	12%	100.0%	0.0%
#80	0.180	10%	10%	100.0%	0.0%
#100	0.150	9%	9%	100.0%	0.0%
#140	0.106		8%	100.0%	0.0%
#170	0.090		8%	100.0%	0.0%
#200	0.075	7.3%	7.3%	100.0%	0.0%



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Sieve Report

Project: Wellington Infilltration
Project #: 18S053
Client: Tri Way Enterprises
Source: TP2 @ 24'
Sample#: S18-0251

Date Received: 27-Feb-18
Sampled By: KH
Date Tested: 28-Feb-18
Tested By: FP

ASTM D-2487 Unified Soils Classification System
SP, Poorly graded Sand with Gravel
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

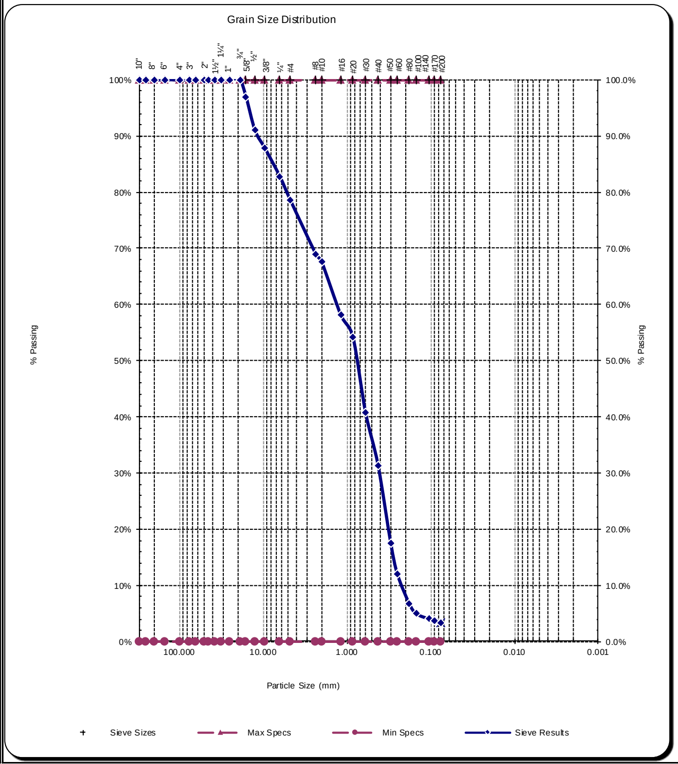
$D_{(5)}$ = 0.150 mm
$D_{(10)}$ = 0.223 mm
$D_{(15)}$ = 0.277 mm
$D_{(30)}$ = 0.412 mm
$D_{(50)}$ = 0.770 mm
$D_{(60)}$ = 1.344 mm
$D_{(90)}$ = 11.565 mm
Dust Ratio = 8/75

% Gravel = 21.4%
% Sand = 75.3%
% Silt & Clay = 3.4%
Liquid Limit = n/a
Plasticity Index = n/a
Sand Equivalent = n/a
Fracture %, 1 Face = n/a
Fracture %, 2+ Faces = n/a

Coeff. of Curvature, C_C = 0.57
Coeff. of Uniformity, C_U = 6.02
Fineness Modulus = 3.43
Plastic Limit = n/a
Moisture %, as sampled = 6.4%
Req'd Sand Equivalent =
Req'd Fracture %, 1 Face =
Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size		Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs	Specs
US	Metric			Max	Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00		100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00	97%	97%	100.0%	0.0%
1/2"	12.50	91%	91%	100.0%	0.0%
3/8"	9.50	88%	88%	100.0%	0.0%
1/4"	6.30	83%	83%	100.0%	0.0%
#4	4.75	79%	79%	100.0%	0.0%
#8	2.36		69%	100.0%	0.0%
#10	2.00	68%	68%	100.0%	0.0%
#16	1.18		58%	100.0%	0.0%
#20	0.850	54%	54%	100.0%	0.0%
#30	0.600		41%	100.0%	0.0%
#40	0.425	31%	31%	100.0%	0.0%
#50	0.300		18%	100.0%	0.0%
#60	0.250	12%	12%	100.0%	0.0%
#80	0.180	7%	7%	100.0%	0.0%
#100	0.150	5%	5%	100.0%	0.0%
#140	0.106		4%	100.0%	0.0%
#170	0.090		4%	100.0%	0.0%
#200	0.075	3.4%	3.4%	100.0%	0.0%



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Sieve Report

Project: Wellington Infilltration
Project #: 18S053
Client: Tri Way Enterprises
Source: TP1 @ 24'
Sample#: S18-0252

Date Received: 27-Feb-18
Sampled By: KH
Date Tested: 28-Feb-18
Tested By: FP

ASTM D-2487 Unified Soils Classification System
SW-SC, Well-graded Sand with Silty Clay and Gravel
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

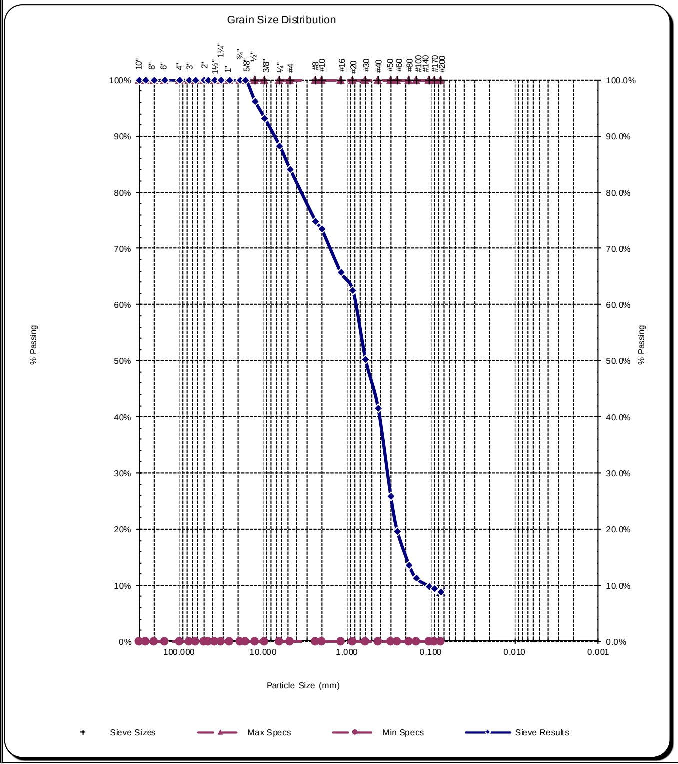
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.042 mm	% Gravel = 15.9%	Coeff. of Curvature, C_C = 1.26
$D_{(10)}$ = 0.110 mm	% Sand = 75.2%	Coeff. of Uniformity, C_U = 7.23
$D_{(15)}$ = 0.197 mm	% Silt & Clay = 8.9%	Fineness Modulus = 2.95
$D_{(30)}$ = 0.333 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 0.595 mm	Plasticity Index = n/a	Moisture %, as sampled = 8.3%
$D_{(60)}$ = 0.798 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 7.472 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 3/14	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00		100%	100.0%	0.0%
3/4"	19.00		100%	100.0%	0.0%
5/8"	16.00	100%	100%	100.0%	0.0%
1/2"	12.50	96%	96%	100.0%	0.0%
3/8"	9.50	93%	93%	100.0%	0.0%
1/4"	6.30	88%	88%	100.0%	0.0%
#4	4.75	84%	84%	100.0%	0.0%
#8	2.36		75%	100.0%	0.0%
#10	2.00	73%	73%	100.0%	0.0%
#16	1.18		66%	100.0%	0.0%
#20	0.850	63%	63%	100.0%	0.0%
#30	0.600		50%	100.0%	0.0%
#40	0.425	42%	42%	100.0%	0.0%
#50	0.300		26%	100.0%	0.0%
#60	0.250	20%	20%	100.0%	0.0%
#80	0.180	13%	13%	100.0%	0.0%
#100	0.150	11%	11%	100.0%	0.0%
#140	0.106		10%	100.0%	0.0%
#170	0.090		9%	100.0%	0.0%
#200	0.075	8.9%	8.9%	100.0%	0.0%



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Appendix 3C
Soils Report Addendum (Materials Testing & Consulting)

ADDENDUM #1
SUMMARY OF INFILTRATION EVALUATION

Wellington Heights
South of Division St SW & 16th Ave SW,
Olympia, WA 98502

Alex Vo
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Olympia, WA 98507
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alexv@triwayenterprises.com

Prepared by:

Luke P. M

Luke Preston McCann, G.I.T.
Senior Geologist

MEDHANIE GHEBRETENSAE TECLE
50966
07-23-2018

Medhanie G. Tecle, P.E.
Engineering Manager

MATERIALS TESTING & CONSULTING, INC. (MTC)
2118 Black Lake Blvd SW
Olympia, WA 98512
Phone: (360) 534-9777
Fax: (360) 534-9779

July 13, 2018; ***Revised July 23, 2018***

MTC Project Number: **18S053-01**

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Table of Contents

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE OF SERVICES

At your request, Materials Testing & Consulting, Inc. (MTC) has performed an additional limited evaluation of existing subsurface conditions, to supplement our original letter (dated March 5, 2018) in support of newly proposed infiltration design. MTC understands the City is requiring supplemental analysis of mounding potential, and stability of the adjacent slope be evaluated. This letter summarizes the findings of our additional scope of evaluation and addresses the requested recommendations.

The information included in this addendum should be considered supplemental to the information contained in the original letter and, as such, should be read in conjunction with the above referenced report. The selected recommendations presented in this addendum are intended to supersede only the specific corresponding recommendations contained in the original report. All other recommendations of the above-mentioned report remain valid, unless otherwise specified herein.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in this or similar localities. No warranties, express or implied, are intended or made.

2.0 SITE EXPLORATION

2.1 SITE EXPLORATION METHODOLOGY

An MTC Staff Geologist revisited the site on June 21, 2018 to complete the proposed exploration and observe the advancements of one (1) geotechnical boring within the area proposed for infiltration, and two (2) test pits to better evaluate the impact of the proposed feature on site conditions in relation to soil and groundwater stratigraphy. Exploration locations are shown in Figure 2 of Appendix B. The boring was advanced to 51.5 feet below present grade (BPG). The test pits TP-1 and TP-2 were excavated to depths of 30 feet and 24 feet BPG, respectively.

During boring advancement, an MTC project geologist logged, visually classified, and sampled the encountered subsoils in accordance with the Unified Soil Classification System (USCS) as well as ASTM D2487. Representative soil samples were collected of each unit encountered, identified according to excavation location and depth, placed in plastic bags to protect against moisture loss, and transported to MTC laboratory for supplemental classification and analysis. Additional information pertaining to the field exploration activities, as well as our previous explorations, can be found by referring to the exploration logs included as an attachment to this report in Appendix D.

Site dimensions and general slope topography were observed and estimated at representative intervals as access allowed, and cross referenced with available topographic survey data. Salient slope features and existing vegetation were documented as observed in order to assess general site and slope stability as well as to look for signs of local instability of an erosional or subsurface nature currently or in the past. All test locations are shown on Figure 2 of Appendix B, within provided site plans of proposed development features.

3.0 EXISTING SITE CONDITIONS

3.1 REVIEW OF GEOLOGICAL LITERATURE

The *Geologic Map of the Tumwater 7.5-minute Quadrangle, Thurston County, Washington* (Walsh et al, 2003) published by the Washington Division of Geology and Earth Resources indicates the entirety of the project site is located within Vashon recessional outwash (Qgo), commonly described as stratified, poorly sorted, and comprised of sand and gravel, locally containing silt and clay. Vashon till (Qgt) is also mapped within 0.5 miles of the project area. Vashon till (Qgt) is commonly described as an unsorted and highly compacted mixture of clays, silts, sands, and gravels that are variably cemented. Maps of greater scale indicate the possible presence of till in local variation, and other areas where advanced and recessional outwash deposits are undifferentiated, if no intervening till horizon is present to identify the contact.

Shallow soils are mapped by the NRCS Web Soil Survey as *Alderwood gravelly sandy loam* (1), with 0 to 8 percent slopes. Alderwood gravelly sandy loam is described to have formed in hills and ridges as a derivative of recessional glacial outwash. The soil is described to be moderately well drained and typically consists of very gravelly sandy loam to depths beyond 59 inches. Depth to the restrictive feature or water table is described as 18 to 39 inches and can be noted by the presence of densic material.

3.2 SOIL CONDITIONS

A general characterization of relevant on-site soil units encountered during our exploration is presented in this section. The exploration logs in Appendix D present details of the subsurface soils encountered at the exploration locations. The site soils appear to correlate with mapped soil units. The on-site soils are generally characterized as follows:

Weathered Glacial Deposits – Silty Sand to Silt (SM to ML):

- Beneath gravelly organic-rich topsoil deposits, native shallow soils consisting of alternating bands of variably thick silty sand and silt were encountered from approximately 3.0 to 10.0 feet BPG at TP-2 and BH-1. The material was typically moist, faintly mottled, medium brown, appeared loose/soft, and may be a combination of weathered recessional outwash and till. Minor weak seepage was noted at the base of this unit, appearing to be the result of a minor accumulation of recent stormwater.

Glacial Till – Silty Gravel with Sand (GM):

- Beneath gravelly topsoil deposits, native shallow soils consisting of silty gravel with sand were encountered approximately 3.0 feet BPG at exploration location TP-1 on the east side of the site. The till was not encountered on the west side of the site in TP-2 or BH-1, possibly due to the till deposits tapering out towards this extent of the site. The material was typically cemented, moist, gray and very dense throughout. This unit was encountered to 24.0 feet BPG before transitioning to unconsolidated poorly graded sand with silt and gravel.

Advanced Glacial Outwash – Sand with Silty Clay and Gravel (SP to SM):

- Beneath glacial till deposits at TP-1, and found directly beneath recessional outwash deposits at TP-2 and BH-1, native soil consisting of poorly graded sand with silt and gravel were encountered from 5.0 feet BPG to the maximum depth of exploration at 51.5 feet BPG. This material was typically moist, gray, and appeared in a medium dense condition. Beneath glacial till deposits encountered at exploration location TP-1, native soil consisting of well graded sand with silty clay and gravel was encountered from 24.0 feet BPG to 30.0 feet BPG. This material was typically moist, gray, unconsolidated, and may be advanced outwash deposits. Ground water was encountered in this unit at 40.0 feet BPG in BH-1. No confining units appear present within the outwash.

4.0 DESIGN CONSIDERATIONS

4.1 INFILTRATION RATE DETERMINATION

During excavations for potential site infiltration feasibility, MTC collected representative samples of native soil deposits among potentially infiltrative strata and depths. We understand the project will be subject to infiltration design based on the City of Olympia *Stormwater Management Manual*. For initial site infiltration characterization within the scope of this study, laboratory gradation analyses were completed including sieve tests for stormwater design characterization and rate determination to supplement field observations. Results of laboratory testing in terms of rate calculation are summarized below.

4.1.1 Design Rates

Laboratory results were interpreted to recommended design inputs in accordance with methods of the 2012 DoE SMMWW. Gradation results were applied to the Massmann (2003) equation (1) to calculate Ksat representing the initial saturated hydraulic conductivity.

(1) $\log10(Ksat) = -1.57 + 1.90*D10 + 0.015*D60 - 0.013*D90 - 2.08*ff$

Table 1 reports for each sample the input laboratory values and calculated Ksat. Corrected Ksat values presented below are a product of the initial Ksat and correction factor CFT. For a generalized site-wide design situation, we have applied a conservative site variability factor of CFv = 0.6 along with typical values of CFt = 0.4 (for the Grain Size Method) and CFm = 0.9 (assuming standard influent control).

(2) $CFT = CFv \times CFt \times CFm = 0.6 \times 0.4 \times 0.9 = 0.22$

Table 1. Results of Massmann Analysis

Sample Depth *(ft BPG)*	**Unit Extent** *(ft)*	**Soil Type**	**D10**	**D60**	**D90**	**Ff** (%)	**Ksat** *(inches/hour)*	**Corrected Ksat** *(inches/hour)*
15	5 to 51+	SP-SM	0.192	4.978	15.483	7.3	46.54	**10.2**

MTC understands the stormwater management system is undergoing design at this time and pending the results of this assessment to confirm general site feasibility & stability. Potential restrictive horizons specifically include the uppermost weathered outwash soils encountered from the surface to approximately 5.0 feet BPG. Any infiltration facility bottom will need to adequately penetrate and be founded beneath this overriding unit.

We recommend considering the lower rate of up to **10.2 inches/hour** for any general infiltration facility base, placed within underlying sandy (SP-SM) native soils found below 5.0 feet BPG in BH-1. This rate considers the generally minimal variability noted in the lower soil unit. Final design application may employ a further reduced rate depending on chosen infiltration method, and design factors such as dimension, and capacity. It is the responsibility of the designer to account for all reductions required.

MTC recommends the facility designer review these results and stated assumptions per reference literature to ensure applicability with the proposed development, level of anticipated controls, and long-term maintenance plan. The designer may make reasonable adjustments to correction factors and the resulting design values based on these criteria to ensure design and operational intent is met.

4.1.2 Clay Capping

MTC understands influx of stormwater from directly above the infiltration trench is of additional concern due to the relatively impermeable surface soils preventing typical percolation, and possibly diverting additional stormwater to the trench. To prevent influx, it is recommended that a "clay cap" be placed overtop of the completed placement of the stormwater trench chamber and all drainage soils. This cap should extend across the entire exposed excavation, making contact on all sides of the trench walls, and make direct contact with the shallow impermeable surface soils. The cap shall have a minimum thickness of 12 inches, and be placed with a minimum thickness of 12 inches. It shall be placed within 3% of the optimum moisture as determined by the modified Proctor test per ASTM D1557. Compactive effort shall be applied with a vibratory plate compactor; however, compaction testing will not be required due to the inherent difficulty of compacting clay-rich soils, and the lack of any structural development over the trench. Clay cap material may be composed of any readily available manufactured impermeable detention "pond-liner" material from a reputable local supplier, approved by the civil engineer, and placed per the manufacturer's recommendations.

4.2 SIMPLIFIED MOUNDING ANALYSIS

MTC performed a simplified mounding calculation using methods derived and published by Zomordi (1991; 2005). The purpose of mounding analysis was to verify the minimum design vertical and horizontal separation proposed from the identified groundwater table and the adjacent slope face is sufficient to ensure suitable facility operation under the design conditions and in consideration of site-specific soil conditions.

In the simplified case where facility length is assumed to be infinite, the mounding potential for infiltrating water above a restrictive horizon (h) is a direct function of the recharge rate (i), uncorrected horizontal Ksat (k), and recharge facility width (w) per the following equation (3):

$$h = (0.86 * i * w) / (k - i) \qquad (3)$$

Width of the trench is set at w = 75 feet. To address a maximum input scenario, recharge rate (i) was set equal to design infiltration rate (10.0 inches/hour, or 20.0 feet/day) for the facility. Conductivity (k) was applied using the assigned Ksat values above. Mounding inputs and results are tabulated in Table 2:

Table 2. Summary of Mounding Calculation Inputs and Results

Width (w) **(ft)**	**Ksat (k)** (ft/day)	**Infiltration/ Recharge (i)** (ft/day)	**Center Mound Height (h)** (ft)
40.0	92.0	20	**17.9**

According to this analysis, mounding will occur to a moderate extent under the facility while stormwater infiltrates and dissipates vertically and laterally. Mounding is interpreted to occur over the groundwater table encountered at 40.0 feet BPG. The results indicate that when using the most conservative lower-bound Ksat value, the central peak of the mound approaches 17.9 feet in height over the groundwater table. This dissipates to 6.0 feet at 90 feet from the center of the facility. In no calculated scenario does the mound height approach a point at which daylighting water would be expected to occur on site, or the adjacent slopes. This projection anticipates approximately 9.0 feet of separation from the top of the mound and the bottom of the trench. Additional worst-case-scenarios that were calculated, implementing reduced Ksat values did not yield any significant changes that would appear to compromise the facility function, or cause daylighting water along slope faces. Additionally, mounding water does not appear to reach an elevation where slope stability would be directly influenced.

The results of mounding analysis were compared to the design elevations on the provided Storm Drainage Plan (excerpt attached). The modified layout design section indicates at least 20.0 feet of vertical separation between mounding stormwater and the slope surface, and no lateral encroachment is expected with vertical infiltration. While this simplified calculation represents a generalized worst-case-scenario, it is our opinion that the results herein demonstrate a significantly reasonable margin exists without the system pushing failure thresholds. In this case, the simplified method is successful in demonstrating the general viability of the system regarding mounding potential, and further analysis does not appear to be necessary.

4.3 GENERAL SLOPE STABILITY ANALYSIS

Large-scale geologic stratigraphy of the site and subject slope was interpreted to construct a generalized slope model. Available map sources, in combination with our own observations, were assessed and compiled to form a reasonably conservative slope and stratigraphy profile for the subject site.

MTC reviewed available map publications to assess known geologic conditions and hazards present at the site location. Indicators of ongoing or potential instability on a slope can be classified into two categories: primary and secondary. Primary indicators of active or historic failures include direct signs of instability such as slope scarps, slumps or hummocks, slope creep and tension cracks, or ongoing erosion or barren failure zones. Secondary indicators are interpreted as indirect signs of instability or erosion, such as relatively steep slopes compared to nearby areas, tilted trees, young vegetation and missing trees, as well as geomorphic evidence of older events that can suggest an increased risk of future failure hazard. Slope conditions at the subject site did not appear to display any evidence of present or historic slope instability.

MTC understands the City has requested evaluation of the site slope, and impacts associated with the proposed infiltration trench construction. Based on field observations and the map resources, MTC does not consider the site to be an active landslide hazard area, or at immediate risk of landslide hazards.

Slope factor of safety were determined by the following the simplified relationship (Landslides: Investigation and Mitigation, Turner and Schuster, 1996):

Factor of Safety (FS) = Tan (ϕ) / Tan (α)

Where ϕ = Inferred Internal friction angle of soil
α = Angle of slope or projection plane.

An inferred $\phi = 31$ degrees friction angle was assigned to the generally dense outwash profile for use in assessing slope factor of safety. Target factor of safety for new structures is typically FS = 1.5 for static analysis. Factor of safety is an indication of stability where an FS = 1.0 or below would correspond to the point of failure. The setback projection angle for a suitable factor of safety is found by using:

Factor of Safety (FS) = Tan (ϕ) / Tan (α) = Tan (34) / Tan (α) = **1.5**
α = 21 degrees

MTC's profile estimates, as shown in Figure 1 of this addendum, were used to create a projection from the slope base for an $\alpha = 21$ degrees projection angle, does not intersect the infiltration trench at any point, indicating the lack of prominent failure planes emanating from the base of the slope, and the closest face of proposed trench. This geometry meets typical factor of safety requirements. These measurements and models are schematically detailed in the attached slope profile in Figure 1 below.

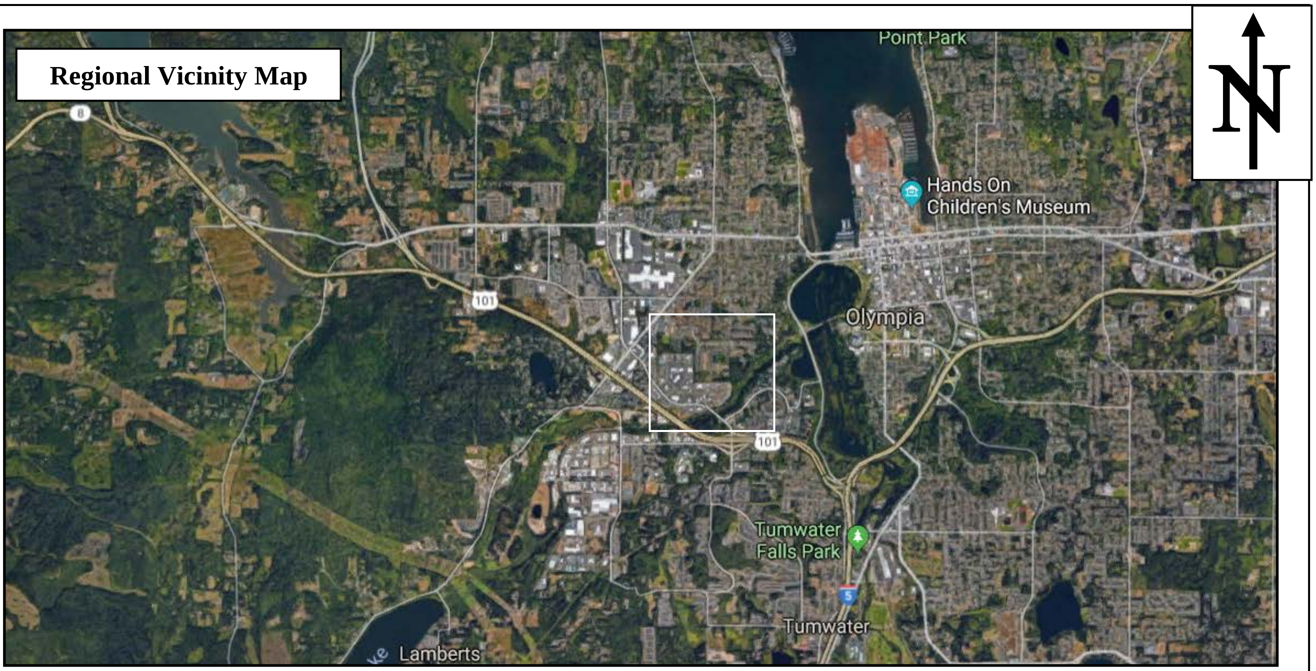
Results indicate that construction of the trench, as it is currently proposed, appears feasible assuming industry standard methods and long-term site management efforts are applied. For general non-disturbance protection, MTC recommends the infiltration trench maintain a minimum slope crest setback of 15 feet. Based on this evaluation, the proposed trench location does not pose a risk to general slope stability, and therefore no further analysis or setback increase is recommended at this time.

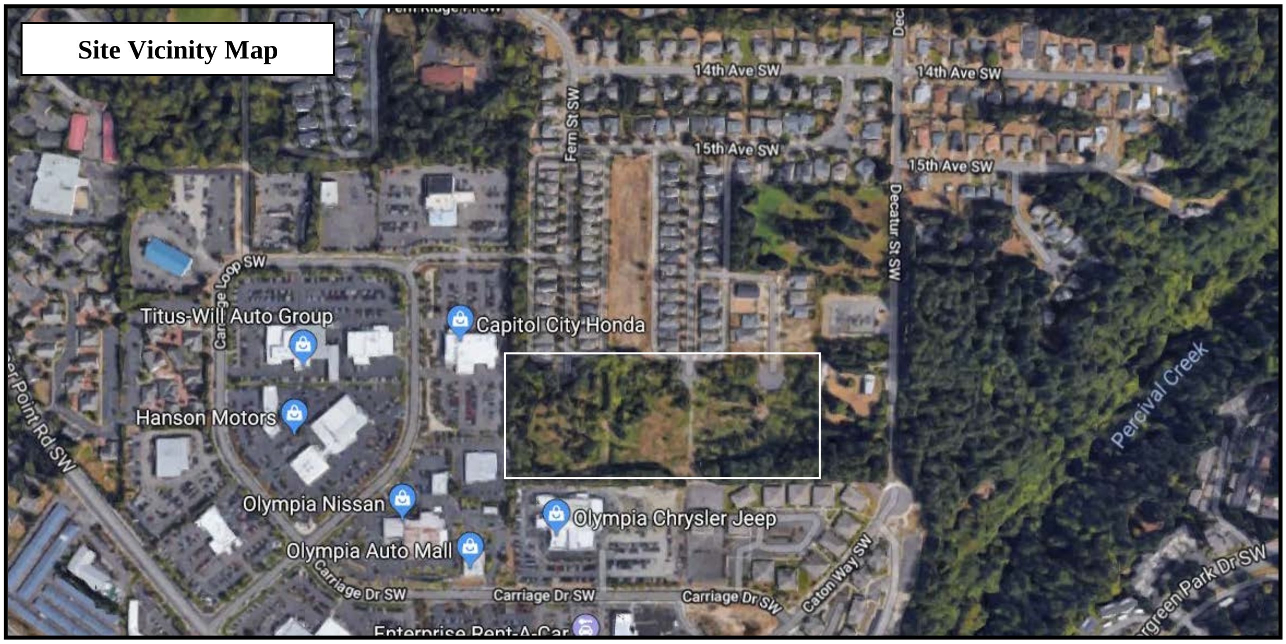
MTC's scope of services did not include conducting slope stability analysis of structures other than the proposed infiltration trench.

4.4 SURFACE WATER SWALE

MTC understands additional concerns may exist regarding the proposed surface water swale that is proposed to convey stormwater across the open space tract, and down along the slope face, to an existing drainage ditch near the southwest corner of the project site. Based on the scale of the slope, extent of the swale, anticipated outfall location, and known site conditions, we do not anticipate the swale or transient stormwater passing through will impact the stability of the site slope, or infiltration facility function, so long as the swale incorporates appropriate energy reducing features, such as filter fabric and quarry spall lining in its design.

Appendix A. REGIONAL & SITE VICINITY MAPS

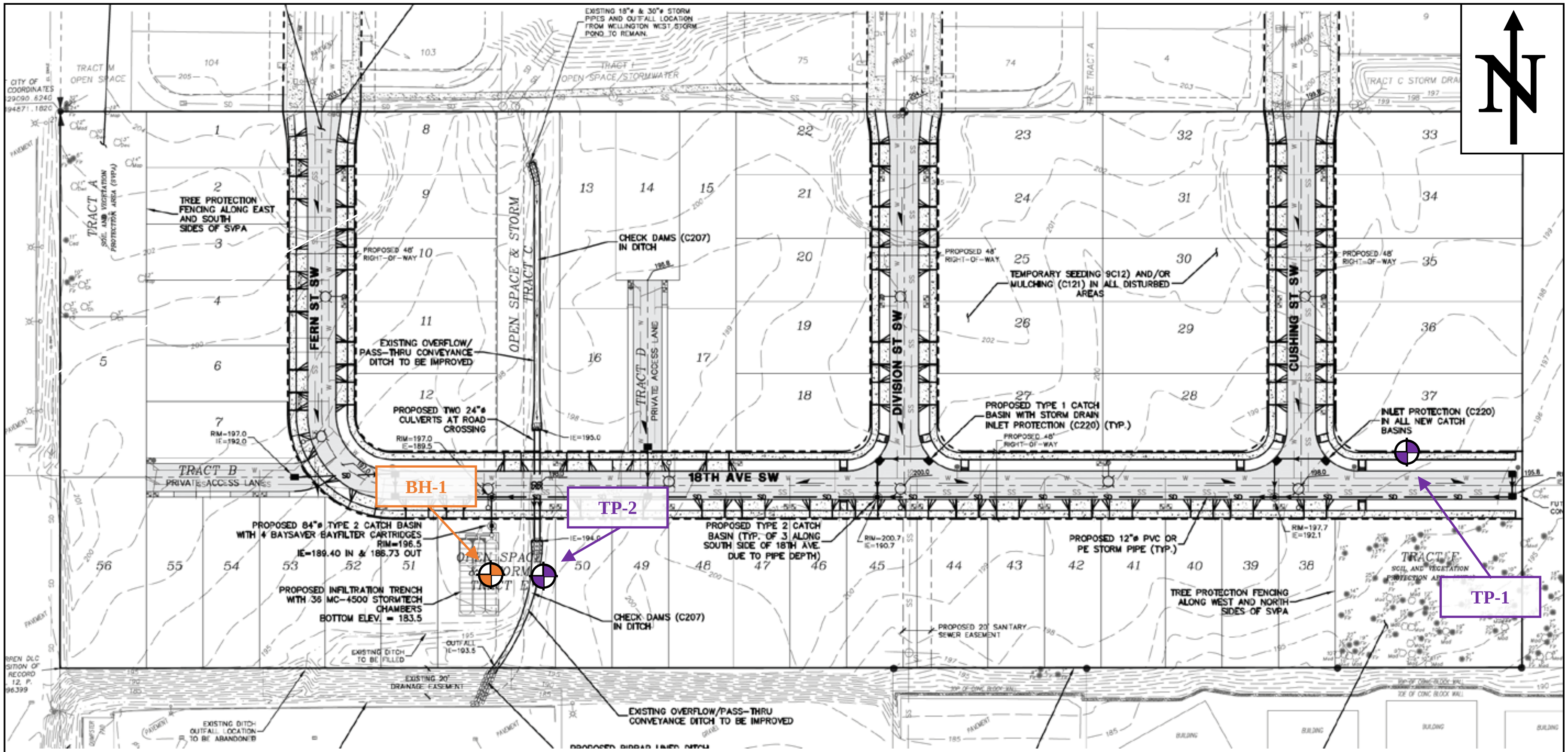




Locations are approximate ***Not for Construction***	Maps Source: Google Imagery 2018

Materials Testing & Consulting, Inc. 2118 Black Lake Blvd SW Olympia, WA 98512	**Regional & Site Vicinity Maps** Wellington Heights New Subdivision	**FIGURE** **1**

Appendix B. SITE MAP & EXPLORATION LOCATIONS



0 150
SCALE (FEET)

SCALE IS APPROXIMATE
*** Not for Construction ***

Map Source: Olympic Engineering (11/20/17)

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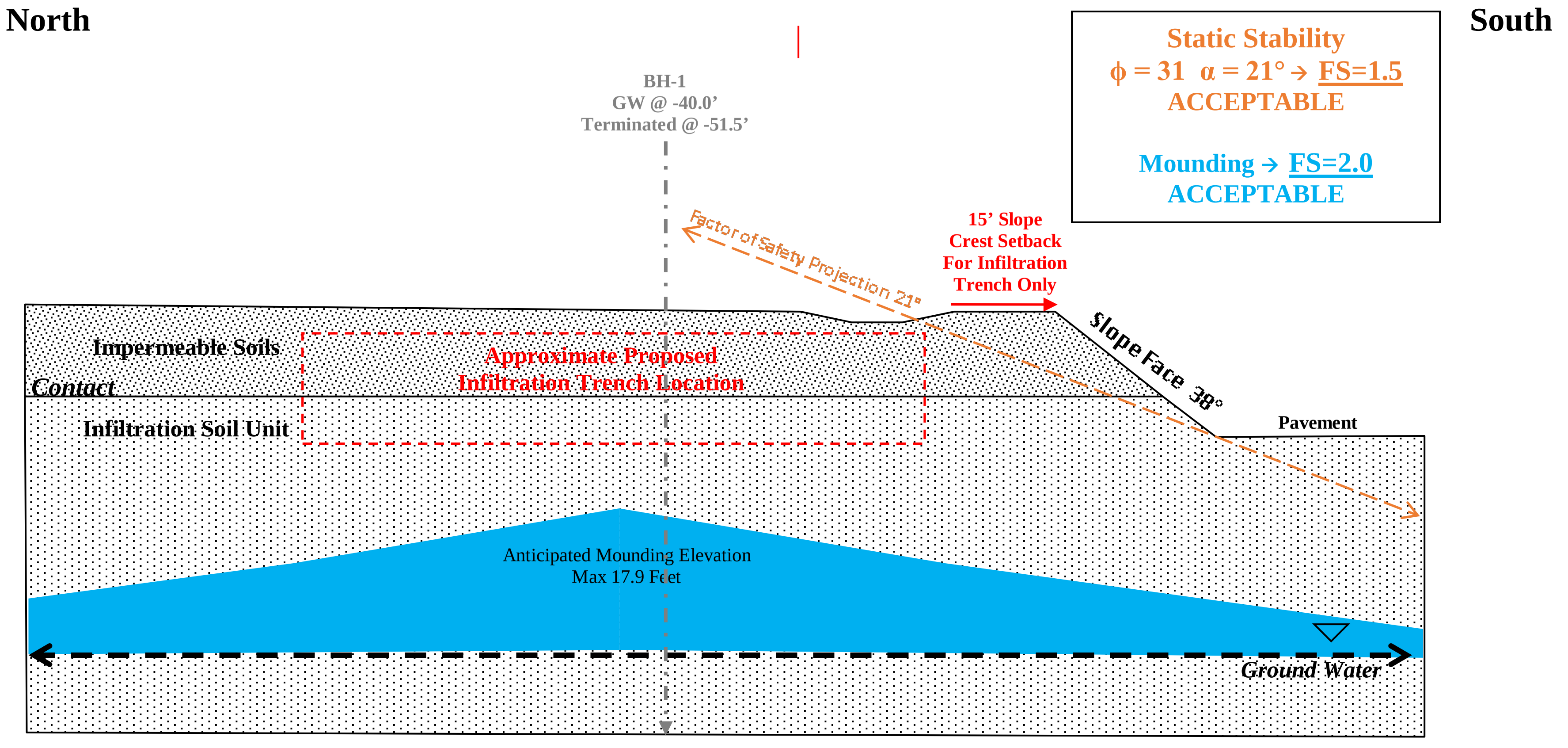
Olympia, WA 98512

Site Map with Exploration Locations
Wellington Heights
New Subdivision

FIGURE
2

Appendix C. SLOPE PROFILES



Static Stability
ϕ = 31 α = 21° → FS=1.5
ACCEPTABLE

Mounding → FS=2.0
ACCEPTABLE

SCALE IS APPROXIMATE
(Based on site visual estimates and mapped topography)
*** Not for Construction ***

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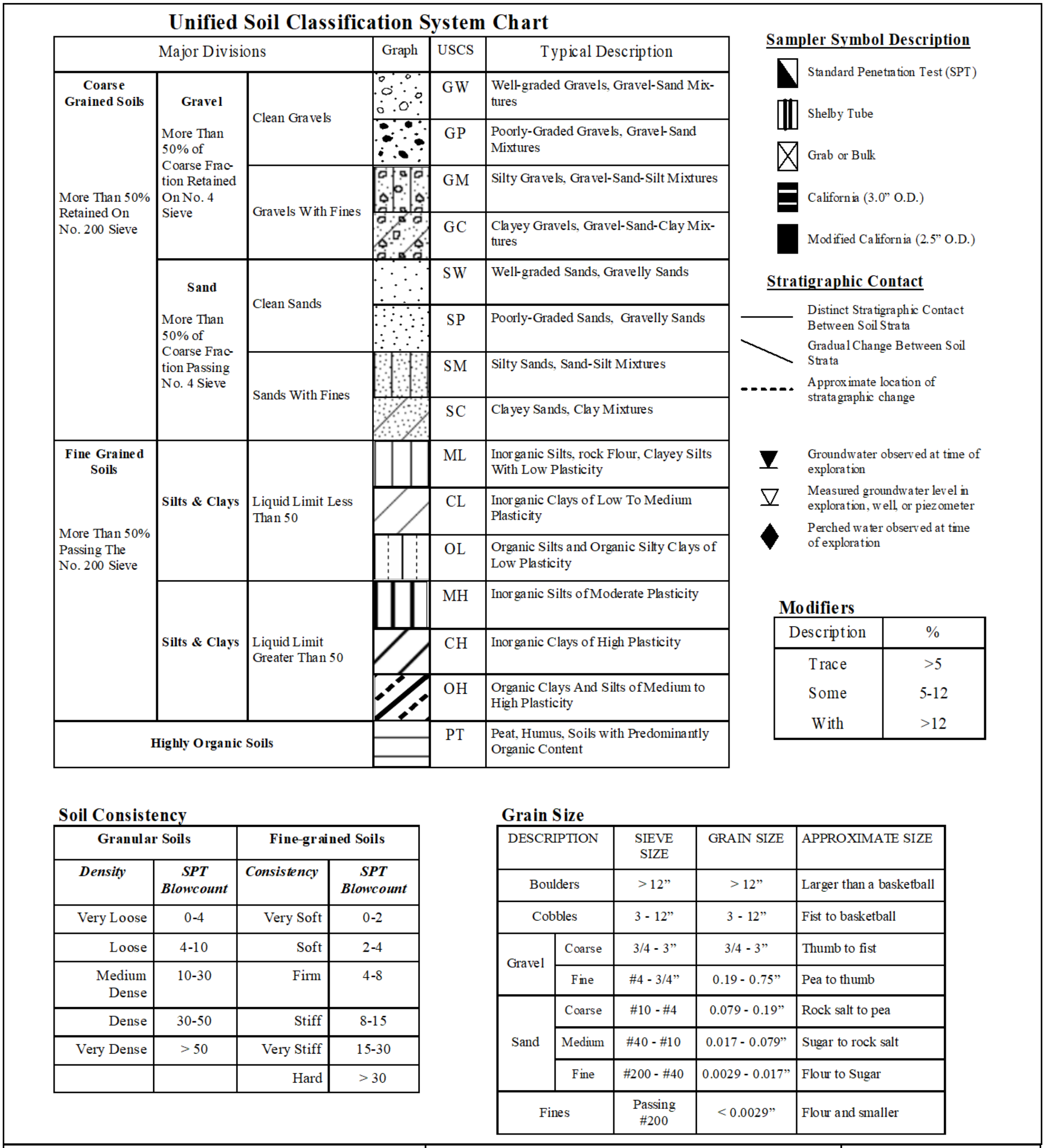
Critical Slope Stability Profile (Profile SP-A)
Existing Conditions
Static Scenario

FIGURE
3

Appendix D. EXPLORATION LOGS



Unified Soil Classification System Chart

Major Divisions			Graph	USCS	Typical Description
Coarse Grained Soils More Than 50% Retained On No. 200 Sieve	**Gravel** More Than 50% of Coarse Fraction Retained On No. 4 Sieve	Clean Gravels		GW	Well-graded Gravels, Gravel-Sand Mixtures
				GP	Poorly-Graded Gravels, Gravel-Sand Mixtures
		Gravels With Fines		GM	Silty Gravels, Gravel-Sand-Silt Mixtures
				GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	Sand More Than 50% of Coarse Fraction Passing No. 4 Sieve	Clean Sands		SW	Well-graded Sands, Gravelly Sands
				SP	Poorly-Graded Sands, Gravelly Sands
		Sands With Fines		SM	Silty Sands, Sand-Silt Mixtures
				SC	Clayey Sands, Clay Mixtures
Fine Grained Soils More Than 50% Passing The No. 200 Sieve	**Silts & Clays**	Liquid Limit Less Than 50		ML	Inorganic Silts, rock Flour, Clayey Silts With Low Plasticity
				CL	Inorganic Clays of Low To Medium Plasticity
				OL	Organic Silts and Organic Silty Clays of Low Plasticity
	Silts & Clays	Liquid Limit Greater Than 50		MH	Inorganic Silts of Moderate Plasticity
				CH	Inorganic Clays of High Plasticity
				OH	Organic Clays And Silts of Medium to High Plasticity
Highly Organic Soils				PT	Peat, Humus, Soils with Predominantly Organic Content

Sampler Symbol Description

◣	Standard Penetration Test (SPT)
▥	Shelby Tube
☒	Grab or Bulk
▤	California (3.0" O.D.)
■	Modified California (2.5" O.D.)

Stratigraphic Contact

—	Distinct Stratigraphic Contact Between Soil Strata
╲	Gradual Change Between Soil Strata
- - -	Approximate location of stratagraphic change
▼	Groundwater observed at time of exploration
▽	Measured groundwater level in exploration, well, or piezometer
◆	Perched water observed at time of exploration

Modifiers

Description	%
Trace	>5
Some	5-12
With	>12

Soil Consistency

Granular Soils		Fine-grained Soils	
Density	***SPT Blowcount***	***Consistency***	***SPT Blowcount***
Very Loose	0-4	Very Soft	0-2
Loose	4-10	Soft	2-4
Medium Dense	10-30	Firm	4-8
Dense	30-50	Stiff	8-15
Very Dense	> 50	Very Stiff	15-30
		Hard	> 30

Grain Size

DESCRIPTION		SIEVE SIZE	GRAIN SIZE	APPROXIMATE SIZE
Boulders		> 12"	> 12"	Larger than a basketball
Cobbles		3 - 12"	3 - 12"	Fist to basketball
Gravel	Coarse	3/4 - 3"	3/4 - 3"	Thumb to fist
	Fine	#4 - 3/4"	0.19 - 0.75"	Pea to thumb
Sand	Coarse	#10 - #4	0.079 - 0.19"	Rock salt to pea
	Medium	#40 - #10	0.017 - 0.079"	Sugar to rock salt
	Fine	#200 - #40	0.0029 - 0.017"	Flour to Sugar
Fines		Passing #200	< 0.0029"	Flour and smaller

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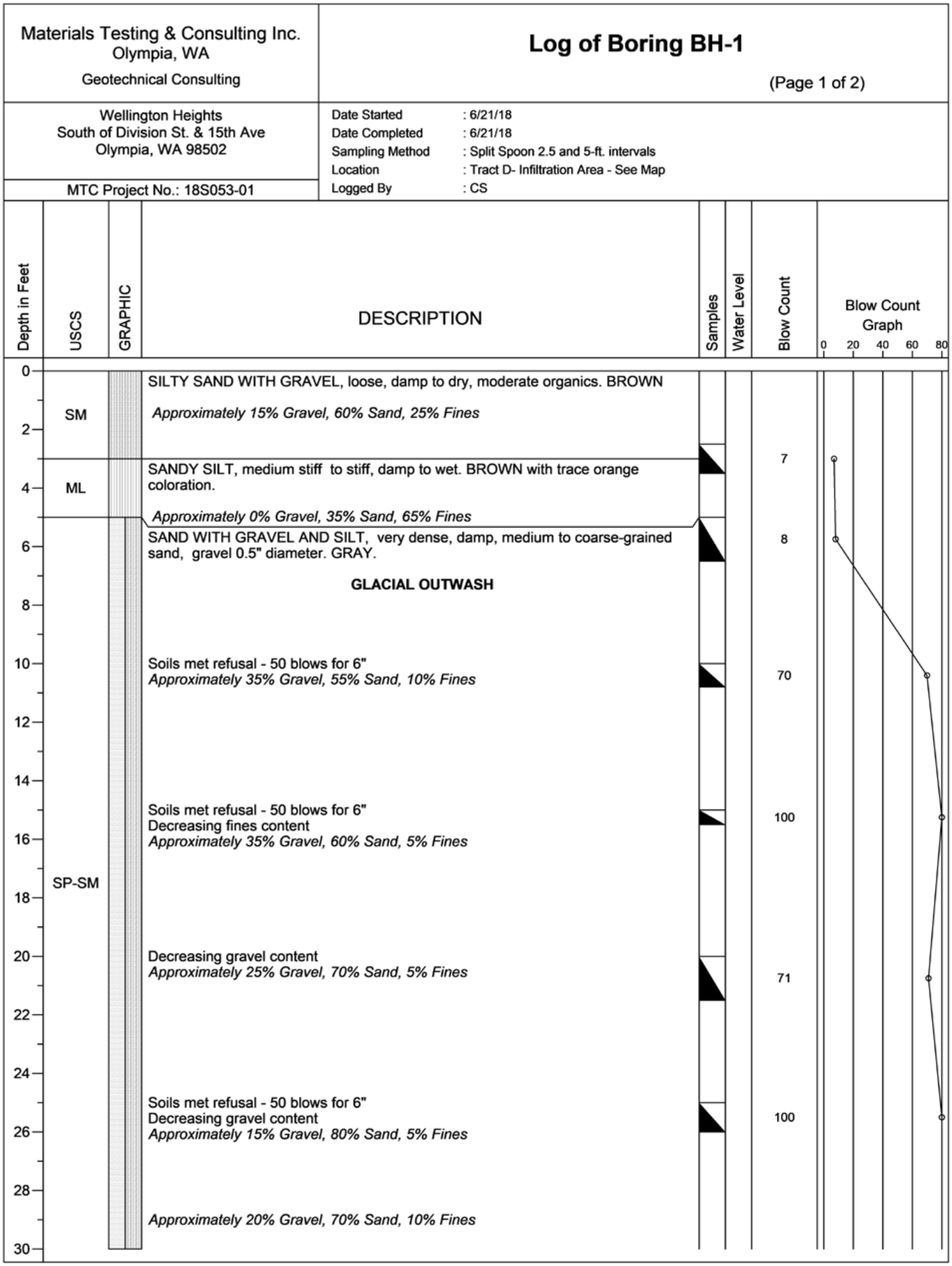
Exploration Log Key

FIGURE
5



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Log of Boring BH-1

(Page 1 of 2)

Wellington Heights
South of Division St. & 15th Ave
Olympia, WA 98502

MTC Project No.: 18S053-01

Date Started : 6/21/18
Date Completed : 6/21/18
Sampling Method : Split Spoon 2.5 and 5-ft. intervals
Location : Tract D- Infiltration Area - See Map
Logged By : CS

Depth in Feet	USCS	DESCRIPTION	Blow Count
0	SM	SILTY SAND WITH GRAVEL, loose, damp to dry, moderate organics. BROWN *Approximately 15% Gravel, 60% Sand, 25% Fines*	
3	ML	SANDY SILT, medium stiff to stiff, damp to wet. BROWN with trace orange coloration. *Approximately 0% Gravel, 35% Sand, 65% Fines*	7
5	SP-SM	SAND WITH GRAVEL AND SILT, very dense, damp, medium to coarse-grained sand, gravel 0.5" diameter. GRAY. **GLACIAL OUTWASH**	8
10		Soils met refusal - 50 blows for 6" *Approximately 35% Gravel, 55% Sand, 10% Fines*	70
15		Soils met refusal - 50 blows for 6" Decreasing fines content *Approximately 35% Gravel, 60% Sand, 5% Fines*	100
20		Decreasing gravel content *Approximately 25% Gravel, 70% Sand, 5% Fines*	71
25		Soils met refusal - 50 blows for 6" Decreasing gravel content *Approximately 15% Gravel, 80% Sand, 5% Fines*	100
29		*Approximately 20% Gravel, 70% Sand, 10% Fines*	

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Olympia, WA
Geotechnical Consulting

Log of Boring BH-1

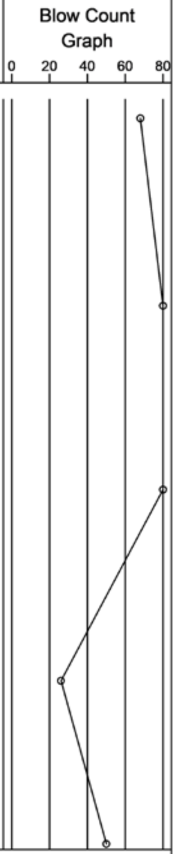
(Page 2 of 2)

Wellington Heights
South of Division St. & 15th Ave
Olympia, WA 98502

MTC Project No.: 18S053-01

Date Started : 6/21/18
Date Completed : 6/21/18
Sampling Method : Split Spoon 2.5 and 5-ft. intervals
Location : Tract D- Infiltration Area - See Map
Logged By : CS

Depth in Feet	USCS	DESCRIPTION	Water Level	Blow Count
30		SAND WITH GRAVEL AND SILT, very dense, damp, medium to coarse-grained sand, gravel 0.5" diameter. GRAY.		68
32		**GLACIAL OUTWASH**		
		Soils met refusal - 50 blows for 6" *Approximately 20% Gravel, 70% Sand, 10% Fines*		100
40	SP-SM	**Regional Water Table - Saturated Conditions** Soils met refusal - 50 blows for 4"	▼	100
		Decreasing gravel content *Approximately 10% Gravel, 85% Sand, 5% Fines*		
		Approximately 25% Gravel, 70% Sand, 5% Fines		26
		Soils met refusal - 50 blows for 6" *Limited Return*		50
50		Total Depth 50' Boring terminated at contracted depth. Groundwater and saturated conditions at 40 feet BPG.		



Materials Testing & Consulting, Inc.

Geotechnical Engineering

Log of Test Pit TP-1

Wellington Heights
S of Division St & 15th Ave
Olympia, WA 98502

MTC Project No.: 18S053

Date Started : February 27, 2018
Date Completed : February 27, 2018
Sampling Method : Grab Samples
Location : 100' N, 80' W of SE Corner
Logged By : KH

Depth in Feet	USCS	DESCRIPTION	Samples	Water Level
0	GM	SILTY GRAVEL with SAND, loose, roots and organics, damp. Medium BROWN. *Approximately 58.0% Gravel, 26.0% Sand, 14.0% Fines* Minor seepage at 3.0 feet		
5 10 15 20	GM	SILTY GRAVEL with SAND, dense, damp, cemented, minor cobbles. Medium GRAY. **(Glacial Till)** *Approximately 54.0% Gravel, 29.0% Sand, 17.0% Fines*		
25	SW-SC	*Sample No. S18-0252: 15.9% Gravel, 75.2% Sand, 8.9% Fines* SAND with SILTY CLAY and GRAVEL, medium dense, damp, gravel up to 2.0 inch diameter. Medium GRAY. **(Suspected Advanced Glacial Outwash)**	☒	
30		Total Depth:30.0 feet Test pit terminated at maximum equipment depth No groundwater encountered		

03-05-2018 C:\Documents and Settings\Luke McCann\Desktop\GeoGraphics logs\WellingtonInfiltration - TP-1 - KH.bor

Materials Testing & Consulting, Inc. Geotechnical Engineering	Log of Test Pit TP-2
Wellington Heights S of Division St & 15th Ave Olympia, WA 98502 MTC Project No.: 18S053	Date Started : February 27, 2018 Date Completed : February 27, 2018 Sampling Method : Grab Samples Location : 60' N, 360' E of SW Corner Logged By : KH

Depth in Feet	USCS	GRAPHIC	DESCRIPTION	Samples	Water Level
0	GM		SILTY GRAVEL with SAND, loose, damp, TOPSOIL. Medium BROWN. *Approximately 55.0% Gravel, 25.0% Sand, 20.0% Fines*		
5	SM-ML		SILTY SAND with GRAVEL to SILT, loose to medium dense, damp, interbedded coarse-grained and fine-grainedhorizons 0.5 to 2.0 feet in thickness. Medium BROWN. **(Suspected Recessional Glacial Outwash)** *Silty Sand with Gravel: Approximately 21.0% Gravel, 65.0% Sand, 14.0% Fines* *Silt: Approximately 0.0% Gravel, 4.0% Sand, 96.0% Fines* Minor seepage at 10 feet		
10	SP-SM		SAND with SILT and GRAVEL, poorly graded, medium dense, damp, gravel up to 2.0 inches in diameter, minor cobbles. Medium GRAY-BROWN. **(Suspected Advanced Glacial Outwash)**		
15			*Sample No. S18-0250: 40.8% Gravel, 51.9% Sand, 7.3% Fines*	☒	
20			Soil becomes sandier with depth		
			Sample No. S18-025: 21.4% Gravel, 75.3% Sand, 3.4% Fines	☒	
25			Total Depth:24.0 feet Test pit terminated at maximum equipment depth No groundwater encountered		
30					

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Appendix E. LABORATORY TEST RESULTS

Laboratory tests were conducted on several representative soil samples to better identify the soil classification of the units encountered and to evaluate the material's general physical properties and engineering characteristics. A brief description of the tests performed for this study is provided below. The results of laboratory tests performed on specific samples are provided at the appropriate sample depths on the individual boring logs. However, it is important to note that these test results may not accurately represent in situ soil conditions. All of our recommendations are based on our interpretation of these test results and their use in guiding our engineering judgment. MTC cannot be responsible for the interpretation of these data by others.

Soil samples for this project will be retained for a period of three months following completion of this report, unless we are otherwise directed in writing.

SOIL CLASSIFICATION

Soil samples were visually examined in the field by our representative at the time they were obtained. They were subsequently packaged and returned to our laboratory where they were reexamined and the original description checked and verified or modified. With the help of information obtained from the other classification tests, described below, the samples were described in general accordance with ASTM Standard D2487. The resulting descriptions are provided at the appropriate locations on the individual exploration logs, located in Appendix C, and are qualitative only.

GRAIN-SIZE DISTRIBUTION

Grain-size distribution analyses were conducted in general accordance with ASTM Standard D422 on representative soil samples to determine the grain-size distribution of the on-site soil. The information gained from these analyses allows us to provide a description and classification of the in-place materials. In turn, this information helps us to understand engineering properties of the soil and thus how the in-place materials will react to conditions such as heavy seepage, traffic action, loading, potential liquefaction, and so forth. The results are presented in this Appendix.

Sieve Report

Project: Wellington Infilltration
Project #: 18S053
Client: Tri Way Enterprises
Source: TP2 @ 15'
Sample#: S18-0250

Date Received: 27-Feb-18
Sampled By: KH
Date Tested: 28-Feb-18
Tested By: FP

ASTM D-2487 Unified Soils Classification System
SP-SM, Poorly graded Sand with Silt and Gravel
Sample Color:
Gray

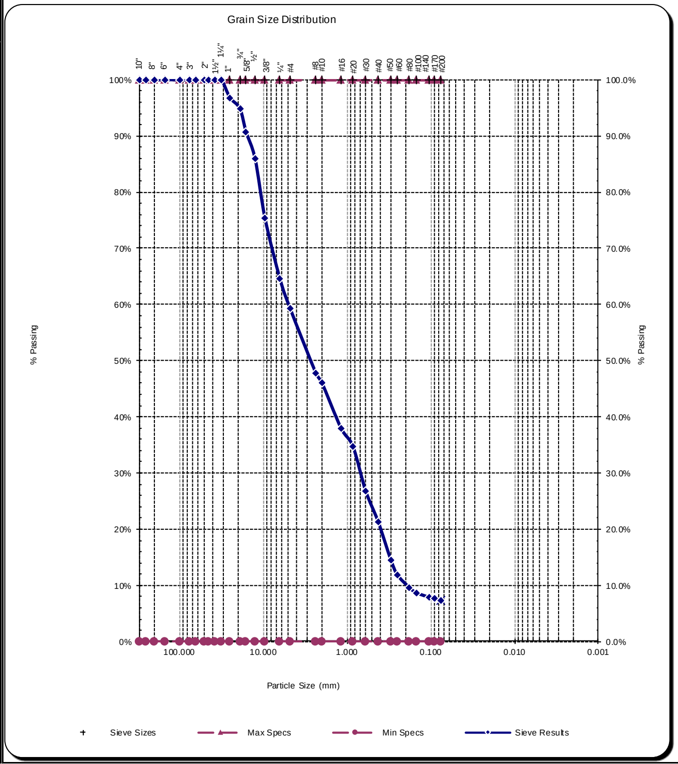
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.051 mm	% Gravel = 40.8%	Coeff. of Curvature, C_C = 0.51
$D_{(10)}$ = 0.192 mm	% Sand = 51.9%	Coeff. of Uniformity, C_U = 25.93
$D_{(15)}$ = 0.308 mm	% Silt & Clay = 7.3%	Fineness Modulus = 4.35
$D_{(30)}$ = 0.699 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 2.813 mm	Plasticity Index = n/a	Moisture %, as sampled = 7.4%
$D_{(60)}$ = 4.978 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 15.483 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 11/32	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50	100%	100%	100.0%	0.0%
1.00"	25.00	97%	97%	100.0%	0.0%
3/4"	19.00	95%	95%	100.0%	0.0%
5/8"	16.00	91%	91%	100.0%	0.0%
1/2"	12.50	86%	86%	100.0%	0.0%
3/8"	9.50	75%	75%	100.0%	0.0%
1/4"	6.30	65%	65%	100.0%	0.0%
#4	4.75	59%	59%	100.0%	0.0%
#8	2.36		48%	100.0%	0.0%
#10	2.00	46%	46%	100.0%	0.0%
#16	1.18		38%	100.0%	0.0%
#20	0.850	35%	35%	100.0%	0.0%
#30	0.600		27%	100.0%	0.0%
#40	0.425	21%	21%	100.0%	0.0%
#50	0.300		15%	100.0%	0.0%
#60	0.250	12%	12%	100.0%	0.0%
#80	0.180	10%	10%	100.0%	0.0%
#100	0.150	9%	9%	100.0%	0.0%
#140	0.106		8%	100.0%	0.0%
#170	0.090		8%	100.0%	0.0%
#200	0.075	7.3%	7.3%	100.0%	0.0%



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Sieve Report

Project:	Wellington Infilltration	**Date Received:**	27-Feb-18	**ASTM D-2487 Unified Soils Classification System**
Project #:	18S053	**Sampled By:**	KH	SP, Poorly graded Sand with Gravel
Client:	Tri Way Enterprises	**Date Tested:**	28-Feb-18	**Sample Color:**
Source:	TP2 @ 24'	**Tested By:**	FP	Gray
Sample#:	S18-0251			

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

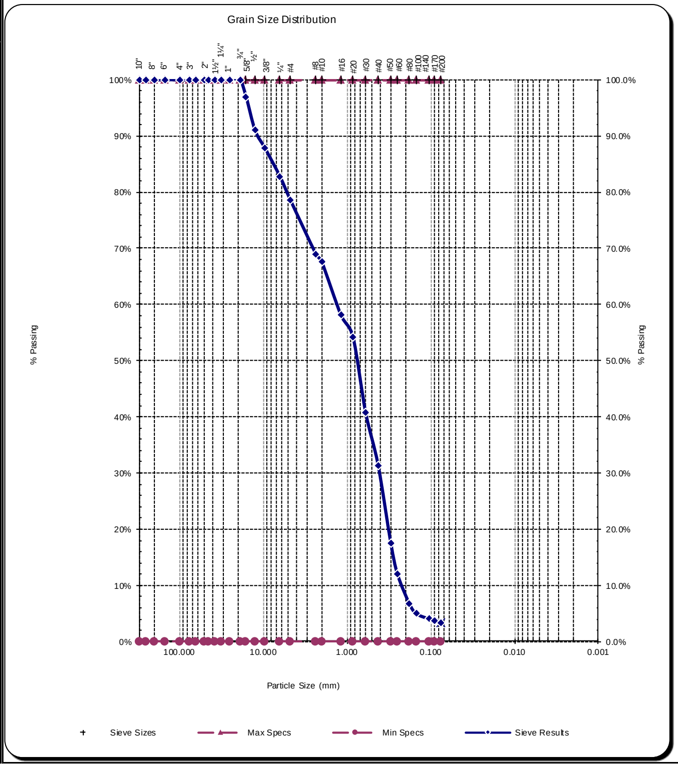
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.150	mm	% Gravel = 21.4%	Coeff. of Curvature, C_C = 0.57
$D_{(10)}$ = 0.223	mm	% Sand = 75.3%	Coeff. of Uniformity, C_U = 6.02
$D_{(15)}$ = 0.277	mm	% Silt & Clay = 3.4%	Fineness Modulus = 3.43
$D_{(30)}$ = 0.412	mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 0.770	mm	Plasticity Index = n/a	Moisture %, as sampled = 6.4%
$D_{(60)}$ = 1.344	mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 11.565	mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 8/75		Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00		100%	100.0%	0.0%
3/4"	19.00	100%	100%	100.0%	0.0%
5/8"	16.00	97%	97%	100.0%	0.0%
1/2"	12.50	91%	91%	100.0%	0.0%
3/8"	9.50	88%	88%	100.0%	0.0%
1/4"	6.30	83%	83%	100.0%	0.0%
#4	4.75	79%	79%	100.0%	0.0%
#8	2.36		69%	100.0%	0.0%
#10	2.00	68%	68%	100.0%	0.0%
#16	1.18		58%	100.0%	0.0%
#20	0.850	54%	54%	100.0%	0.0%
#30	0.600		41%	100.0%	0.0%
#40	0.425	31%	31%	100.0%	0.0%
#50	0.300		18%	100.0%	0.0%
#60	0.250	12%	12%	100.0%	0.0%
#80	0.180	7%	7%	100.0%	0.0%
#100	0.150	5%	5%	100.0%	0.0%
#140	0.106		4%	100.0%	0.0%
#170	0.090		4%	100.0%	0.0%
#200	0.075	3.4%	3.4%	100.0%	0.0%



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Sieve Report

Project: Wellington Infilltration
Project #: 18S053
Client: Tri Way Enterprises
Source: TP1 @ 24'
Sample#: S18-0252

Date Received: 27-Feb-18
Sampled By: KH
Date Tested: 28-Feb-18
Tested By: FP

ASTM D-2487 Unified Soils Classification System
SW-SC, Well-graded Sand with Silty Clay and Gravel
Sample Color:
Gray

ACCREDITED
Certificate #: 1366.01, 1366.02 & 1366.04

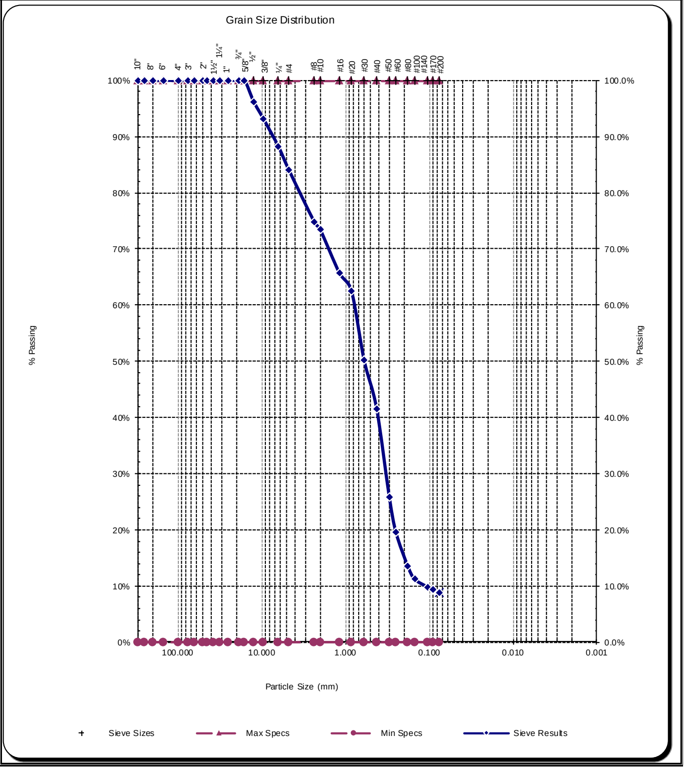
ASTM D-2216, ASTM D-2419, ASTM D-4318, ASTM D-5821

Specifications
No Specs
Sample Meets Specs ? N/A

$D_{(5)}$ = 0.042 mm	% Gravel = 15.9%	Coeff. of Curvature, C_C = 1.26
$D_{(10)}$ = 0.110 mm	% Sand = 75.2%	Coeff. of Uniformity, C_U = 7.23
$D_{(15)}$ = 0.197 mm	% Silt & Clay = 8.9%	Fineness Modulus = 2.95
$D_{(30)}$ = 0.333 mm	Liquid Limit = n/a	Plastic Limit = n/a
$D_{(50)}$ = 0.595 mm	Plasticity Index = n/a	Moisture %, as sampled = 8.3%
$D_{(60)}$ = 0.798 mm	Sand Equivalent = n/a	Req'd Sand Equivalent =
$D_{(90)}$ = 7.472 mm	Fracture %, 1 Face = n/a	Req'd Fracture %, 1 Face =
Dust Ratio = 3/14	Fracture %, 2+ Faces = n/a	Req'd Fracture %, 2+ Faces =

ASTM C-136, ASTM D-6913

Sieve Size US	Sieve Size Metric	Actual Cumulative Percent Passing	Interpolated Cumulative Percent Passing	Specs Max	Specs Min
12.00"	300.00		100%	100.0%	0.0%
10.00"	250.00		100%	100.0%	0.0%
8.00"	200.00		100%	100.0%	0.0%
6.00"	150.00		100%	100.0%	0.0%
4.00"	100.00		100%	100.0%	0.0%
3.00"	75.00		100%	100.0%	0.0%
2.50"	63.00		100%	100.0%	0.0%
2.00"	50.00		100%	100.0%	0.0%
1.75"	45.00		100%	100.0%	0.0%
1.50"	37.50		100%	100.0%	0.0%
1.25"	31.50		100%	100.0%	0.0%
1.00"	25.00		100%	100.0%	0.0%
3/4"	19.00		100%	100.0%	0.0%
5/8"	16.00	100%	100%	100.0%	0.0%
1/2"	12.50	96%	96%	100.0%	0.0%
3/8"	9.50	93%	93%	100.0%	0.0%
1/4"	6.30	88%	88%	100.0%	0.0%
#4	4.75	84%	84%	100.0%	0.0%
#8	2.36		75%	100.0%	0.0%
#10	2.00	73%	73%	100.0%	0.0%
#16	1.18		66%	100.0%	0.0%
#20	0.850	63%	63%	100.0%	0.0%
#30	0.600		50%	100.0%	0.0%
#40	0.425	42%	42%	100.0%	0.0%
#50	0.300		26%	100.0%	0.0%
#60	0.250	20%	20%	100.0%	0.0%
#80	0.180	13%	13%	100.0%	0.0%
#100	0.150	11%	11%	100.0%	0.0%
#140	0.106		10%	100.0%	0.0%
#170	0.090		9%	100.0%	0.0%
#200	0.075	8.9%	8.9%	100.0%	0.0%



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Appendix 4
SWPPP

CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

FOR

WELLINGTON HEIGHTS

TPN's: 59000200100, 59000200400, 59000200600, 59000200900, 59000400100, 59000400600, 59000400800, 59000300100, 59000500100, 59000600100, 59000700100, 59000700300

Unassigned 18th Ave. NW
Olympia, WA 98502

Prepared by:

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All new development and redevelopment projects are responsible for preventing erosion and discharge of sediment and other pollutants into receiving waters.

General Requirements

Clearing and grading activities for developments shall be permitted only if conducted pursuant to an approved site development plan (e.g., subdivision approval) that establishes permitted areas of clearing, grading, cutting, and filling. These permitted clearing and grading areas and any other areas required to preserve critical or sensitive areas, buffers, native growth protection easements, or tree retention areas shall be delineated on the site plans and the development site.

The SWPPP shall be implemented beginning with initial land disturbance and until final stabilization. Sediment and Erosion control BMPs shall be consistent with the BMPs contained in chapters 3 and 4 of Volume II.

Seasonal Work Limitations - From October 15 through April 1, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:

1. Site conditions including existing vegetative coverage, slope, soil type and proximity to receiving waters.
2. Limitations on activities and the extent of disturbed areas.
3. Proposed erosion and sediment control measures.

Note that projects performing work under a NPDES Construction Stormwater General Permit issued by Ecology may have more restrictive seasonal work limitations.

Project Requirements - Construction SWPPP Elements

In most cases, all of the following elements shall apply and be implemented throughout construction. Self-contained sites (discharges only to groundwater) must comply with all elements with the exception of Element 3: Control Flow Rates.

Element 1: Preserve Vegetation/Mark Clearing Limits

- Before beginning land disturbing activities, including clearing and grading, clearly mark all clearing limits, sensitive areas and their buffers, and trees that are to be preserved within the construction area.
- Retain the duff layer, native top soil, and natural vegetation in an undisturbed state to the maximum degree practicable.

Element 2: Establish Construction Access

- Limit construction vehicle access and exit to one route, if possible.
- Stabilize access points with a pad of quarry spalls, crushed rock, or other equivalent BMPs, to minimize tracking of sediment onto public roads.
- Locate wheel wash or tire baths on site, if the stabilized construction entrance is not effective in preventing tracking sediment onto roads.
- If sediment is tracked off site, clean the affected roadway thoroughly at the end of each day, or more frequently as necessary (for example, during wet weather). Remove sediment from roads by shoveling, sweeping, or pick up and transport the sediment to a controlled sediment disposal area.
- Conduct street washing only after sediment is removed in accordance with the above bullet.
- Control street wash wastewater by pumping back on-site, or otherwise prevent it from discharging into systems tributary to waters of the State.

Element 3: Control Flow Rates

- Protect properties and waterways downstream of development sites from erosion and the associated discharge of turbid waters due to increases in the velocity and peak volumetric flow rate of stormwater runoff from the project site.
- Where necessary to comply with the bullet above, construct stormwater retention or detention facilities as one of the first steps in grading. Assure that detention facilities function properly before constructing site improvements (e.g. impervious surfaces).
- If permanent infiltration ponds are used for flow control during construction, protect these facilities from siltation during the construction phase.

Element 4: Install Sediment Controls

- Design, install, and maintain effective erosion controls and sediment controls to minimize the discharge of pollutants.
- Construct sediment control BMPs (sediment ponds, traps, filters, etc.) as one of the first steps in grading. These BMPs shall be functional before other land disturbing activities take place.
- Minimize sediment discharges from the site. The design, installation and maintenance of erosion and sediment controls must address factors such as the amount, frequency, intensity and duration of precipitation, the nature of resulting stormwater runoff, and soil characteristics, including the range of soil particle sizes expected to be present on the site.
- Direct stormwater runoff from disturbed areas through a sediment pond or other appropriate sediment removal BMP, before the runoff leaves a construction site or before discharge to an infiltration facility. Runoff from fully stabilized areas may be discharged without a sediment removal BMP, but must meet the flow control performance standard in Element #3, bullet #1.
- Locate BMPs intended to trap sediment on-site in a manner to avoid interference with the movement of juvenile salmonids attempting to enter off-channel areas or drainages.

- Where feasible, design outlet structures that withdraw impounded stormwater from the surface to avoid discharging sediment that is still suspended lower in the water column.

Element 5: Stabilize Soils

- Stabilize exposed and unworked soils by application of effective BMPs that prevent erosion. Applicable BMPs include, but are not limited to: temporary and permanent seeding, sodding, mulching, plastic covering, erosion control fabrics and matting, soil application of polyacrylamide (PAM), the early application of gravel base early on areas to be paved, and dust control.
- Control stormwater volume and velocity within the site to minimize soil erosion.
- Control stormwater discharges, including both peak flow rates and total stormwater volume, to minimize erosion at outlets and to minimize downstream channel and stream bank erosion.
- Soils must not remain exposed and unworked for more than the time periods set forth below to prevent erosion: • During the dry season (April 2 – October 14): 7 days
- During the wet season (October 15 - April 1): 2 days
- Note that projects performing work under a NPDES Construction Stormwater General Permit issued by Ecology will have more restrictive time periods.
- Stabilize soils at the end of the shift before a holiday or weekend if needed based on the weather forecast.
- Stabilize soil stockpiles from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways and drainage channels.
- Minimize the amount of soil exposed during construction activity.
- Minimize the disturbance of steep slopes.
- Minimize soil compaction and, unless infeasible, preserve topsoil.

Element 6: Protect Slopes

- Design and construct cut-and-fill slopes in a manner to minimize erosion. Applicable practices include, but are not limited to, reducing continuous length of slope with terracing and diversions, reducing slope steepness, and roughening slope surfaces (for example, track walking).
- Divert off-site stormwater (run-on) or ground water away from slopes and disturbed areas with interceptor dikes, pipes and/or swales. Off-site stormwater should be managed separately from stormwater generated on the site.
- At the top of slopes, collect drainage in pipe slope drains or protected channels to prevent erosion. • Temporary pipe slope drains must handle the peak 10-minute velocity of flow from a Type 1A, 10-year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year and 1-hour flow rate predicted by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition,

whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped" area.

- Place excavated material on the uphill side of trenches, consistent with safety and space considerations.
- Place check dams at regular intervals within constructed channels that are cut down a slope.

Element 7: Protect Drain Inlets

- Protect all storm drain inlets made operable during construction so that stormwater runoff shall not enter the conveyance system without first being filtered or treated to remove sediment.
- Clean or remove and replace inlet protection devices when sediment has filled one-third of the available storage (unless a different standard is specified by the product manufacturer).

Element 8: Stabilize Channels and Outlets

- Design, construct, and stabilize all on-site conveyance channels to prevent erosion from the following expected peak flows: • Channels must handle the peak volumetric flow rate calculated using a 10-minute time step from a Type 1A, 10- year, 24-hour frequency storm for the developed condition. Alternatively, the 10-year, 1-hour flow rate indicated by an approved continuous runoff model, increased by a factor of 1.6, may be used. The hydrologic analysis must use the existing land cover condition for predicting flow rates from tributary areas outside the project limits. For tributary areas on the project site, the analysis must use the temporary or permanent project land cover condition, whichever will produce the highest flow rates. If using the Western Washington Hydrology Model (WWHM) to predict flows, bare soil areas should be modeled as "landscaped area.
- Provide stabilization, including armoring material, adequate to prevent erosion of outlets, adjacent stream banks, slopes and downstream reaches at the outlets of all conveyance systems.

Element 9: Control Pollutants

- Design, install, implement and maintain effective pollution prevention measures to minimize the discharge of pollutants.
- Handle and dispose of all pollutants, including waste materials and demolition debris that occur on-site in a manner that does not cause contamination of stormwater.
- Provide cover, containment, and protection from vandalism for all chemicals, liquid products, petroleum products, and other materials that have the potential to pose a threat to human health or the environment. On-site fueling tanks must include secondary containment. Secondary containment means placing tanks or containers within an impervious structure capable of containing 110% of the volume contained in the largest take within the containment structure. Double-walled tanks do not require additional secondary containment.

- Conduct maintenance, fueling, and repair of heavy equipment and vehicles using spill prevention and control measures. Clean contaminated surfaces immediately following any spill incident.
- Discharge wheel wash or tire bath wastewater to a separate on-site treatment system that prevents discharge to surface water, such as closed-loop recirculation or upland application, or to the sanitary sewer, with local sewer district approval.
- Apply fertilizers and pesticides in a manner and at application rates that will not result in loss of chemical to stormwater runoff. Follow manufacturers' label requirements for application rates and procedures.
- Use BMPs to prevent contamination of stormwater runoff by pH modifying sources. The sources for this contamination include, but are not limited to: bulk cement, cement kiln dust, fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, dewatering concrete vaults, concrete pumping and mixer washout waters.
- Adjust the pH of stormwater if necessary to prevent violations of water quality standards.
- Assure that washout of concrete trucks is performed off-site or in designated concrete washout areas only. Do not wash out concrete trucks onto the ground, or into storm drains, open ditches, streets, or streams. Do not dump excess concrete on-site, except in designated concrete washout areas. Concrete spillage or concrete discharge to surface waters of the State is prohibited.
- Obtain written approval from Ecology before using chemical treatment other than CO2 or dry ice to adjust pH.

Element 10: Control De-Watering

- Discharge foundation, vault, and trench de-watering water, which has similar characteristics to stormwater runoff at the site, into a controlled conveyance system before discharge to a sediment trap or sediment pond.
- Discharge clean, non-turbid de-watering water, such as well-point ground water, to systems tributary to, or directly into surface waters of the State, as specified in Element #8, provided the de-watering flow does not cause erosion or flooding of receiving waters. Do not route clean dewatering water through stormwater sediment ponds. Note that "surface waters of the State" may exist on a construction site as well as off site; for example, a creek running through a site.
- Handle highly turbid or otherwise contaminated dewatering water separately from stormwater.
- Other treatment or disposal options may include:

    1. Infiltration.
    2. Transport off-site in a vehicle, such as a vacuum flush truck, for legal disposal in a manner that does not pollute state waters.
    3. Ecology-approved on-site chemical treatment or other suitable treatment technologies.
    4. Sanitary or combined sewer discharge with local sewer district approval, if there is no other option.

5. Use of a sedimentation bag that discharges to a ditch or swale for small volumes of localized dewatering.

Element 11: Maintain BMPs

- Maintain and repair all temporary and permanent erosion and sediment control BMPs as needed to assure continued performance of their intended function in accordance with BMP specifications.
- Remove all temporary erosion and sediment control BMPs within 30 days after achieving final site stabilization or after the temporary BMPs are no longer needed.

Element 12: Manage The Project

- Phase development projects to the maximum degree practicable and take into account seasonal work limitations.
- Inspection and monitoring – Inspect, maintain and repair all BMPs as needed to assure continued performance of their intended function. Projects regulated under the Construction Stormwater General Permit must conduct site inspections and monitoring in accordance with Special Condition S4 of the Construction Stormwater General Permit.
- Maintaining an updated construction SWPPP – Maintain, update, and implement the SWPPP.
- Projects that disturb one or more acres must have site inspections conducted by a Certified Erosion and Sediment Control Lead (CESCL). Project sites disturbing less than one acre may have a CESCL or a person without CESCL certification conduct inspections. By the initiation of construction, the SWPPP must identify the CESCL or inspector, who must be present on-site or on-call at all times.
- The CESCL or inspector (project sites less than one acre) must have the skills to assess the:

    1. Site conditions and construction activities that could impact the quality of stormwater.
    2. Effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.

- The CESCL or inspector must examine stormwater visually for the presence of suspended sediment, turbidity, discoloration, and oil sheen. They must evaluate the effectiveness of BMPs and determine if it is necessary to install, maintain, or repair BMPs to improve the quality of stormwater discharges.
- Based on the results of the inspection, construction site operators must correct the problems identified by: • Reviewing the SWPPP for compliance with the 13 construction SWPPP elements and making appropriate revisions within <u>seven (7) calendar days</u> of the inspection.
- Immediately beginning the process of fully implementing and maintaining appropriate source control and/or treatment BMPs as soon as possible, addressing the problems not later than within 10 days of the inspection. If installation of necessary treatment BMPs is not feasible within 10 days, the construction site operator may request an extension within the initial 10-day response period.

- Documenting BMP implementation and maintenance in the site log book (sites larger than 1 acre).
- The CESCL or inspector must inspect all areas disturbed by construction activities, all BMPs, and all stormwater discharge points at least once every calendar week and within 24 hours of any discharge from the site. (For purposes of this condition, individual discharge events that last more than one day do not require daily inspections. For example, if a stormwater pond discharges continuously over the course of a week, only one inspection is required that week.) The CESCL or inspector may reduce the inspection frequency for temporary stabilized, inactive sites to once every calendar month.

Element 13: Protect Low Impact Development BMPs

- Protect all Bioretention and Rain Garden BMPs from sedimentation through installation and maintenance of erosion and sediment control BMPs on portions of the site that drain into the Bioretention and/or Rain Garden BMPs. Restore the BMPs to their fully functioning condition if they accumulate sediment during construction. Restoring the BMP must include removal of sediment and any sediment-laden Bioretention/rain garden soils, and replacing the removed soils with soils meeting the design specification.
- Prevent compacting Bioretention and rain garden BMPs by excluding construction equipment and foot traffic. Protect completed lawn and landscaped areas from compaction due to construction equipment.
- Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Do not allow sediment-laden runoff onto permeable pavements or base materials.
- Pavement fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures in accordance with this manual or the manufacturer’s procedures.
- Keep all heavy equipment off existing soils under LID facilities that have been excavated to final grade to retain the infiltration rate of the soils.

Objective

To control erosion and prevent sediment and other pollutants from leaving the site during the construction phase of a project. To have fully functional stormwater facilities and BMPs for the developed site upon completion of construction.

Supplemental Guidelines

If a Construction SWPPP is found to be inadequate (with respect to erosion and sediment control requirements), then the Plan Approval Authority within the City shall require that other BMPs be implemented, as appropriate.

The Plan Approval Authority may allow development of generic Construction SWPPP’s that apply to commonly conducted public road activities, such as road surface replacement, that trigger this core requirement. They may also develop an abbreviated SWPPP format for project sites that will disturb less than 1 acre.

Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance. The local permitting authority shall take enforcement action - such as a notice of violation, administrative order, penalty, or stop-work order under the following circumstances:

- If, during the course of any construction activity or soil disturbance during the seasonal limitation period, sediment leaves the construction site causing a violation of the surface water quality standard; or
- If clearing and grading limits or erosion and sediment control measures shown in the approved plan are not maintained.

Coordination with Utilities and Other Contractors - The primary project proponent shall evaluate, with input from utilities and other contractors, the stormwater management requirements for the entire project, including the utilities, when preparing the Construction SWPPP.