1st Review
PRGR20230972
July 2023

Drainage Report and Stormwater Pollution Prevention Plan

East Town Crossing

City of Puyallup, Washington
Parcel No. 0420264021, 0420264053, 0420264053, 0420351066, 0420351030, 0420351029, 0420351026

6/29/2023

See Civil application PRCCP20230970 for review comments associated with the stormwater report. Incorporate those comments into the CFG design as appropriate.
[Storm Report; Pg 1 of 164]

Project Address: 1001 Shaw Road
Puyallup, WA 98372

Property Owner:
East Town Crossing LLC
Contact: Greg Helle

Engineer: McInnis Engineering, LLC
202 E 34th Street
Tacoma, WA 98404
Contact: Will McInnis

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Project Engineer's Certification:

"I hereby state that this Storm Drainage Report and Stormwater Pollution Prevention Plan for the East Town Crossing project has been prepared by me or under my supervision and meets the standard of care and expertise which is usual and customary in this community for professional engineers. I understand that City of Puyallup does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities prepared by me."

6/29/2023

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Section 1: Proposed Project Description

The project address is 1001 Shaw Road, Puyallup, WA 98372. Parcel Numbers 0420264021, 0420264053, 0420264053, 0420351066, 0420351030, 0420351029, 0420351026. See Figure 1: Vicinity Map in Appendix A for a vicinity map showing the site in context. The project will include a commercial area containing 2 commercial buildings, and 5 multifamily buildings totaling 120 units.

This storm report details the proposed stormwater plans and the calculations to support the design. The breakdown of impervious surfaces pre and post developed is shown below in Table 1.

Table 1: Impervious/ Pervious Areas

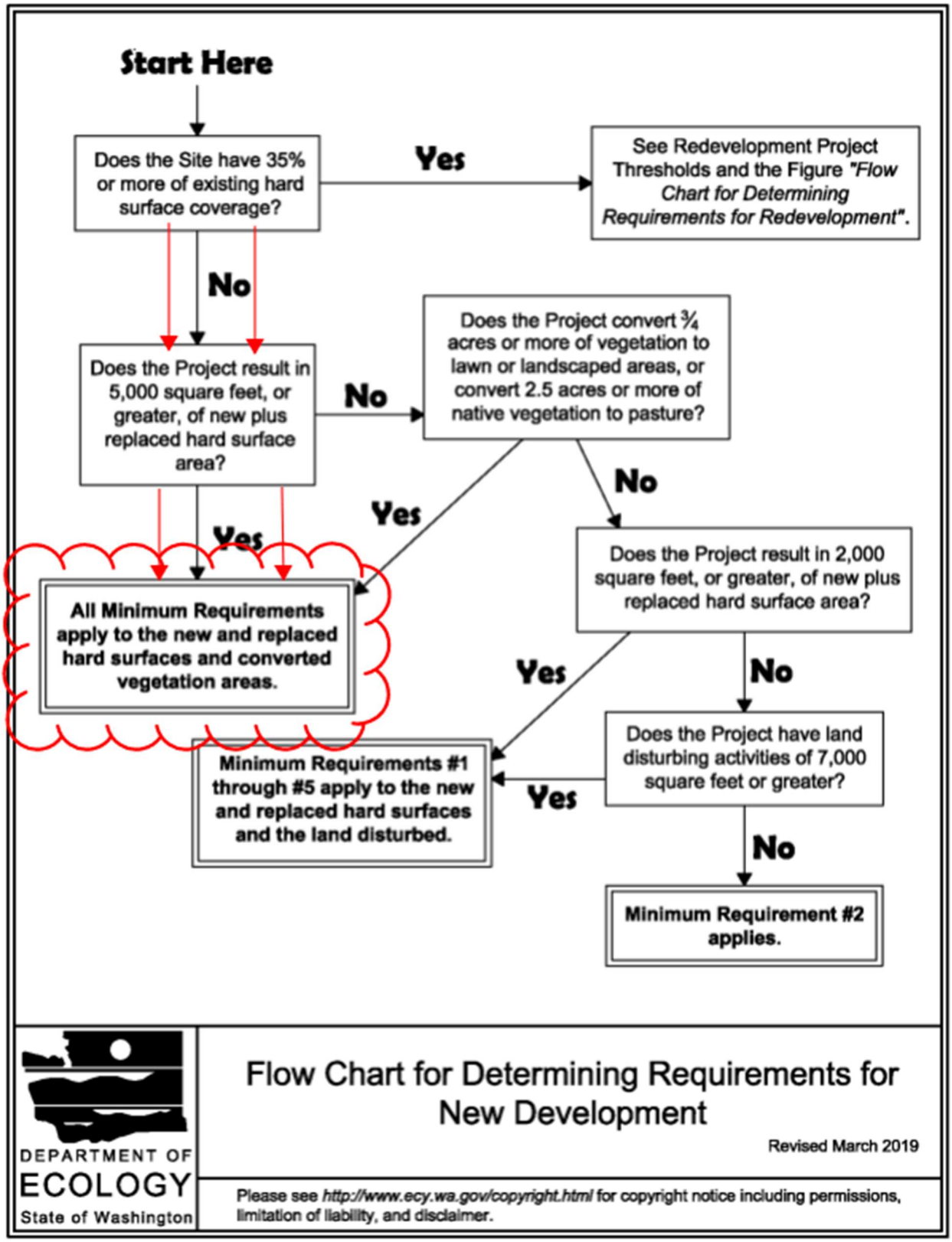
Project Land Use	Existing Area (Acres)	Proposed Area (Acres)	Area Change (Acres)	Frontage Improvement Area (Acres)
Roof	0	1.39	1.39	-
Driveway/Parking /Walkway	0	2.98	2.98	-
Concrete Walkways	0	0.76	0.78	
Undisturbed/Landscaping	10.36	5.23	-5.13	-
Total Impervious	0	5.13	5.13	0.74
Total Pervious	10.36	5.23	-5.13	0.18 (includes porous hard surfaces from Shaw Road Frontage)

Section 2: Existing Conditions Description

In existing conditions, the land is grassy with a network of existing dirt/gravel access roads. The existing site has been filled in the recent past. It also houses a stormwater pond serving the nearby Absher Construction office complex.

Compliance with Minimum Requirement

The proposed project improvements consist of approximately 5.13 acres of new hard surfaces and will result in coverage of 49% of the project area being covered by impervious surfaces. Per the 2019 Ecology Stormwater Management Manual as adapted by the City of Puyallup, this project must comply with all minimum requirements 1-9. See flowchart below:


Start Here
Does the Site have 35% or more of existing hard surface coverage?
Yes
See Redevelopment Project Thresholds and the Figure "Flow Chart for Determining Requirements for Redevelopment".
No
Does the Project result in 5,000 square feet, or greater, of new plus replaced hard surface area?
No
Does the Project convert ¾ acres or more of vegetation to lawn or landscaped areas, or convert 2.5 acres or more of native vegetation to pasture?
No
Yes
Yes
Does the Project result in 2,000 square feet, or greater, of new plus replaced hard surface area?
All Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas.
Yes
No
Does the Project have land disturbing activities of 7,000 square feet or greater?
Minimum Requirements #1 through #5 apply to the new and replaced hard surfaces and the land disturbed.
Yes
No
Minimum Requirement #2 applies.
DEPARTMENT OF ECOLOGY
State of Washington
Flow Chart for Determining Requirements for New Development
Revised March 2019
Please see http://www.ecy.wa.gov/copyright.html for copyright notice including permissions, limitation of liability, and disclaimer.

Minimum Requirement # 1: Preparation of Stormwater Site Plan

A stormwater site plan has been prepared to provide water quality and flow control to the site and will be submitted with this report. See Figure 4: Grading and Drainage Plan in Appendix A.

Minimum Requirement # 2: Construction Stormwater Pollution Prevention

A temporary erosion and sediment control plan is part of the construction documents provided with this report and Figure 3: Temporary Erosion and Sediment Control Plan is included in Appendix A.

See below for how each of the 13 elements of the Stormwater Pollution Prevention Plan (SWPPP) are addressed as follows.

Element # 1: Preserve vegetation/mark clearing limits

- Clearing limits are shown on the plan and as noted, they shall be marked using high visibility plastic fencing. All vegetated areas outside the marked clearing limits shall be preserved in existing conditions.

Element # 2: Established Construction Entrance

- As shown on the plans, a construction entrance is provided at the north east corner of the site off of Pioneer per City of Puyallup standards.

Element # 3: Control Flow Rates

- Straw wattles shall be provided to prevent erosion and control flow rates leaving the site. The velocity of water leaving the site shall not exceed 3 ft/s if the discharge is to a stream or a ditch. A temporary sediment pond has been designed to meet the 2-year flow and will control drainage leaving the site to the outfall in Pioneer.

Element # 4: Install Sediment Control

- Silt fence will be placed along all the downgradient boundaries of the proposed project limits to remove any sediment laden runoff from leaving the site, as shown on plans. The contractor needs to protect all catch basins and adjust silt fencing as necessary to keep sediment laden runoff onsite. A temporary

sediment pond has been designed to meet the 2-year flow and will help remove sediment from the runoff.

Element # 5: Stabilize Soils

o Per the standard erosion control notes provided on the plans, all exposed soils shall be hydroseeded and exposed soils shall be covered if left unworked for a period of 7 days between May 1st- September 30th and for a period of 2 days between October 1st and April 30th.

Element # 6: Protect Slopes

o The site has flat slopes of 0-3% on the majority of the site. No slopes over 20% are being disturbed. All exposed soils not covered by the buildings, roadway, or sidewalks will be hydroseeded, and there will be no slopes greater than 2:1. Interceptor dikes and swales will be used to protect slopes and direct water to a temporary sediment pond.

Element # 7: Protect Drain Inlets

o Drain inlets are being protected from sediment and high energy flows through the use of catch basin inserts. Catch basin inserts will be installed in any existing catch basins within 500 feet from the project site including structures on Shaw Road E and Pioneer Way E.

Element # 8: Stabilize Channels and Outlets

o There is an existing channel along Pioneer Way E that will be protected as necessary.

Element # 9: Control Pollutants

o The only pollutants generated by this project are those that are commonly associated with the construction of a multi-family complex and commercial lots. Contractor is responsible to follow all City of Puyallup pollution prevention measures. Contractor to follow all City of Puyallup pollution control standard, particularly when handling concrete and vehicle activity.

Element # 10: Control De-watering

o The groundwater table is high on the site, so it was important to check if the plan will require dewatering. After consulting with the contractor, it was concluded that the project improvements are at a height above the observed groundwater so that dewatering will not be required. If dewatering is required, the contractor will be required to hire an experienced dewatering contractor and obtain any necessary permits.

Element # 11: Maintain BMPs

o The contractor and property owner will be responsible for checking and maintaining all stormwater BMPs. Contractor to repair as needed.

Element # 12: Manage the Project

o The owner and contractor will be tasked with managing the project and are responsible for ensuring all SWPPP measures are followed per the provided plans and this report.

Element # 13: Protect Low Impact Development BMPs

o The proposed TESC plan includes details on a Filter Fabric Fence, Inlet protection, and a construction entrance. The TESC plan provided in Figure 1 outlines more details on each of these preventative measures taken to protect the area during construction. The contractor shall inspect LID proposed facility location pre and post construction to ensure no sediment laden water can enter the LID facilities area.

Minimum Requirement # 3: Source Control of Pollution

The plans provided with this report will be followed in the field to reduce the potential of pollution. It is anticipated that the only source of pollution generated on site will be from the minimal disturbance of soils which will be controlled by following the provided SWPPP and TESC plan. However, construction equipment can be a big source of pollution, so it is important to adhere to the recommendations in the SWPPP and TESC plan. New construction equipment will be used, and drip pads will be placed under them when at rest. There is no anticipated pollutant post construction other than pollutants from vehicular traffic typical of a multifamily complex and commercial lots. The property owner is responsible for the control of pollutants on their property, post construction.

Minimum Requirement # 4: Preservation of Natural Drainage System and Outfalls

There is a channel to the east and one to the north, these are being preserved and enhanced. Discharge from the site is being preserved and will be directed to the natural conveyance system on East Pioneer Way. The topography of the site drains primarily from east to west. No flowing runoff has been observed or reported and no stormwater related flooding has been observed or reported.

Minimum Requirement # 5: Onsite Stormwater Management

Using the LID approach to onsite stormwater management the Contech Modular Wetlands systems were used to provide enhanced water quality on the site. To provide flow control detention RTanks were sized. These passed the LID duration standards shown in the WWHM report in Appendix D.

The storm drain system designed for the East Town Crossing project will utilize a standard on-site detention system using underground RTanks. The design involves the collection of stormwaters from both the roofs and the paved surfaces in standard catch basins and pipes. The conveyance system will convey the stormwater to one of two RTank systems.

The Commercial site in the northwest corner includes a single RTank. The runoff from the commercial site will be collected in the conveyance system to the RTank and then released through a control manhole through a water quality system and then to the downstream system in East Pioneer Way. The commercial access to Shaw Road, which cannot be routed to the on-site detention system due to grades, is being accounted for via over-detention in the on-site detention system. The post-detention pipe conveyance will include a Contech Modular Wetlands that provides water quality to the stormwater based on the mitigated release rate from the RTank.

The remainder of the site will also utilize a piped conveyance system, consisting of catch basins and roof drain lines around each building, to convey stormwater to a large detention system consisting of two RTanks joined by a 36” diameter detention system, effectively creating one large detention system. The release from that system will be routed through a control manhole before joining the stormwater from the commercial site going through the Modular Wetlands system and being released to the ditch conveyance in the south shoulder of East Pioneer Way.

The project required additional Pollution Generating Hard Surface in Shaw Road, as well. This run off volume is being accounted for by over-detaining in the large on-site detention system.

The storm system is shown on Figure 4: Grading and Drainage Plan in Appendix A

Minimum Requirement # 6: Stormwater Treatment

The entire site will be treated for water quality via Contech Modular Wetlands systems. A stormwater biofiltration system will be located on the commercial site in the northwest corner of the site and will intercept the discharge pipe that discharges water from the flow control RTanks on the site. The water quality system was designed by Contech to meet Ecology requirements and is detailed on the plans submitted with this report. This water quality system is sized to the 2-year release flow rate.

Minimum Requirement # 7: Flow Control

The stormwater system designed for the site includes 3 large RTank systems, one serving the commercial site and a two-RTank system joined by a 36” detention pipe serving the remainder of the site.

The RTank serving the commercial site in the northwest portion of the site is designed to include an active detention area that is 229’ Long x 63’ wide x 3.5’ deep. The RTanks are designed for outrigger loading.

The RTank system serving the remainder of the site is comprised of 2 RTanks joined by a 36” diameter detention pipe. The RTank on the west side of the site is 200’ long x 74’ wide x 5.5’ deep, and the last RTank is 189’ x 63’ x 5.5’ deep. Again, the RTanks are rated for outriggers.

While the specific structural details for the RTanks will be provided in the final design, ACF was consulted for the layout of the RTanks, so the sizing, depth, and volume have been fully vetted to work with the site and the depth available without being impacted by groundwater. The RTanks have been designed as slightly larger than the size given in WWHM to account for sediment build up that could result from infrequent maintenance.

Minimum Requirement # 8: Wetlands Protection

There is a potential wetland on the parcel adjacent to the subject parcel on the east. This wetland will be evaluated, and all necessary buffers will be adhered to.

Minimum Requirement # 9: Operations and Maintenance

Sediment control structures need to be cleaned at least once every 3 months in the winter and fall months. Catch basin shall be checked per maintenance recommendations and after major storm events. A maintenance checklist has been provided in Appendix C.

Section 3: Infiltration Rates / Soils Report

The Soil Conservation Service identifies this land as Briscot loam and Puyallup fine sandy loam. A geotechnical engineering report was prepared for the project by Krazan and Associates and is included in Appendix B.

According to the report from Krazan and Associates, included in Appendix B, infiltration is not feasible on this site.

Section 4: Wells and Septic Systems

There are no existing wells identified on the property, nor are there any known septic systems on the site. Neither a well nor a septic is proposed for the site.

Section 5: Fuel Tanks

There are no identified fuel tanks on the property.

Section 6: Subbasins Description

The site has a slight moderate slope from the east to west of the project site. The proposed storm water design utilizes a catch and convey system to collect water from either the commercial basin or the multifamily housing basin. The water will flow to one of three RTanks. The RTanks will provide detention for the stormwater system. Downstream of the RTanks the two basins will join via a trunk pipe and flow through a Contech Modular Wetlands system, after being treated the water will flow out to a

discharge point in a ditch in Pioneer Way E. The commercial and multifamily basins are shown in Figure 5 in Appendix A.

All stormwater facilities proposed for the site have been designed per the current City of Puyallup Surface Water Management Manual.

Section 7: Floodplain Analysis

From the Pierce County GIS database, the site area is shown in the 2017 Regulated Floodplain. A Letter of Map Revision was issued on April 27th, 2022 and went into effect on September 8th, 2022. See attached Letter of Map Revision in Appendix E.

Section 8: Aesthetic Consideration for Facilities

The proposed facilities for stormwater quality and management are based on City of Puyallup standards and contractor shall take aesthetic into consideration when installing stormwater management BMPs. Most of the stormwater facilities will not be visible as they are underground systems.

Section 9: Facility Sizing and Downstream Analysis

Facility Sizing

The proposed stormwater facilities were designed and sized per the 2019 Ecology Manual as adapted by the City of Puyallup. We are proposing an LID method of Contech Modular Wetlands water quality and RTanks for flow control.

Water Quality

Contech Modular Wetlands water quality systems will treat stormwater onsite from the impervious pollution generating surfaces. Off-site the Shaw frontage road will utilize pervious sidewalks. The half street frontage from Pioneer has been over detained for in the modeling of the storm mitigation system. The Modular Wetlands system has been designed by Contech Engineers to meet the Ecology requirements. The water quality system sizing was done by Contech Engineering using the water quality output from the WWHM report provided in Appendix D, Appendix F shows the Contech Modular Wetlands approval from the DOE.

Flow Control

Three RTanks will provide detention onsite. The first RTank will provide 45,780 cubic feet of detention to the commercial basin and has been oversized to allow the commercial entrance to bypass detention. The other two RTanks will work together to provide detention to the rest of the site. The second RTank will provide 77,000 cubic feet of detention and the third RTank will provide 59,400 cubic feet of detention; in total the two RTanks provide 136,400 cubic feet of detention volume. These values meet/exceed the values calculated in the WWHM report provided in Appendix D. The two RTanks that provide flow control treatment for the multifamily housing area of the site are connected by a 24” pipe at 0% slope. The RTanks have also been oversized to allow for the stormwater on the half street of Pioneer frontage to bypass the site. The Rtanks have been sized in WWHM and the report is provided in Appendix D.

Conveyance System

The conveyance system consists of roof drain lines for each building, which will connect to 12” pipes that will flow stormwater from the impervious surfaces into the RTanks. From the RTanks the stormwater enters a 12” trunk pipe and the stormwater will be treated using a Contech Modular Wetlands system. Once treated the stormwater will flow out of a 12” pipe and flow into a regulated stream in Pioneer Way E.

Downstream Analysis

The system will ultimately flow to the regulated stream in pioneer that has an 18” PVC pipe. The stream will continue and ultimately end up at the Puyallup River, for this reason it is especially important to have water quality treatment.

Section 10: Utilities

All utilities will be designed and installed per City of Puyallup standards. Storm facilities and conveyance systems will be designed and constructed with appropriate cover and separation from water and sanitary sewer systems.

Section 11: Covenants, Dedications, Easements

There are no covenants, dedications, or easements necessary at this time.

Section 12: Property Owners' Association Articles of Incorporation

There are no articles on incorporation available for this property at this time.

Section 13: Other Permits or Conditions Placed on the Project

No other permits or conditions are necessary at this time.

Appendix A – Supporting Figures

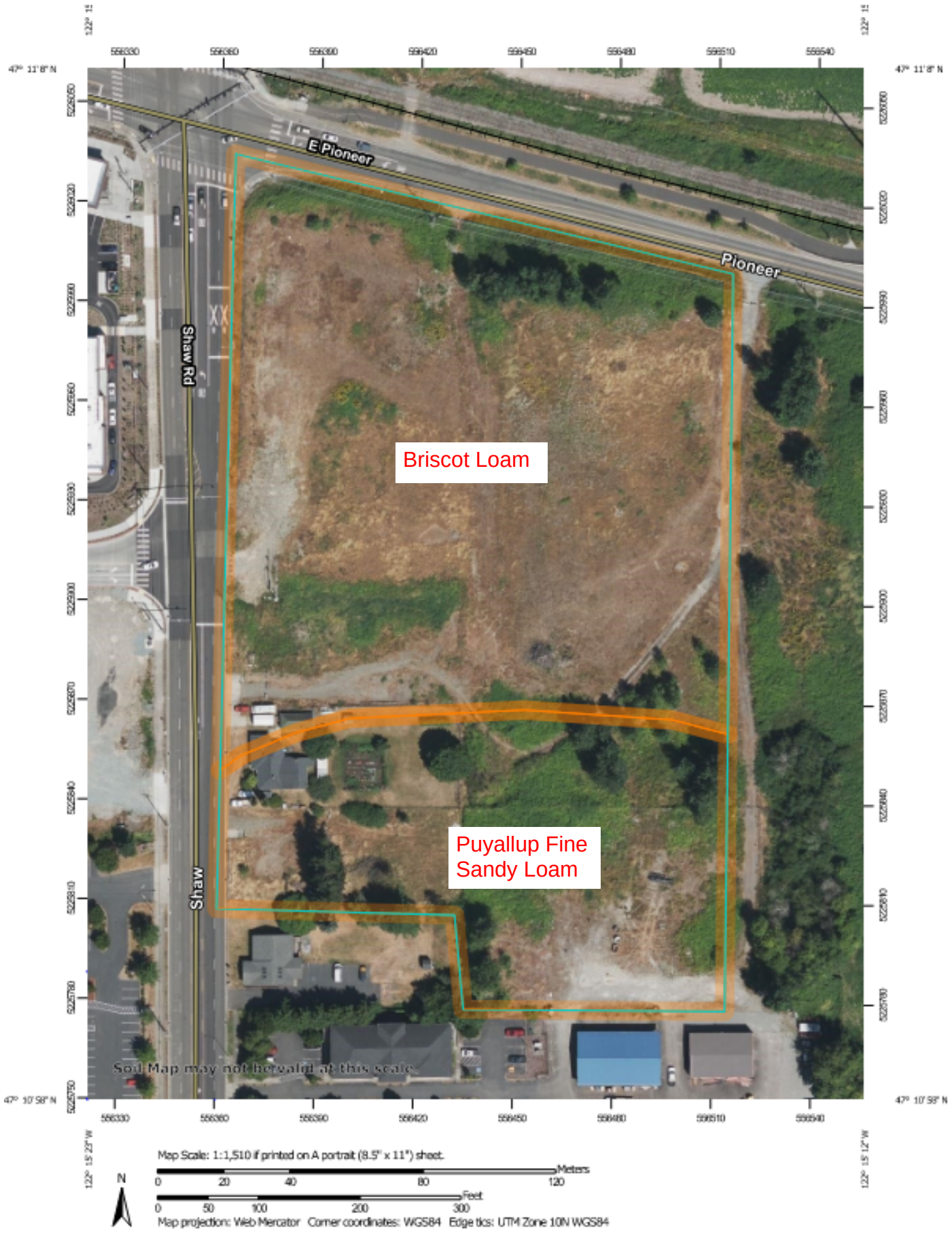
Figure 1: Vicinity Map

McInnis ENGINEERING

East Town Crossing
Vicinity Map

Figure #1

Figure 2: Soils Map



McInnis ENGINEERING

East Town Crossing
Soils Map

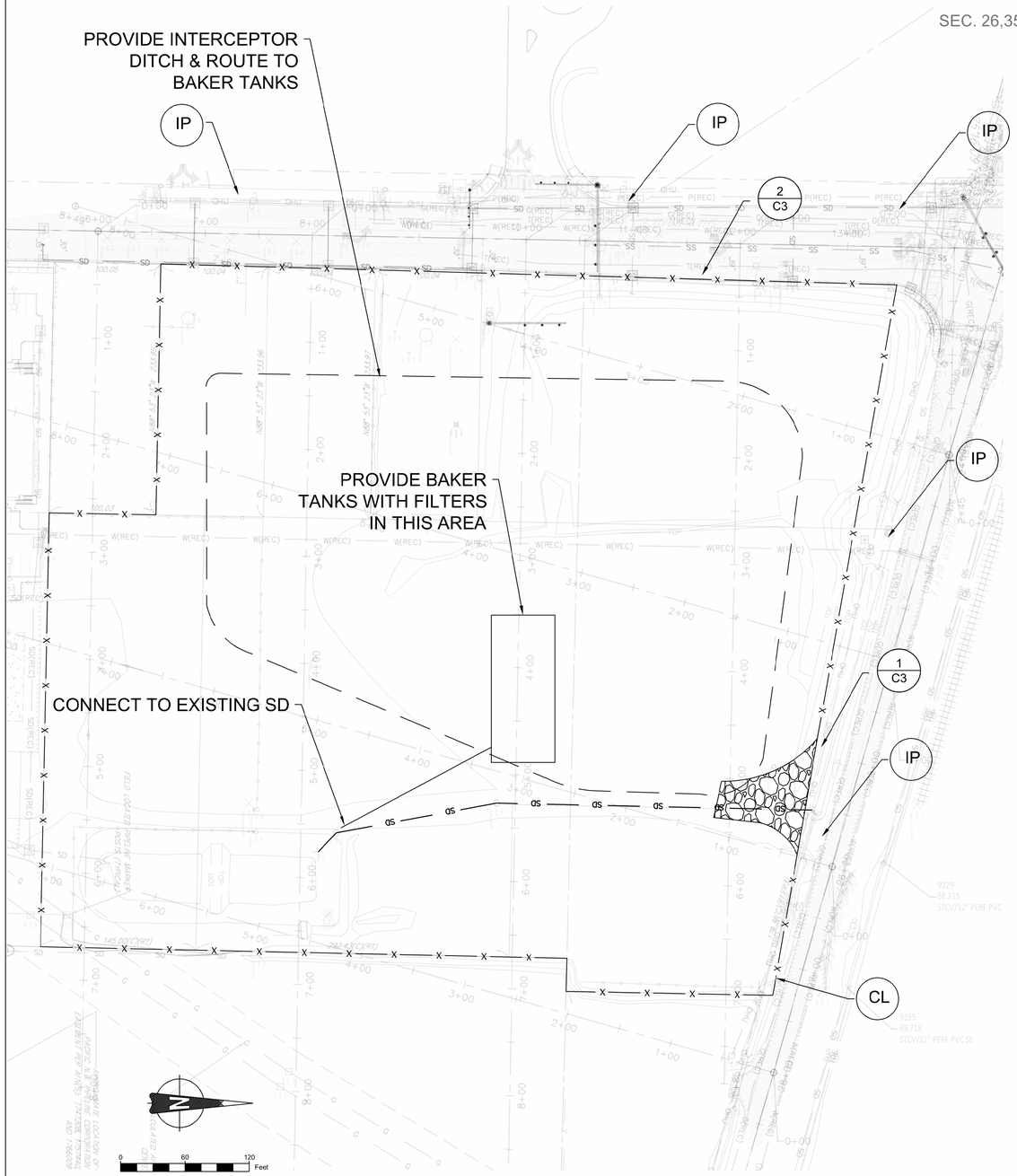
Figure #2

Figure 3: Temporary Erosion and Sediment Control Plan

EAST TOWN CROSSING

TESC PLAN

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



TESC INSPECTION NOTES:

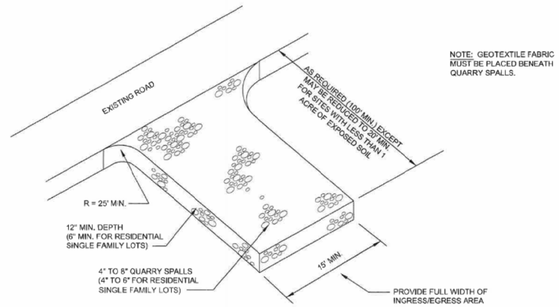
1. INSPECT ALL INLET PROTECTION ON CATCH BASINS. CLEAN OR REPLACE IF FULL OF SEDIMENT /DEBRIS AND REPAIR/REPLACE AS NEEDED IF DAMAGED TO MAINTAIN PROTECTION.
2. INSPECT ALL PERMANENT AND TEMPORARY STABILIZED SLOPES. REPAIR ANY DAMAGED SECTIONS AND RE-VEGETATE AS NEEDED TO ENSURE THE ESTABLISHMENT OF VEGETATION AND THAT NO EROSION OF THE SLOPES OCCUR.
3. INSPECT ALL FILTER FABRIC FENCING FOR SIGNS OF EROSION, DAMAGE OR FAILURES. REPAIR AND/OR REPLACE AS NEEDED. SEE FILTER FABRIC NOTES. SEDIMENT BUILD-UP ALONG FENCE SHALL BE REMOVED WHEN REACHES 1/3 THE FENCE HEIGHT. IF EROSION IS OCCURRING, CONTRACTOR SHALL INSTALL ADDITIONAL EROSION CONTROL MEASURES AS NEEDED TO PREVENT EROSION.
4. ANY FILL/CUT SLOPES SHALL BE INSPECTED FOR EROSION. IF SIGNS OF EROSION ARE PRESENT, INSTALL APPROPRIATE BMPS AS NEEDED TO STOP EROSION AND STABILIZE SLOPES.
5. TESC LEAD RESPONSIBLE FOR NOTIFYING ENGINEER IF ADDITIONAL MEASURES ARE WARRANTED.

PERMANENT STABILIZATION NOTES:

1. ALL EXPOSED SOILS AND SLOPES SHALL BE SEEDED OR OTHERWISE STABILIZED IMMEDIATELY AFTER CONSTRUCTION AND GRADING ACTIVITIES HAVE BEEN COMPLETED.
2. SILT FENCE, IF DEEMED APPROPRIATE, SHALL REMAIN FOR A MINIMUM OF 30 DAYS AFTER THE FINAL STABILIZATION OF THE SLOPES HAS OCCURRED.
3. ALL TEMPORARY EROSION CONTROL BMP'S SHALL BE REMOVED 30 DAYS AFTER FINAL STABILIZATION HAS OCCURRED AS DIRECTED BY CITY OR COUNTY INSPECTOR.
4. CONTRACTOR SHALL REFER TO THE CONSTRUCTION SWPP FOR APPLICABLE BMPS.

CONSTRUCTION ENTRANCE NOTES:

1. MATERIAL SHALL BE 4" TO 8" QUARRY SPALLS (4 TO 6 INCH FOR RESIDENTIAL SINGLE FAMILY LOTS) AND MAY BE TOP-DRESSED WITH 1 TO 3 INCH ROCK.
2. THE ROCK PAD SHALL BE AT LEAST 12" THICK AND 100' LONG (REDUCED TO 20 FEET FOR SITES LESS THAN 1 ACRE OF DISTURBED SOIL) WIDTH SHALL BE FULL WIDTH OF INGRESS AND EGRESS AREA. SMALLER PADS MAY BE APPROVED FOR SINGLE-FAMILY RESIDENTIAL AND COMMERCIAL SITES.
3. ADDITIONAL ROCK SHALL BE ADDED PERIODICALLY TO MAINTAIN FUNCTION OF THE PAD.
4. IF THE PAD DOES NOT ADEQUATELY REMOVE MUD FROM THE VEHICLE WHEELS, THE WHEELS SHALL BE HOSED OFF BEFORE THE VEHICLE ENTERS A PAVED STREET.THE WASHING SHALL BE DONE ON AN AREA COVERED WITH CRUSHED ROCK AND WASH WATER SHALL DRAIN TO A SEDIMENT RE"ENTION FACILITY OR THROUGH A SILT FENCE.

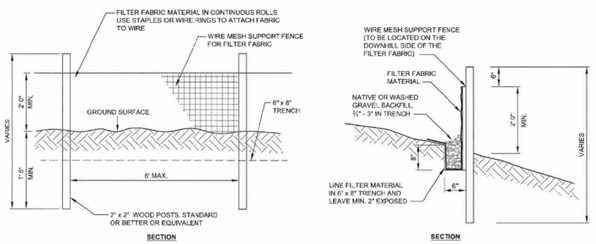


NOTE: GEOTEXTILE FABRIC MUST BE PLACED BENEATH QUARRY SPALLS.

1 CONSTRUCTION ENTRANCE
SCALE:NTS

FILTER FABRIC FENCE NOTES:

1. SUPPORT POST, WITH A MINIMUM 6-INCH OVERLAP. AND SECURELY FASTENED AT BOTH ENDS TO POSTS.
2. POSTS SHALL BE SPACED A MAXIMUM OF 8 FEET APART AND DRIVEN SECURELY INTO THE GROUND (MINIMUM OF 30 INCHES).
3. A TRENCH SHALL BE EXCAVATED APPROXIMATELY 8 INCHES WIDE AND 12 INCHES DEEP ALONG THE LINE OF POSTS
4. AND UPSLOPE FROM THE BARRIER. THIS TRENCH SHALL BE BACKFILLED WITH WASHED GRAVEL.
5. WHEN STANDARD STRENGTH FILTER FABRIC IS USED, A WIRE MESH SUPPORT FENCE SHALL BE FASTENED SECURELY TO THE UPSLOPE SIDE OF THE POSTS USING HEAVY-DUTY WIRE STAPLES AT LEAST 1 INCH LONG, TIE WIRES OR HOG RINGS. THE WIRE SHALL EXTEND INTO THE TRENCH A MINIMUM OF 4 INCHES AND SHALL NOT EXTEND MORE THAN 24 INCHES ABOVE THE ORIGINAL GROUND SURFACE.
6. THE STANDARD STRENGTH FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE FENCE, AND 20 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 24 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO EXISTING TREES.
7. WHEN EXTRA-STRENGTH FILTER FABRIC AND CLOSER POST SPACING IS USED, THE WIRE MESH SUPPORT FENCE MAY BE ELIMINATED. IN SUCH A CASE, THE FILTER FABRIC IS STAPLED OR WIRED DIRECTLY TO THE POSTS WITH ALL OTHER PROVISIONS OF ABOVE NOTES APPLYING.
8. FILTER FABRIC FENCES SHALL NOT BE REMOVED BEFORE THE UPSLOPE AREA HAS BEEN PERMANENTLY STABILIZED.
9. FILTER FABRIC FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
10. SILT FENCES WILL BE INSTALLED PARALLEL TO ANY SLOPE CONTOURS.
11. CONTRIBUTING LENGTH TO FENCE WILL NOT BE GREATER THAN 100 FEET.
12. DO NOT INSTALL BELOW AN OUTLET PIPE OR WEIR.
13. INSTALL DOWNSLOPE OF EXPOSED AREAS.
14. DO NOT DRIVE OVER OR FILL OVER SILT FENCES.



2 FILTER FABRIC FENCE
SCALE:NTS

TESC LEGEND:

- CL — CLEARING/ GRADING/ DISTURBED LIMITS
- FF — FILTER FABRIC FENCE SEE DETAIL (2 / C2)
- CE — CONSTRUCTION ENTRANCE (1 / C2)
- IP — INLET PROTECTION (3 / C2)

AMENDED SOILS NOTES:

- SOIL AMENDMENTS ARE REQUIRED FOR ALL DISTURBED AREAS IN ACCORDANCE WITH BMP L613: POST-CONSTRUCTION SOIL QUALITY AND DEPTH OF THE 2021 SURFACE WATER MANAGEMENT MANUAL
- AMENDED SOILS SHALL BE A MINIMUM OF 8" (NON-COMPACTED) WITH SUBSOILS SCARIFIED AT LEAST 4" WITH INCORPORATION OF THE UPPER MATERIAL TO AVOID STRATIFIED LAYERS, WHERE FEASIBLE.
- QUALITY OF COMPOST AND OTHER MATERIALS USED TO MEET THE ORGANIC CONTENT REQUIREMENTS ARE AS FOLLOWS:

a. THE ORGANIC CONTENT FOR "PRE-APPROVED" AMENDMENT RATES CAN BE MET ONLY USING COMPOST THAT MEETS THE DEFINITION OF "COMPOSTED MATERIALS" IN WAC 173-350-220. THE WAC IS AVAILABLE ONLINE AT: HTTP://WWW.ECY.WA.GOV/PROGRAMS/SWFA/FACILITIES/350.HTML THE COMPOST MUST ALSO HAVE AN ORGANIC MATTER CONTENT OF 35% TO 65%, AND A CARBON TO NITROGEN RATIO BELOW 25:1. THE CARBON TO NITROGEN RATIO MAY BE AS HIGH AS 35: 1 FOR PLANTINGS COMPOSED ENTIRELY OF PLANTS NATIVE TO THE PUGET SOUND LOWLANDS REGION.
b. CALCULATED AMENDMENT RATES MAY BE MET THROUGH USE OF COMPOSTED MATERIALS AS DEFINED ABOVE; OR OTHER ORGANIC MATERIALS AMENDED TO MEET THE CARBON TO NITROGEN RATIO REQUIREMENTS, AND MEETING THE CONTAMINANT STANDARDS OF GRADE A COMPOST.

- USE ONE OF THE FOLLOWING OPTIONS TO MEET THE POST CONSTRUCTION SOIL QUALITY AND DEPTH REQUIREMENTS. USE THE MOST RECENT VERSION OF "GUIDELINES FOR RESOURCES FOR IMPLEMENTING SOIL QUALITY AND DEPTH BMP T5.13" TO MEET THE REQUIREMENTS OF THIS BMP. THIS GUIDANCE CAN BE FOUND ONLINE AT:WWW.SOILSFORSALMON.ORG

a. LEAVE NATIVE VEGETATION AND SOIL UNDISTURBED, AND PROTECT FROM COMPACTION DURING CONSTRUCTION
b. AMEND EXISTING SITE TOPSOIL OR SUBSOIL EITHER AT DEFAULT "PRE-APPROVED" RATES, OR AT CUSTOM CALCULATED RATES BASED ON SPECIFIC TESTS OF THE SOIL AND AMENDMENT
c. STOCKPILE EXISTING TOPSOIL DURING GRADING, AND REPLACE IT PRIOR TO PLANTING. STOCKPILED TOPSOIL MUST ALSO BE AMENDED IF NEEDED TO MEET THE ORGANIC MATTER OR DEPTH REQUIREMENTS, EITHER AT A DEFAULT "PRE-APPROVED" RATE OR AT A CUSTOM CALCULATED RATE.
d. IMPORT TOPSOIL MIX OF SUFFICIENT ORGANIC CONTENT AND DEPTH TO MEET THE REQUIREMENTS. MORE THAN ONE METHOD MAY BE USED ON DIFFERENT PORTIONS OF THE SAME SITE. SOIL THAT ALREADY MEETS THE DEPTH AND ORGANIC MATTER QUALITY STANDARDS, AND IS NOT COMPACTED, DOES NOT NEED TO BE AMENDED.

- AMENDED SOILS SHALL BE MAINTAINED AS FOLLOWS:

a. SOIL QUALITY AND DEPTH SHOULD BE ESTABLISHED TOWARD THE END OF CONSTRUCTION AND ONCE ESTABLISHED, SHOULD BE PROTECTED FROM COMPACTION, SUCH AS FROM LARGE MACHINERY USE, AND FROM EROSION.
b. SOIL SHOULD BE PLANTED AND MULCHED AFTER INSTALLATION.
c. PLANT DEBRIS OR ITS EQUIVALENT SHOULD BE LEFT ON THE SOIL SURFACE TO REPLENISH ORGANIC MATTER.
d. IT SHOULD BE POSSIBLE TO REDUCE USE OF IRRIGATION, FERTILIZERS, HERBICIDES AND PESTICIDES. THESE ACTIVITIES SHOULD BE ADJUSTED WHERE POSSIBLE,RATHER THAN CONTINUING TO IMPLEMENT FORMERLY ESTABLISHED PRACTICES.

- SEE PROJECT CONSTRUCTION SWPPP FOR ADDITIONAL INFORMATION OR SECTION 2.2.1.4 OF CHAPTER 2 OF VOLUME 6 OF THE 2021 SURFACE WATER MANAGEMENT MANUAL

MULCHING NOTES:

1. MULCH MATERIALS USED SHALL BE STRAW OR HAY, AND SHALL BE APPLIED AT THE RATE OF 75-100 POUNDS PER 1000 SQ. FT. (APPX 2" THICK).
2. MULCH SHALL BE APPLIED IN ALL AREAS WITH EXPOSED SLOPES GREATER THAN 2: 1.
3. MULCHING SHALL BE USED IMMEDIATELY AFTER SEEDING OR IN AREAS WHICH CANNOT BE SEEDED BECAUSE OF THE SEASON.
4. ALL AREAS NEEDING MULCH SHALL BE COVERED BY NOVEMBER 1.

CONTRACTOR NOTES:

1. INLET PROTECTION SHALL BE INSTALLED IN ALL NEWLY CONSTRUCTED CATCH BASINS AND ALONG ALL IMPACTED FRONTAGE AND OFFSITE AREAS PER THE REQUIREMENTS OF THE COUNTY INSPECTOR PER DETAIL 5 ON THIS SHEET 5.
2. CONSTRUCTION FENCE CAN BE UTILIZED IN PLACE OF FILTER FABRIC FENCE ONLY IN AREAS WHERE THE GRADES DO NOT ALLOW THE POTENTIAL FOR ANY STORMWATER TO LEAVE THE SITE.
3. ALL DEMOLISHED MATERIALS SHALL BE REMOVED FROM THE SITE AND DISPOSED OF AT A CITY APPROVED LOCATION AND IN A MANNER CONSISTENT WITH CURRENT REGULATIONS AND REQUIREMENTS.
4. ALL AREAS THAT WILL BE UNWORKED FOR MORE THAN SEVEN (7) DAYS DURING THE DRY SEASON OR TWO (2) DAYS DURING THE WET SEASON, SHALL BE COVERED WITH STRAW, WOOD FIBER MULCH, COMPOST, PLASTIC SHEETING, OR OTHER EQUIVALENT PER CURRENT CITY OR COUNTY STANDARDS. SEE SEEDING NOTES AND MULCHING NOTES ON THIS SHEET.
5. CONTRACTOR SHALL DESIGNATE A WASHINGTON DEPT OF ECOLOGY CERTIFIED EROSION CONTROL LEAD PERSON, AND SHALL COMPLY WITH THE CONSTRUCTION STORMWATER POLLUTION PREVENTION PLAN (SWPPP) PREPARED FOR THE PROJECT.
6. AT ANY TIME DURING CONSTRUCTION IT IS DETERMINED BY THE CITY OR COUNTY THAT MUD AND DEBRIS ARE BEING TRACKED ONTO PUBLIC STREETS WITH INSUFFICIENT CLEANUP, ALL WORK SHALL CEASE ON THE PROJECT UNTIL THIS CONDITION IS CORRECTED. THE CONTRACTOR AND/OR THE OWNER SHALL IMMEDIATELY TAKE ALL STEPS NECESSARY TO PREVENT FUTURE TRACKING OF MUD AND DEBRIS INTO THE PUBLIC ROW, WHICH MAY INCLUDE THE INSTALLATION OF A WHEEL WASH FACILITY ON-SITE.
7. SEDIMENT LADEN RUNOFF SHALL NOT BE ALLOWED TO DISCHARGE BEYOND THE LIMITS OF THE IMPROVEMENTS. ADDITIONAL MEASURES SHALL BE INSTALLED AS NEEDED.
8. SAND BAGS SHALL BE SECURELY PLACED AROUND INSTALLED CATCH BASINS WITH INLET PROTECTION AS FIELD AND WEATHER CONDITIONS WARRANT SO TO PROTECT ALL DISPERSION AND INFILTRATION TRENCHES SEDIMENT LADEN RUNOFF.
9. TREES WITHIN WORKING LIMITS TO BE SAVED, SHALL BE MARKED AS SUCH ON SITE AND PROTECTION FENCE PLACED AROUND EACH TREE.

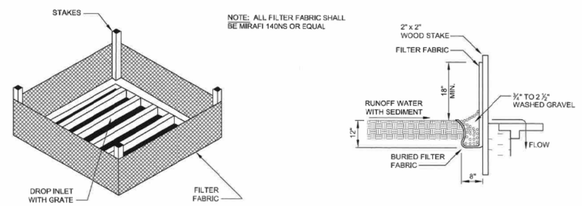
SEEDING NOTES:

1. THE FOLLOWING SEED MIXTURE SHALL BE AS BELOW AND SHALL BE APPLIED AT THE RATE RECOMMENDED BY THE SUPPLIER.

TABLE D.3.2.B TEMPORARY EROSION CONTROL SEED MIX

	% WEIGHT	% PURITY	% GERMINATION
CHEWINGS OR RED FESCUE FESTUCA *RUBRA VAR. COMMUTATA OR FESTUCA RUBRA*	40	98	90
ANNUAL OR PERENNIAL RYE *LOLIUM MULTIFLORUM OR LOLIUM PERENNE*	40	98	90
REDTOP OR COLONIAL BENTGRASS *AGROSTIS ALBA OR AGROSTIS TENUIS*	10	92	85
WHITE DUTCH CLOVER *TRIFOLIUM REPENS*	10	98	90

2. SEED BEDS PLANTED BETWEEN MAY 1 AND OCTOBER 31 WILL REQUIRE IRRIGATION AND OTHER MAINTENANCE AS NECESSARY TO FOSTER AND PROTECT THE ROOT STRUCTURE.
3. FOR SEED BEDS PLANTED BETWEEN OCTOBER 31 AND APRIL 30, ARMORING OF THE SEED BED WILL BE NECESSARY. (E.G., GEOTEXTILES, JUTE MAT, CLEAR PLASTIC COVERING),
4. BEFORE SEEDING, INSTALL NEEDED SURFACE RUNOFF CONTROL MEASURES SUCH AS GRADIENT TERRACES, INTERCEPTOR DIKES, SWALES, LEVEL SPREADERS AND SEDIMENT BASINS.
5. THE SEEDBED SHALL BE FIRM WITH A FAIRLY FINE SURFACE, FOLLOWING SURFACE ROUGHENING. PERFORM ALL OPERATIONS ACROSS OR AT RIGHT ANGLES TO THE SLOPE.
6. FERTILIZERS ARE TO BE USED ACCORDING TO SUPPLIER'S RECOMMENDATIONS. AMOUNTS USED SHOULD BE MINIMIZED, ESPECIALLY ADJACENT TO WATER BODIES AND WETLANDS.



3 INLET PROTECTION
SCALE:NTS

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mcinnisengineering.com
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202 East 34th Street
Tacoma, Washington 98404

EAST TOWN CROSSING
1001 SHAW ROAD
PUYALLUP, WA 98372

JEFFREY W. McINNIS — STATE OF WASHINGTON — 37799 — REGISTERED PROFESSIONAL ENGINEER — 6/2/23

NUM	DATE	DESCRIPTION

DESIGNED J. MCINNIS	SCALE 1"=20'
DRAWN W. MCINNIS	CHECKED CHCK
DATE 6/2/23	APPROVED APRD

SHEET 2 OF 47

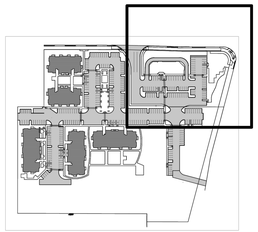
C-2

Figure 4: Grading and Drainage Plan

EAST TOWN CROSSING

GRADING AND PAVING PLAN I

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



KEY MAP

RAISED CROSSWALK

SEE PAVING DETAIL 5/23

RAISED CROSSWALK

CURB INLETS

MATCH LINE
SEE SHEET C5

MATCH LINE
SEE SHEET C6

FF = 74.70'

FF = 74.60'

TC: 70.64
BC: 70.14

TC: 74.53
BC: 74.03

SDMH Type 1
RIM:73.36
IE = 71.00 12" (CPEP E)

TC: 78.01
BC: 77.61

TC: 74.08
BC: 73.58

TC: 71.99
BC: 71.49

TC: 73.84
BC: 73.34

TC: 74.25
BC: 73.75

TC: 74.25
BC: 73.75

TC: 73.83
BC: 73.33

TC: 74.43
BC: 73.93

TC: 74.43
BC: 73.93

TC: 74.05
BC: 73.55

SDMH Type 1
RIM:73.00
IE = 70.52 12" (CPEP E)

90LF of 12" CPEP @ 1.00%

SDMH Type 1
RIM:73.27
IE = 70.27 12" (CPEP E)

TC: 74.25
BC: 73.75

TC: 74.25
BC: 73.75

TC: 73.22
BC: 72.72

TC: 73.67
BC: 73.17

TC: 74.40
BC: 73.90

TC: 74.55
BC: 74.05

TC: 74.41
BC: 73.91

TC: 74.47
BC: 73.97

TC: 74.26
BC: 73.76

TC: 74.57
BC: 74.07

SDMH Type 1
RIM:73.30
IE = 69.29 12" (CPEP E)

TC: 74.53
BC: 74.03

TC: 74.20
BC: 73.70

TC: 74.09
BC: 73.59

TC: 74.12
BC: 73.62

TC: 74.33
BC: 73.83

SDMH Type 1
RIM:73.20
IE = 69.37 12" (CPEP W)
IE = 69.37 12" (CPEP E)
IE = 69.37 12" (CPEP N)

TC: 74.12
BC: 73.62

TC: 74.34
BC: 73.84

SDMH Type 1
RIM:73.00
IE = 70.11 12" (CPEP W)
IE = 70.11 12" (CPEP E)

TC: 74.03
BC: 73.53

TC: 73.95
BC: 73.45

TC: 74.13
BC: 73.63

TC: 74.19
BC: 73.69

TC: 74.34
BC: 73.84

TC: 74.51
BC: 74.01

TC: 74.04
BC: 73.54

TC: 74.45
BC: 73.95

TC: 74.23
BC: 73.73

TC: 74.09
BC: 73.59

TC: 74.29
BC: 73.79

SDMH Type 1
RIM:73.20
IE = 69.80 12" (CPEP S)
IE = 69.80 12" (CPEP W)
IE = 69.80 12" (CPEP E)

TC: 74.24
BC: 73.74

TC: 74.09
BC: 73.59

TC: 74.29
BC: 73.79

TC: 74.29
BC: 73.79

TC: 74.86
BC: 74.36

TC: 74.45
BC: 73.95

TC: 74.50
BC: 74.00

TC: 74.06
BC: 73.56

SDMH Type 1
RIM:73.20
IE = 70.26 12" (CPEP W)

TC: 74.05
BC: 73.55

TC: 74.20
BC: 73.70

TC: 74.50
BC: 74.00

TC: 75.02
BC: 74.52

TC: 74.26
BC: 73.76

TC: 74.05
BC: 73.55

TC: 74.45
BC: 73.95

TC: 74.73
BC: 74.23

TC: 75.50
BC: 75.00

TC: 75.52
BC: 75.02

TC: 74.80
BC: 74.30

SDMH Type 1
RIM:69.23
IE = 70.00 12" (CPEP W)
IE = 68.00 12" (CPEP N)

SDMH Type 1
RIM:69.23
IE = 68.00 12" (CPEP S)
IE = 68.00 12" (CPEP N)

TC: 77.12
BC: 76.62

TC: 77.66
BC: 77.16

TC: 77.18
BC: 76.68

TC: 76.31
BC: 75.81

TC: 75.93
BC: 75.43

TC: 76.11
BC: 75.61

TC: 77.47
BC: 76.97

TC: 76.99
BC: 76.49

TC: 77.35
BC: 76.85

TC: 75.90
BC: 75.40

TC: 76.13
BC: 75.63

SDMH Type 1
RIM:74.79
IE = 68.00 24" (CPEP S)
IE = 68.00 24" (CPEP W)

TC: 75.98
BC: 75.48

SDMH Type 1
RIM:65.23
IE = 64.00 12" (CPEP S)
IE = 64.00 12" (CPEP W)

SDMH Type 1
RIM:75.00
IE = 68.00 24" (CPEP S)
IE = 68.00 24" (CPEP N)

SDMH Type 1
RIM:75.90
IE = 68.00 24" (CPEP S)
IE = 68.00 24" (CPEP N)

TC: 76.57
BC: 76.07

TC: 77.22
BC: 76.72

TC: 77.26
BC: 76.76

TC: 77.18
BC: 76.68

TC: 77.37
BC: 76.87

TC: 76.00
BC: 75.50

TC: 75.98
BC: 75.48

TC: 77.58
BC: 77.08

TC: 75.93
BC: 75.43

0 20 40 Feet

TOPOGRAPHIC NOTE

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APPROVED

BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

NOTE: THIS APPROVAL IS VOID AFTER 180 DAYS FROM APPROVAL DATE.
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FIELD CONDITIONS MAY DICTATE CHANGES TO THESE PLANS AS DETERMINED BY THE DEVELOPMENT ENGINEERING MANAGER.

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1001 SHAW ROAD
PUYALLUP, WA 98372

JEFFREY W. MCINNIS
STATE OF WASHINGTON
37399
REGISTERED
PROFESSIONAL ENGINEER
6/2/23

NUM	DATE	DESCRIPTION

DESIGNED	SCALE
J. MCINNIS	1:40
DRAWN	CHECKED
W. MCINNIS	CHCK
DATE	APPROVED
6/2/23	APRD

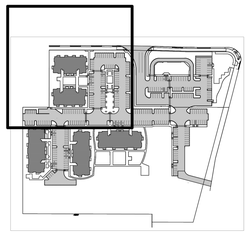
SHEET
3 OF 46

C-3

EAST TOWN CROSSING

GRADING AND PAVING PLAN II

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



KEY MAP

APPROVED

BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

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GRADE @ 2:1 SLOPE

MATCH EXISTING GRADE

MATCH LINE
SEE SHEET C4

MATCH LINE
SEE SHEET C7

0 20 40 Feet

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1001 SHAW ROAD
PUYALLUP, WA 98372

JEFFREY W. McINNIS
STATE OF WASHINGTON
37399
REGISTERED
PROFESSIONAL ENGINEER
6/2/23

NUM	DATE	DESCRIPTION

DESIGNED J. MCINNIS	SCALE 1:40
DRAWN W. MCINNIS	CHECKED CHCK
DATE 6/2/23	APPROVED APRD

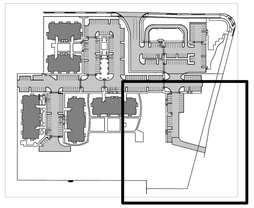
SHEET
4 OF 46

C-4

EAST TOWN CROSSING

GRADING AND PAVING PLAN III

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



KEY MAP

APPROVED

BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

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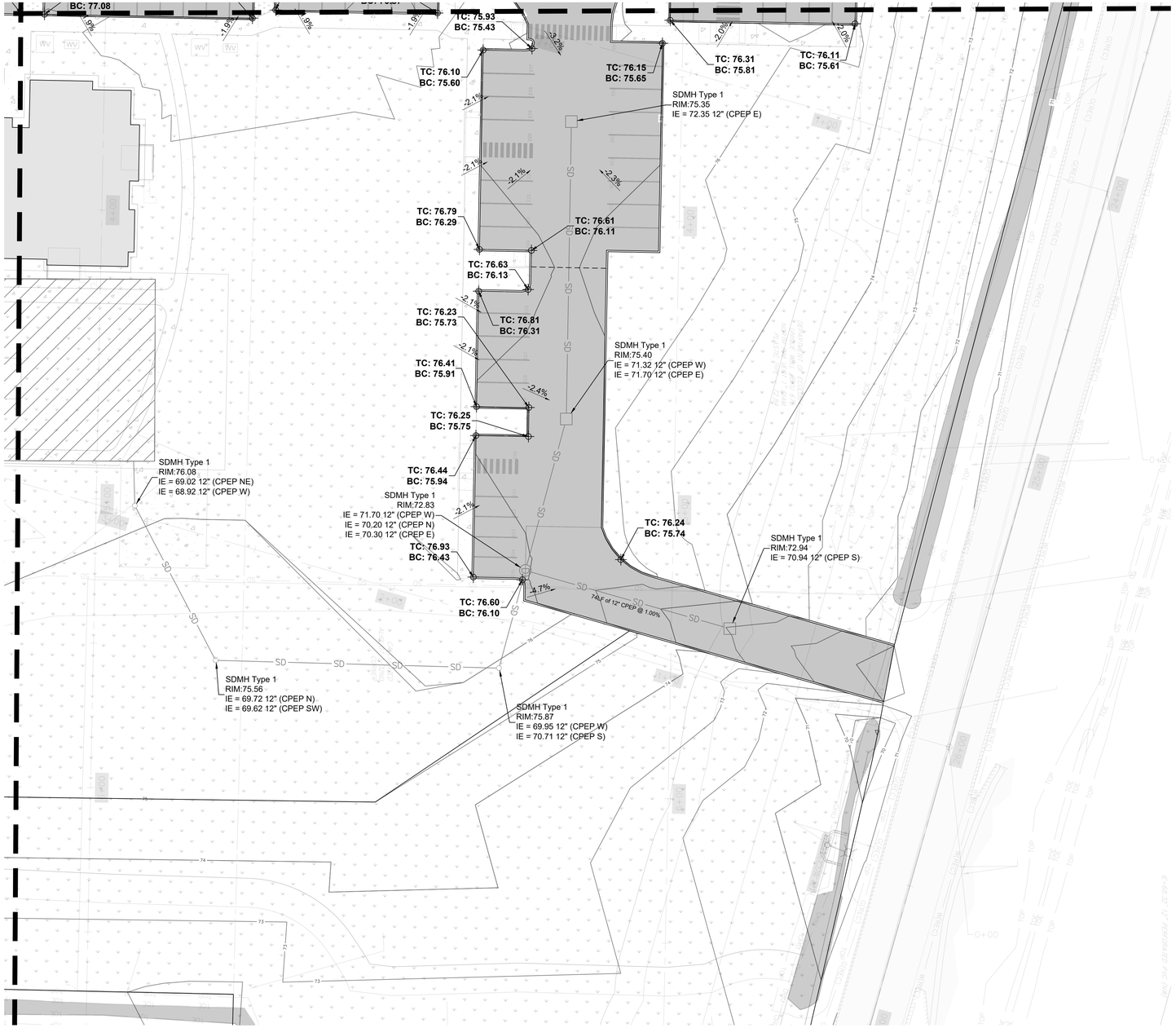
MATCH LINE
SEE SHEET C4



MATCH LINE
SEE SHEET C7

0 20 40 Feet

N

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PUYALLUP, WA 98372

JEFFREY W. McINNIS
STATE OF WASHINGTON
37399
REGISTERED
PROFESSIONAL ENGINEER
6/2/23

NUM	DATE	DESCRIPTION

DESIGNED J. MCINNIS	SCALE 1:40
DRAWN W. MCINNIS	CHECKED CHCK
DATE 6/2/23	APPROVED APRD

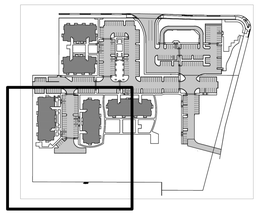
SHEET 5 OF 46

C-5

EAST TOWN CROSSING

GRADING AND PAVING PLAN IV

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



KEY MAP

APPROVED

BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

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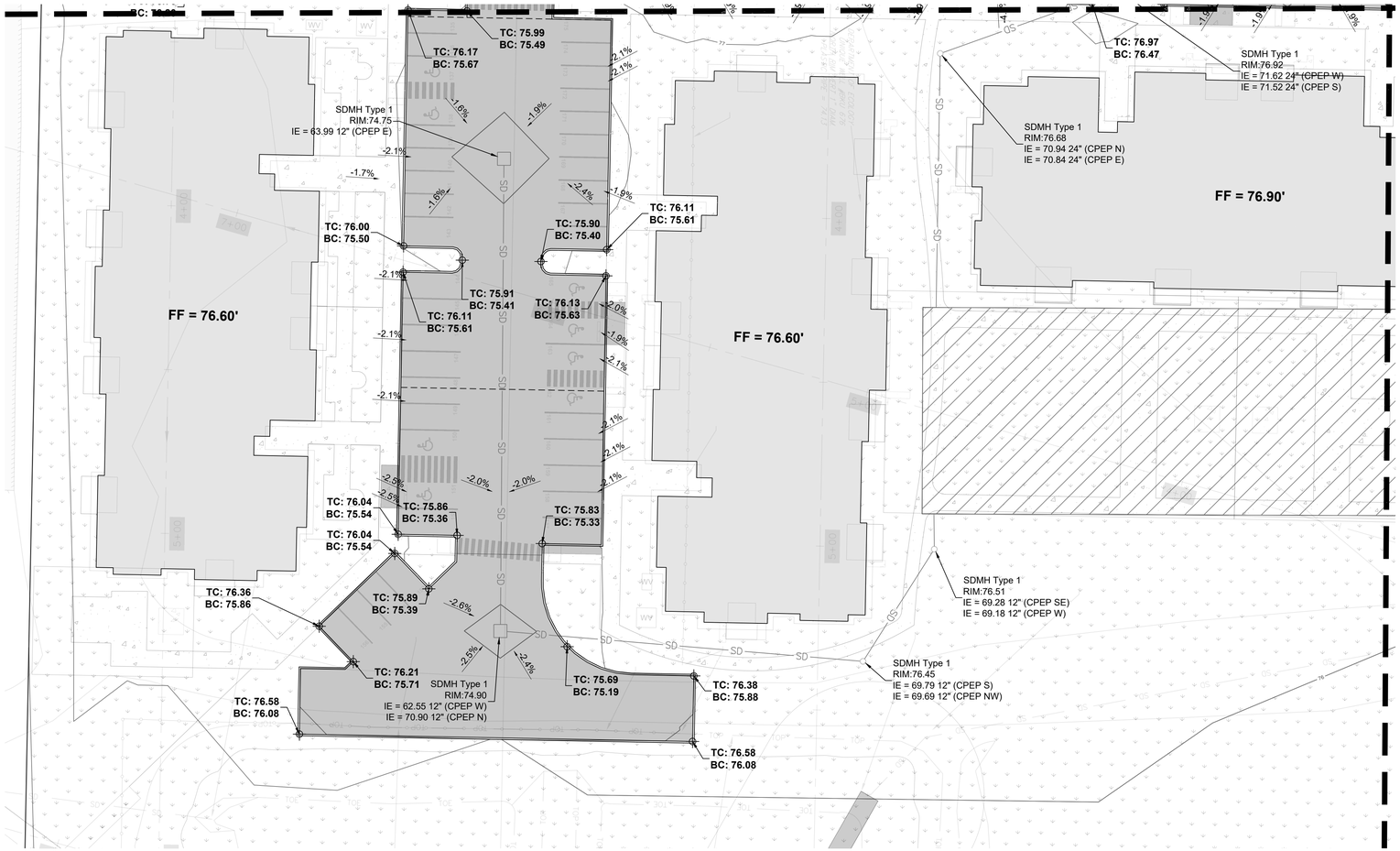
MATCH LINE
SEE SHEET C5



MATCH LINE
SEE SHEET C6

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0 20 40 Feet

N

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PUYALLUP, WA 98372

JEFFREY W. McINNIS
STATE OF WASHINGTON
37399
REGISTERED
PROFESSIONAL ENGINEER
6/2/23

NUM	DATE	DESCRIPTION

DESIGNED J. MCINNIS	SCALE 1:40
DRAWN W. MCINNIS	CHECKED CHCK
DATE 6/2/23	APPROVED APRD

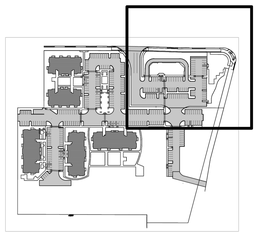
SHEET
6 OF 46

C-6

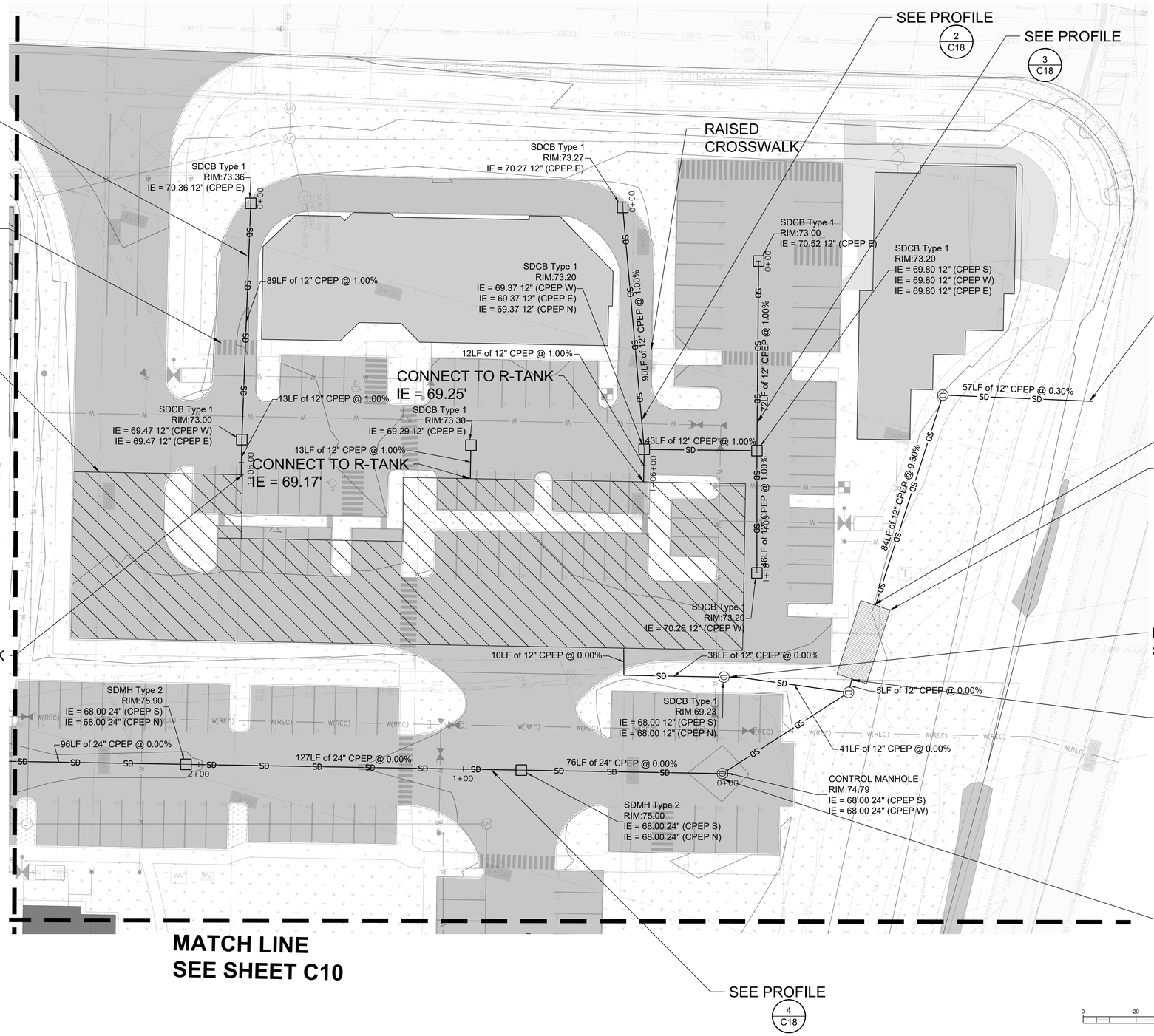
EAST TOWN CROSSING

STORM PLAN I

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



KEY MAP



TOPOGRAPHIC NOTE

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0 20 40 Feet

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BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

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PUYALLUP, WA 98372

JEFFREY W. McINNIS STATE OF WASHINGTON 37399 REGISTERED PROFESSIONAL ENGINEER
6/2/23

NUM	DATE	DESCRIPTION

DESIGNED J. MCINNIS	SCALE 1:40
DRAWN W. MCINNIS	CHECKED CHCK
DATE 6/2/23	APPROVED APRD

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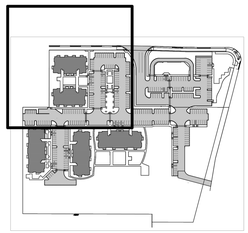
C-7

EAST TOWN CROSSING

STORM PLAN II

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



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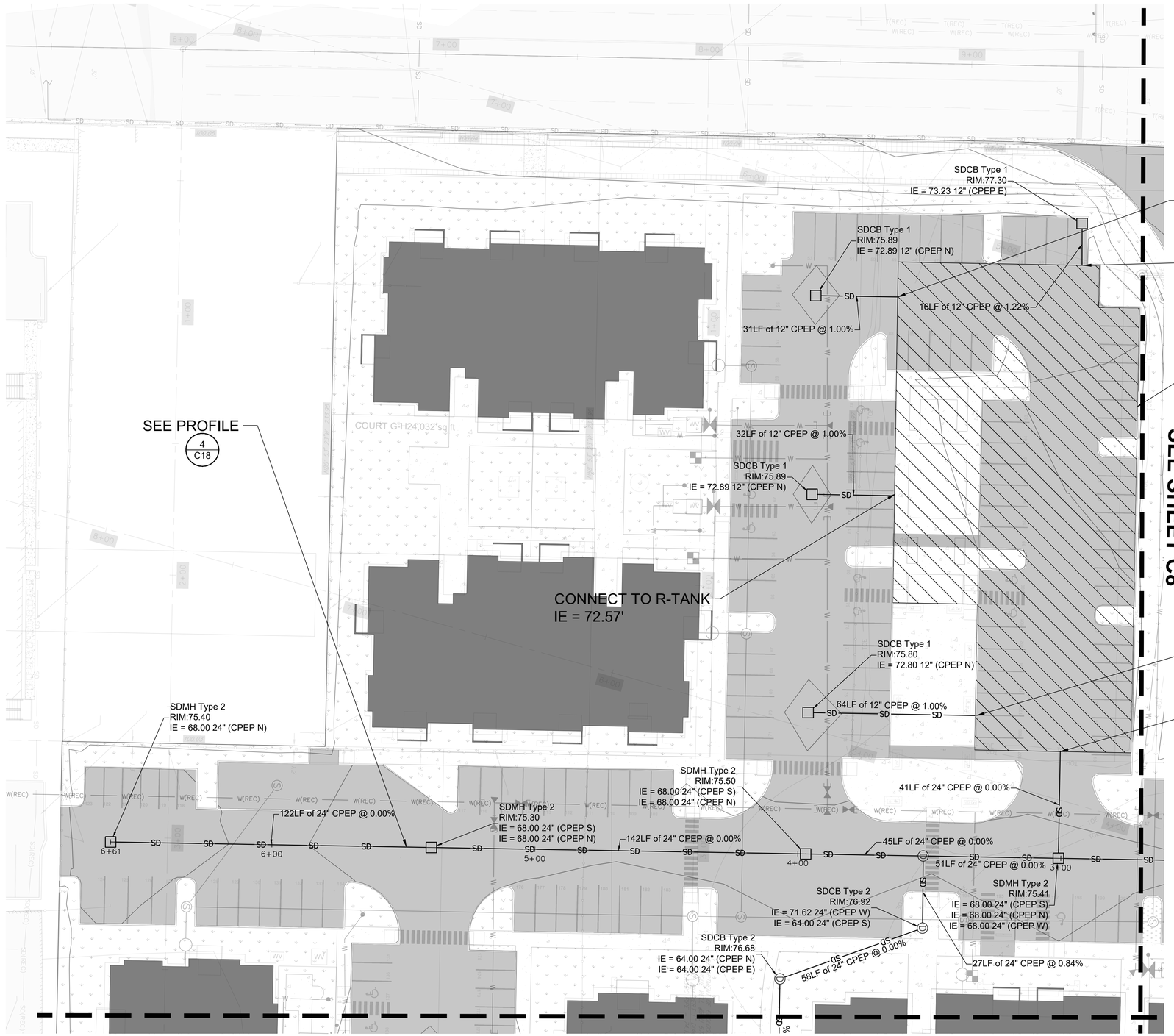

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PUYALLUP, WA 98372

STATE OF WASHINGTON
JEFFREY W. McINNIS
37399
REGISTERED
PROFESSIONAL ENGINEER
6/2/23

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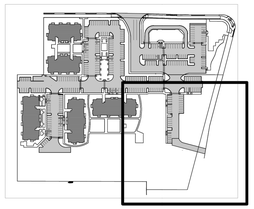
EAST TOWN CROSSING

STORM PLAN III

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



KEY MAP

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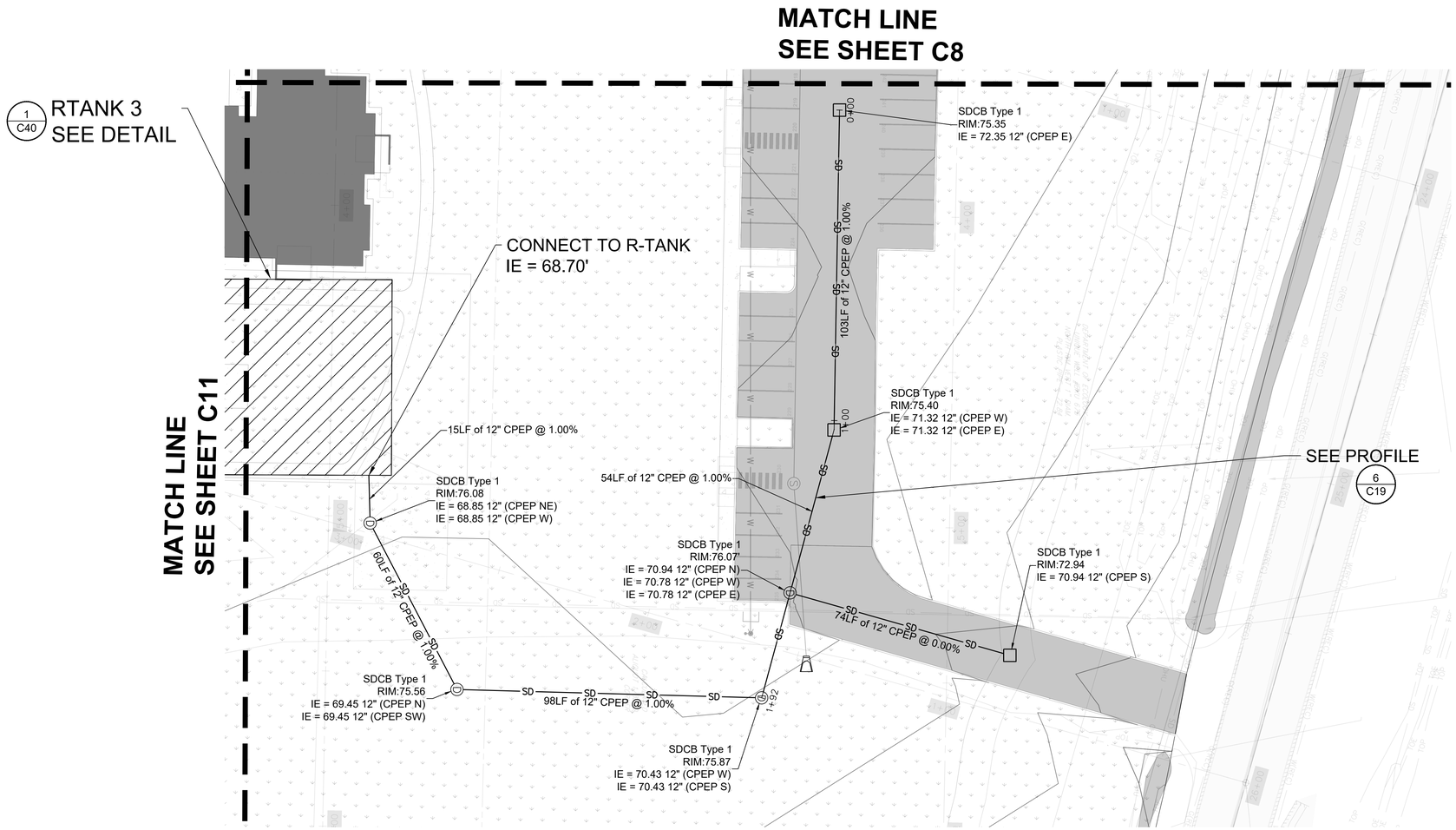

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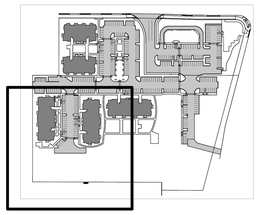
EAST TOWN CROSSING

STORM PLAN IV

SEC. 26,35/ TWP. 20 N./ RGE. 4 E., W.M.



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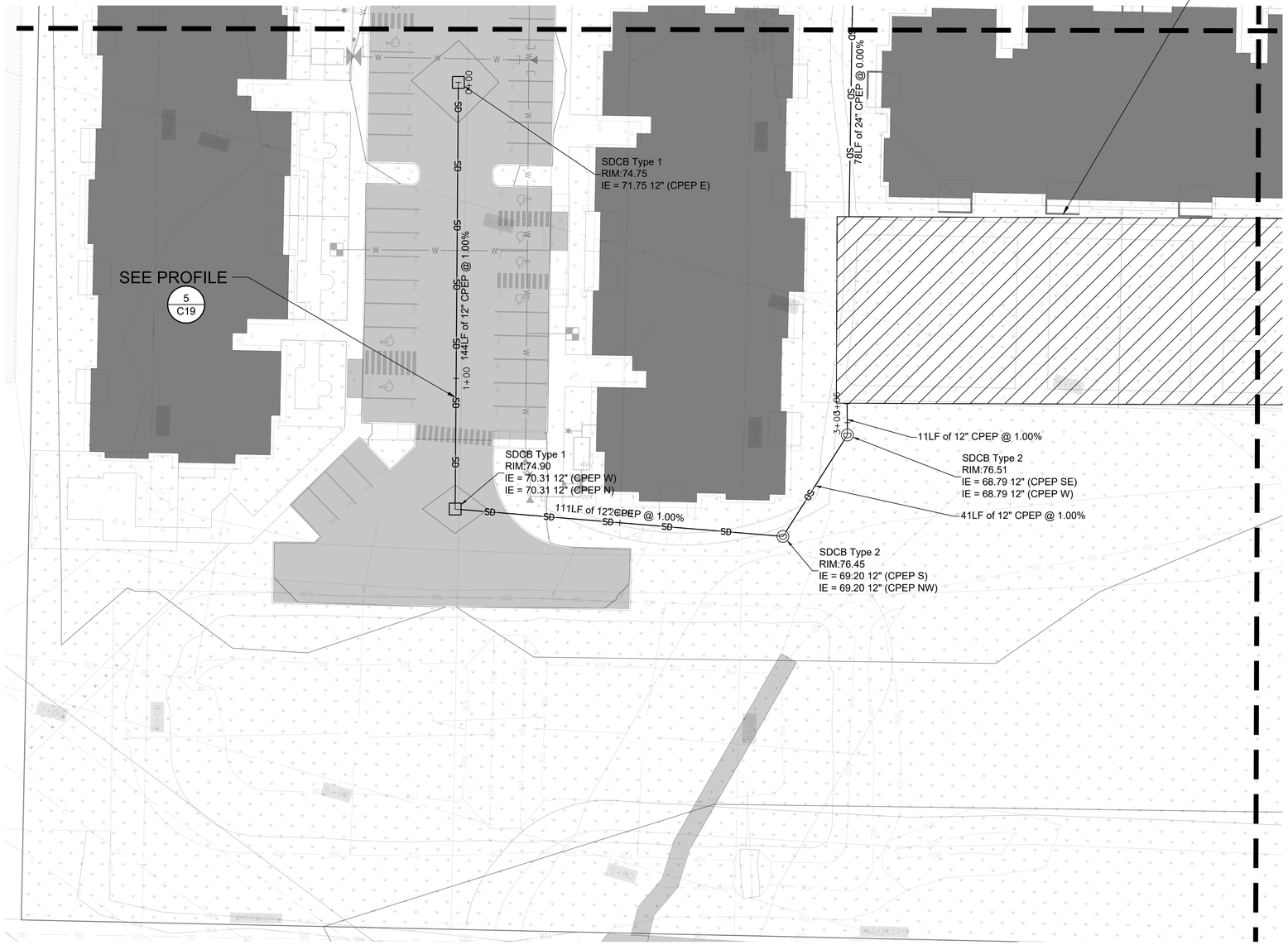

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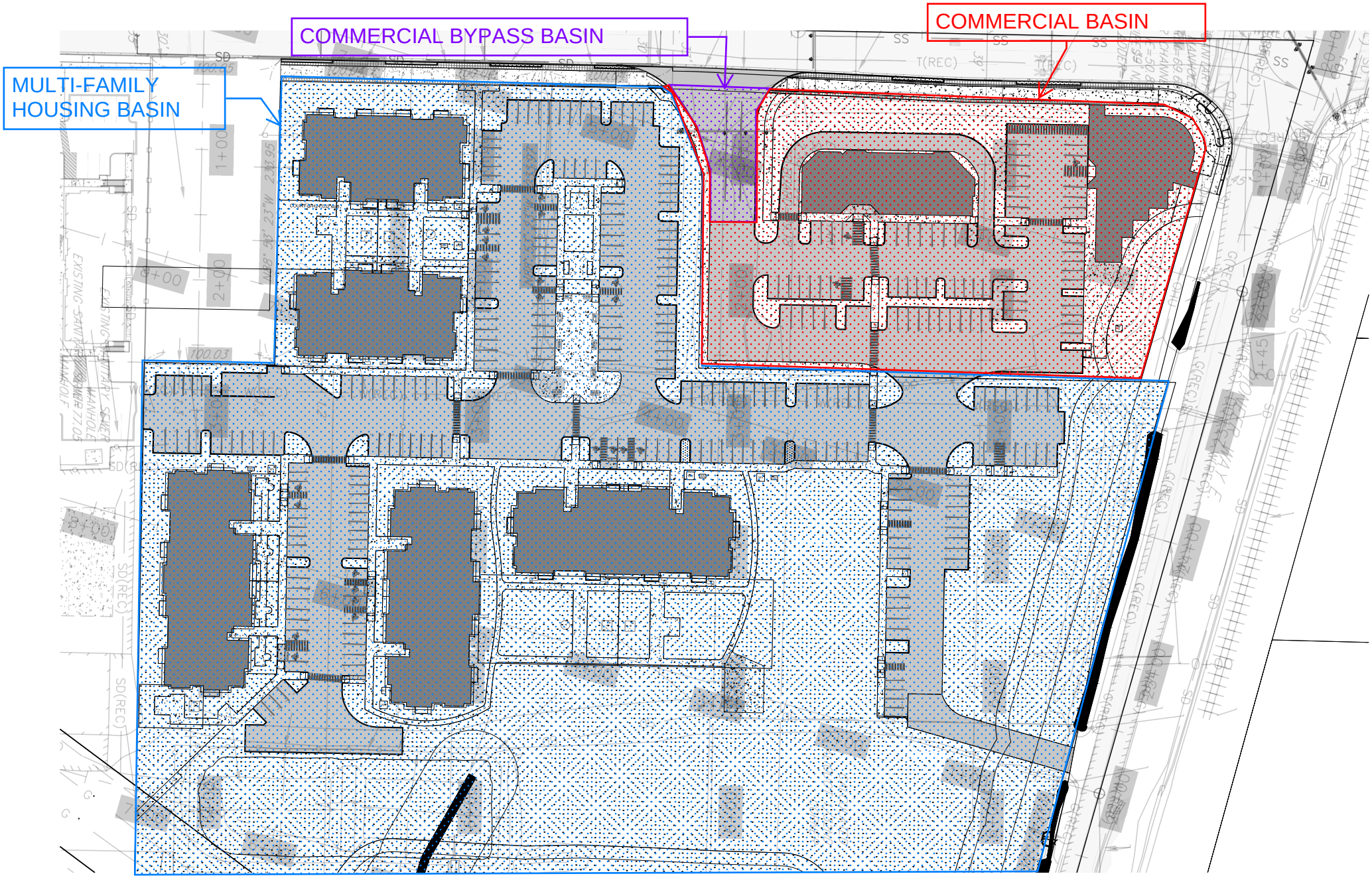
Figure 5: Subbasins



McInnis ENGINEERING

East Town Crossing
Subbasins

Figure 5

Appendix B – Geotechnical Analysis

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

April 11, 2019

KA Project No. 062-19005

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Mr. Gil Hulsmann

Email: Gil.Hulsmann@AbbeyRoadGroup.com
Tel: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation**
East Town Crossing
Parcel Nos. 0420264053, 0420264054, 0420351066
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington 98371

Dear Mr. Hulsmann,

In accordance with your request, we have completed a Geotechnical Engineering Investigation for the referenced site. The results of our investigation are presented in the attached report.

If you have any questions, or if we can be of further assistance, please do not hesitate to contact our office.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

Theresa R. Nunan

Theresa R. Nunan
Project Engineer

TRN:MR

GEOTECHNICAL ENGINEERING INVESTIGATION
EAST TOWN CROSSING
PARCEL NOS. 0420264053, 0420264054, 0420351066
SE CORNER OF E. SHAW ROAD & E. PIONEER WAY
PUYALLUP, WASHINGTON

PROJECT NO. 062-19005
APRIL 11, 2019

Prepared for:

ABBEY ROAD GROUP LAND DEVELOPMENT
SERVICES COMPANY, LLC
ATTN: MR. GIL HULSMANN
PO BOX 1224
PUYALLUP, WA 98371

Prepared by:

KRAZAN & ASSOCIATES, INC.
GEOTECHNICAL ENGINEERING DIVISION
825 CENTER STREET, STE A
TACOMA, WASHINGTON 98409
(253) 939-2500

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April 11, 2019 KA Project No. 062-19005

GEOTECHNICAL ENGINEERING INVESTIGATION
EAST TOWN CROSSING
PARCEL NOS. 0420264053, 0420264054, 0420351066
SE CORNER OF EAST SHAW ROAD AND EAST PIONEER WAY
PUYALLUP, WASHINGTON

INTRODUCTION

This report presents the results of our Geotechnical Engineering Investigation for the proposed East Town Crossing project located near the southeast corner of East Shaw Road and East Pioneer Way in Puyallup, Washington, as shown on the Vicinity Map in Figure 1. Discussions regarding site conditions are presented in this report, together with conclusions and recommendations pertaining to site preparation, excavations, structural fill, utility trench backfill, drainage and landscaping, erosion control, foundations, concrete floor slabs and exterior flatwork, lateral earth pressures, and pavement.

A Site Plan showing the approximate exploratory boring and monitoring well locations is presented following the text of this report in Figure 2. Appendix A includes USCS Soil Classification information, as well as a description of the field investigation, exploratory boring logs, and the laboratory testing results. Appendix B contains a guide to aid in the development of earthwork specifications. Pavement design guidelines are presented in Appendix C. The recommendations in the main text of the report have precedence over the more general specifications in the appendices.

PURPOSE AND SCOPE

This investigation was conducted to evaluate the subsurface soil and groundwater conditions at the site, to develop geotechnical engineering recommendations for use in design of specific construction elements, and to provide criteria for site preparation and earthwork construction.

Our scope of services was performed in general accordance with our proposal for this project, dated January 25, 2019 (Proposal Number G19001WAT) and included the following:

- Exploration of the subsurface soil and groundwater conditions by conducting approximately three (3) geotechnical borings and installing two (2) groundwater level monitoring wells using a subcontracted drill rig;
- Provide a site plan showing the geotechnical boring and monitoring well locations;

- Provide comprehensive boring and monitoring well logs, including soil stratification and classification, and groundwater levels where applicable;
- Recommended foundation type for the proposed structures;
- Allowable foundation bearing pressure, anticipated settlements (both total and differential), coefficient of horizontal friction for footing design, and frost penetration depth;
- Recommendations for seismic design considerations including site coefficient and ground acceleration based on the 2015 IBC;
- Recommendations for structural fill materials, placement, and compaction;
- Recommendations for suitability of on-site soils as structural fill;
- Recommendations for temporary excavations;
- Recommendations for site drainage and erosion control;
- Recommendations for flexible and rigid pavements, as well as permeable pavement.

PROPOSED CONSTRUCTION

Based on the Overall Site Plan prepared by Abbey Road Group Land Development Services, dated December 12, 2018, we understand that the proposed development will include construction of six residential structures (designated Buildings A through E) and a club house/office building. Site drainage systems will include a subsurface stormwater system located in the southern portion of the property, and a rain garden along the northern and eastern edges of the site. We have not been provided with details regarding construction of the subsurface stormwater system. The planned development will also include utility installation, and paved parking areas and driveways. For the purpose of our analyses, we have assumed that the residential buildings and club house will be 1- to 2-story structures with a slab-on-grade floor system. We have also assumed only minor grading up to 1 foot of cut or fill will be required to establish planned elevations for the site.

SITE LOCATION AND DESCRIPTION

The site consists of three undeveloped parcels encompassing approximately 7 acres of land located south and east of the intersection of Shaw Road with East Pioneer Way. The site is bordered to the north by East Pioneer Way, to the south by commercial property, to the east by undeveloped land and a creek, and to the west by undeveloped land and abandoned residences. The site is roughly rectangular in shape and relatively level at approximately Elevation 72 to 74 feet. A dirt road runs north-south through the center of the site, and also extends from the center of the site westward towards Shaw Road. An existing storm pond is located in the southeast corner of the site, with the bottom at Elevation 69

feet. A wetland that has been field verified by others is located within the western central edge of the site. A creek runs along the eastern boundary of the site.

Most of the property is covered with seasonal vegetation, brambles, and a few trees located within the central portion of the site. Some trash and an abandoned trailer are located in the north central portion of the site. The southern portion of the site is currently being used by the adjacent business for container storage.

We understand that past construction activities for the undeveloped parcel to the west of the site that borders Shaw Road and East Pioneer Way consisted of the placement of fill material to raise the existing grades, based on the Geotechnical Evaluation and Additional Recommendations report prepared by Krazan & Associates, dated March 13, 2007. Those fill activities did not extend into this site.

GEOLOGIC SETTING

The site lies within the central Puget Lowland. The lowland is part of a regional north-south trending trough that extends from southwestern British Columbia to near Eugene, Oregon. North of Olympia, Washington, this lowland is glacially carved, with a depositional and erosional history including at least four separate glacial advances and retreats. The Puget Lowland is bounded to the west by the Olympic Mountains and to the east by the Cascade Range. The lowland is filled with glacial and nonglacial sediments.

The Washington Division of Geology and Earth Resources, Geologic Map of the South Half of the Tacoma Quadrangle, Washington (Open File Report 87-3) indicates that the property is located in an area that is predominantly underlain by recent alluvium deposited by the Puyallup River. The recent alluvium consists of interbedded silt, sandy silt, silty sand, sand, gravel, local areas of peat and clay. The finer material represents overbank material and local lacustrine deposits, and the coarser materials most likely represent deposits in abandoned channels of the Puyallup River.

FIELD INVESTIGATION

A field investigation consisting of three (3) exploratory soil borings and installation of two (2) monitoring wells was completed to evaluate the subsurface soil and groundwater conditions at the project location. The soil borings were completed on March 11, 2019 by a Krazan subcontractor utilizing a hollow stem auger drill rig. The soil borings were advanced to depths ranging from 21.5 to 38.5 feet below the existing ground surface (bgs). A geotechnical engineer from Krazan and Associates was present during the explorations, examined the soils and geologic conditions encountered, obtained samples of the different soil types, and maintained logs of the explorations.

Representative samples of the subsurface soils encountered in the borings were collected and sealed in plastic bags. These samples were transported to our laboratory for further examination and testing. The

soils encountered in the exploratory borings were continuously examined and visually classified in accordance with the Unified Soil Classification System (USCS).

SOIL PROFILE AND SUBSURFACE CONDITIONS

The geotechnical subsurface exploration for this project consisted of soil borings and monitoring wells advanced to depths of approximately 21.5 to 38.5 feet bgs. The locations of the soil borings and monitoring wells are shown on the Site Plan in Figure 2.

Beneath 5 to 8 inches of surficial topsoil, the borings encountered alluvial soils to their explored depths. The topsoil was underlain by 4.5 to 7 feet of brown silty sand (SM) and poorly graded sand (SP) with relative densities in the loose to medium dense range. The sand soils were underlain by a 3-foot thick stratum of interbedded sandy silt (ML) that exhibited medium stiff to stiff consistencies and silty sand (SM) soils with relative densities in the loose to medium dense range.

Boring B-1 encountered a layer of silty clay and clayey silt beneath the sandy silt and silty sands from 7.5 to 11.0 feet bgs. The silty clay (CL) and clayey silt (ML) exhibited a very soft consistency with a Standard Penetration Test (SPT) resistance (N-value) of 1/12 inches and a moisture content of 51 percent.

The clayey silt in boring B-1 and the silty sand/sandy silt stratum in borings B-2 and B-3 were underlain by silty sand, sand, and gravel soils with varying silt contents to the termination depths of 21.5, 38.5, and 21.5 feet bgs, respectively. These granular soils exhibited relative densities in the loose to very dense range with N-values ranging from 8 to 60/8" blows per foot.

Gradation and Atterberg Limits tests were conducted on representative samples of the soils for classification purposes and for determination of engineering properties. The gradation and Atterberg Limits results are graphically depicted in Appendix A. For additional information about the soils encountered, please refer to the boring logs in Appendix A.

Monitoring Wells: Two monitoring wells, designated W-1 and W-2, were installed at the site on March 11, 2019 using a subcontracted driller and track mounted drill rig. Monitoring well W-1 was installed within borehole B-1. The boreholes for monitoring wells W-1 and W-2 were advanced to a depth of 21.5 feet and 20 feet below the existing ground surface, respectively, using 4¼-inch diameter hollow stem augers. A 10-foot long section of slotted PVC pipe attached to a 10-foot section of solid PVC pipe was inserted into the borehole, and the annular space between the pipe and the augers was backfilled with filter sand to a depth of 8 feet bgs followed by bentonite chips to the ground surface. A metal well cap was then installed over the pipe and cemented in-place to protect the well from unauthorized access. The installation log for monitoring wells W-1 and W-2 are included in Appendix A.

GROUNDWATER

Groundwater was encountered during the drilling operations at a depth of about 7 to 8 feet below the existing ground surface. It should be recognized that groundwater elevations may fluctuate with time. The groundwater level will be dependent upon seasonal precipitation, irrigation, land use, climatic conditions, as well as other factors. Therefore, water levels at the time of the field investigation may be different from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

GEOLOGIC HAZARDS

Erosion Concern/Hazard

The Natural Resources Conservation Services (NRCS) map for Pierce County Area, Washington, classifies the site area as Briscot loam. The NRCS classifies the Briscot loam as Hydrologic Soil Group B/D with low potential for erosion in a disturbed state.

It has been our experience that soil erosion can be minimized through landscaping and surface water runoff control. Typically, erosion of exposed soils will be most noticeable during periods of rainfall and may be controlled by the use of normal temporary erosion control measures, i.e., silt fences, hay bales, mulching, control ditches or diversion trenching, and contour furrowing. Erosion control measures should be in place before the onset of wet weather.

Seismic Hazard

The 2015 International Building Code (IBC), Section 1613.3.2, refers to Chapter 20 of ASCE-7 for Site Class Definitions. It is our opinion that the overall soil profile corresponds to Site Class D as defined by Table 20.3-1 "Site Class Definitions," according to the 2010 ASCE-7 Standard. Site Class D applies to a "stiff soil" profile. The seismic site class is based on a soil profile extending to a depth of 100 feet. The soil borings on this site extended to a maximum depth of 38.5 feet and this seismic site class designation is based on the assumption that similar soil conditions continue below the depth explored.

We referred to the U.S. Geological Survey (USGS) Earthquake Hazards Program Website and 2012/2015 IBC to obtain values for S_S, S_{MS}, S_{DS}, S_1, S_{M1}, S_{D1}, F_a, and F_v. The USGS website includes the most updated published data on seismic conditions. The seismic design parameters for this site are as follows:

Seismic Design Parameters
(Reference: 2015 IBC Section 1613.3.2, ASCE, and USGS)

Seismic Item	Value
Site Coefficient F_a	1.003
S_s	1.243 g
S_{MS}	1.247 g
S_{DS}	0.831 g
Site Coefficient F_v	1.524
S_1	0.476 g
S_{M1}	0.726 g
S_{D1}	0.484 g

Additional seismic considerations include liquefaction potential and amplification of ground motions by loose/soft soil deposits. The liquefaction potential is highest for loose sand with a high groundwater table. Soil liquefaction is a state where soil particles lose contact with each other and become suspended in a viscous fluid. This suspension of the soil grains results in a complete loss of strength as the effective stress drops to zero. Liquefaction normally occurs under saturated conditions in soils such as sand in which the strength is purely frictional. However, liquefaction has occurred in soils other than clean sand. Liquefaction usually occurs under vibratory conditions such as those induced by seismic events.

We have reviewed "Liquefaction Susceptibility Map of Pierce County, Washington" by Stephen P. Palmer et al., (WA DNR, 2004). The map indicates that the site area is located in a zone of high liquefaction susceptibility. At the request of our client, we have conducted a site-specific liquefaction analysis for this project.

To evaluate the liquefaction potential of the site, we analyzed the following factors:

1) Soil type
2) Groundwater depth
3) Relative soil density
4) Initial confining pressure
5) Maximum anticipated intensity and duration of ground shaking

Liquefaction Analysis: The commercially available liquefaction analysis software, LiquefyPro from CivilTech, was used to evaluate the liquefaction potential and the possible liquefaction induced settlement for the site soil and groundwater conditions based on our explorations. The analysis was performed using the information from the soil test boring and laboratory gradation analyses. Maximum

Considered Earthquake (MCE) was selected in accordance with the 2015 International Building Code (IBC) Chapter 16 and the U.S. Geological Survey (USGS) Earthquake Hazards Program website. For this analysis, a maximum earthquake magnitude of 7.11 and peak horizontal ground surface acceleration of 0.5g were used. Our analysis assumed a groundwater depth of 7.0 feet during the earthquake.

The maximum liquefaction induced settlement for this type of seismic event is estimated to be on the order of about 2 inches. The differential settlements are estimated to be on the order of about 1-inch.

CONCLUSIONS AND RECOMMENDATIONS

General

It is our opinion that the planned improvements at this site are feasible, provided that the geotechnical engineering recommendations presented in this report are included in the project design. Based on our explorations, it is our opinion that conventional spread foundations supported on medium dense/stiff or firmer native soil, or on structural fill extending to the medium dense/stiff or firmer native soil would be appropriate for the new buildings.

We recommend that organic topsoil, undocumented fill, and loose/soft soils be stripped to expose the underlying medium dense/stiff or firmer native soil. Footings should extend through any organic or loose soil and be founded on the underlying medium dense or firmer native soil, or structural fill extending to the competent native soils.

Exploration boring B-1 was drilled in the northern portion of the site, in the area of the planned rain garden between Pioneer Way and the Club House and Residential Building E. Boring B-1 encountered a layer of very soft silty clay between 7.5 and 11 feet below the existing ground surface. These materials are not considered suitable to support foundations and will need to be removed where they are encountered. Test pits should be conducted prior to the construction phase to determine the aerial extent (i.e. lateral extent and depth) of this very soft clay layer. If the additional test pit exploration reveals that the soft clay layer extends into the footprint of the Clubhouse or Residential Building E, or any of the other structures, additional foundation recommendations will be necessary to address the effect of the very soft clays. If the very soft clay is encountered in building areas, a deep foundation system may be required for support of the structure(s).

Borings B-2 and B-3 (drilled within the eastern and southern portions of the site) and monitoring well W-2 (installed within the central portion of the site) encountered medium dense/stiff native soils at depths of approximately 5 and 7 feet bgs, respectively; however, deeper layers of loose/soft soils may be encountered in unexplored areas of the site.

The soils encountered on this site are considered moisture-sensitive and will be easily disturbed and difficult to compact when wet. We recommend that construction take place during the drier summer months, if possible. If construction is to take place during wet weather, additional expenses and delays

should be expected due to the wet conditions. Additional expenses could include the need for placing a blanket of rock spalls to protect exposed subgrades and construction traffic areas.

Site Preparation

General site clearing should include removal of any undocumented fill, organics, asphaltic concrete, abandoned utilities, structures including foundations, basement walls and floors, rubble, and rubbish. After stripping operations and removal of any loose and/or debris-laden fill, the exposed subgrade should be visually inspected and/or proof rolled to identify any soft/loose areas. Additional recommendations for preparation of specific areas are provided in **the Foundations, Pavement Design** and **Exterior Flatwork** subsections of this report.

The soils that will be encountered during site development are considered extremely moisture-sensitive and may disturb easily in wet conditions. The prepared subgrade should be protected from construction traffic and surface water should be diverted around prepared subgrade. We recommend that the site be developed only during extended periods of dry weather.

During wet weather conditions, subgrade stability problems and grading difficulties may develop due to excess moisture, disturbance of sensitive soils and/or the presence of perched groundwater. Construction during the extended periods of wet weather could result in the need to remove wet disturbed soils if they cannot be suitably compacted due to elevated moisture contents. The onsite soils have significant silt content in the explored areas and are moisture sensitive, and can be easily disturbed when wet. If over-excavation is necessary, it should be confirmed through continuous monitoring and testing by a qualified geotechnical engineer or geologist. Soils that have become unstable may require drying to near their optimal moisture content before compaction is feasible. Selective drying may be accomplished by scarifying or windrowing surficial material during extended periods of dry, warm weather (typically during the summer months). If the soils cannot be dried back to a workable moisture condition, remedial measures may be required. General project site winterization should consist of the placement of aggregate base and the protection of exposed soils during the construction phase. It should be understood that even if Best Management Practices (BMP's) for wintertime soil protection are implemented and followed there is a significant chance that moisture disturbed soil mitigation work will still be required.

Any buried structures encountered during construction should be properly removed and backfilled. Excavations, depressions, or soft and pliant areas extending below the planned finish subgrade levels should be excavated to expose firm undisturbed soil, and backfilled with structural fill. In general, any septic tanks, underground storage tanks, debris pits, cesspools, or similar structures should be completely removed. Concrete footings should be removed to an equivalent depth of at least 3 feet below proposed footing elevations or as reeommended by the geotechnical engineer. The resulting excavations should be backfilled with structural fill.

We understand that backfilling of the wetland in the central western edge of the site that has been field identified by others will be permitted for construction of the paved parking area and subsurface storm system. We also understand that proposed Residential Building C will be constructed within the area currently occupied by an existing storm pond. Our field explorations were not specifically conducted within either of these areas. Any organic, silt or clay soils, or accumulations of sediment, encountered within the wetland area or the existing storm pond should be removed down to firm undisturbed soil, and backfilled with structural fill to the planned finish grades.

A representative of our firm should be present during all site clearing and grading operations to observe, test and evaluate earthwork construction. This testing and observation is an integral part of our service, as acceptance of earthwork construction is dependent upon compaction and stability of the material. The geotechnical engineer may reject any material that does not meet compaction and stability requirements. Further recommendations, contained in this report, are predicated upon the assumption that earthwork construction will conform to the recommendations set forth in this section and in the Structural Fill section below.

Temporary Excavations

The onsite soils have variable cohesion strengths, therefore the safe angles to which these materials may be cut for temporary excavations is limited, as the soils may be prone to caving and slope failures in temporary excavations. Temporary excavations in the loose to medium dense native soils should be sloped no steeper than 2H:1V (horizontal to vertical) where room permits.

All temporary cuts should be in accordance with Washington Administrative Code (WAC) Part N, Excavation, Trenching, and Shoring. The temporary slope cuts should be visually inspected daily by a qualified person during construction work activities and the results of the inspections should be included in daily reports. The contractor is responsible for maintaining the stability of the temporary cut slopes and minimizing slope erosion during construction. The temporary cut slopes should be covered with plastic sheeting to help minimize erosion during wet weather and the slopes should be closely monitored until the permanent retaining systems are complete. Materials should not be stored and equipment operated within 10 feet of the top of any temporary cut slope.

A Krazan & Associates geologist or geotechnical engineer should observe, at least periodically, the temporary cut slopes during the excavation work. The reasoning for this is that all soil conditions may not be fully delineated by the limited sampling of the site from the geotechnical explorations. In the case of temporary slope cuts, the existing soil conditions may not be fully revealed until the excavation work exposes the soil. Typically, as excavation work progresses the maximum inclination of the temporary slope will need to be evaluated by the geotechnical engineer so that supplemental recommendations can be made. Soil and groundwater conditions can be highly variable. Scheduling for soil work will need to be adjustable, to deal with unanticipated conditions, so that the project can proceed smoothly and required deadlines can be met. If any variations or undesirable conditions are

encountered during construction, Krazan & Associates should be notified so that supplemental recommendations can be made.

Structural Fill

Fill placed beneath foundations, pavement, or other settlement-sensitive structures should be placed as structural fill. Structural fill, by definition, is placed in accordance with prescribed methods and standards, and is monitored by an experienced geotechnical professional. Field monitoring procedures would include the performance of a representative number of in-place density tests to document the attainment of the desired degree of relative compaction. The area to receive the fill should be suitably prepared as described in the Site Preparation subsection of this report prior to beginning fill placement.

Best Management Practices (BMP's) should be followed when considering the suitability of the existing materials for use as structural fill. The on-site soils are generally considered suitable for re-use as structural fill, provided the soil is free of organic material and debris, and it is within ± 2 percent of the optimum moisture content. If the native soils are stockpiled for later use as structural fill, the stockpiles should be covered to protect the soil from wet weather conditions. We recommend that a representative of Krazan & Associates be on site during the excavation work to determine which soils are suitable for use as structural fill.

Imported, all weather structural fill material should consist of well-graded gravel or a sand and gravel mixture with a maximum grain size of 3 inches and less than 5 percent fines (material passing the U.S. Standard No. 200 Sieve). All structural fill material should be submitted for approval to the geotechnical engineer at least 48 hours prior to delivery to the site.

Fill soils should be placed in horizontal lifts not exceeding 8 inches in thickness prior to compaction, moisture-conditioned as necessary (moisture content of soil shall not vary by more than ±2 percent of optimum moisture), and the material should be compacted to at least 95 percent of the maximum dry density based on ASTM D1557 Test Method. In-place density tests should be performed on all structural fill to document proper moisture content and adequate compaction. Additional lifts should not be placed if the previous lift did not meet the compaction requirements or if soil conditions are not considered stable.

Foundations

Our exploratory borings encountered loose to medium dense granular soils underlain by a 3-foot thick stratum of interbedded sandy silt and silty sand, followed by loose to very dense granular alluvial soils to the explored depths. Boring B-1, drilled at the proposed rain garden area in the northern end of the site, encountered a 3.5-foot thick layer of very soft silty clay at a depth of 7.5 feet bgs.

The very soft clay encountered in Boring B-1 between 7.5 and 11 feet below the existing ground surface is not considered suitable to support foundations and will need to be removed where it is encountered.

Further exploration of this area with test pits should be conducted during the planning phase to determine the aerial extent (i.e. lateral extent and depth) of this very soft clay layer. If the additional test pit exploration reveals that the soft clay layer extends into the footprint of the Clubhouse or Residential Building E, or any of the other structures, additional foundation recommendations will be necessary to address the effect of the very soft clays. If the very soft clay is encountered in building areas, a deep foundation system may be required for support of the structure(s).

Borings B-2 and B-3 and monitoring well W-2, drilled within the eastern, southern, and central portions of the site, encountered medium dense/stiff native soils at depths of approximately 5 and 7 feet bgs. however, deeper layers of loose/soft soils may be encountered in unexplored areas of the site.

Pending the findings of further explorations in the northern portion of the site, the proposed structures may be supported on a shallow foundation system. Where loose/soft soils are encountered at the planned footing elevations, the subgrade should be over-excavated to expose suitable bearing soil. The foundation excavations should be evaluated by Krazan & Associates prior to structural fill placement to verify that the foundations will bear on suitable material.

Building foundations should extend at least 18 inches below the lowest adjacent finished ground surface for frost protection and bearing capacity considerations. Footing widths should be based on the anticipated loads and allowable soil bearing pressure, and should conform to current International Building Code (IBC) guidelines. Water should not be allowed to accumulate in foundation excavations. All loose or disturbed soil should be removed from the foundation excavation prior to placing concrete.

For foundations constructed as outlined above, we recommend an allowable design bearing capacity of 2,000 pounds per square foot (psf) may be used for foundation design for this project. A representative of Krazan and Associates should evaluate the foundation bearing soil prior to footing form construction.

Resistance to lateral footing displacement can be computed using an allowable friction factor of 0.35 acting between the bases of foundations and the supporting subgrade. Lateral resistance for footings can alternatively be developed using an allowable equivalent fluid passive pressure of 150 pounds per cubic foot (pcf) acting against the appropriate vertical footing faces (neglecting the upper 12 inches). The allowable friction factor and allowable equivalent fluid passive pressure values include a factor of safety of 1.5. The frictional and passive resistance of the soil may be combined without reduction in determining the total lateral resistance. A 1/3 increase in the above values may be used for short duration wind and seismic loads.

For foundations constructed as recommended, the total static settlement is not expected to exceed 1-inch. Differential settlement, along a 20-foot exterior wall footing, or between adjoining column footings should be less than ½ inch. Most settlement is expected to occur during construction, as the loads are applied. However, additional post-construction settlement may occur if the foundation soils become flooded or saturated. It should be noted that the estimated settlement provided herewith is a

static settlement and does not include liquefaction induced settlement. Static settlement is induced by the applied dead load from the structures.

Up to 2 inches of total settlement and 1 inch of differential settlement could occur during and/or following a seismic event. The foundation elements, i.e. spread and wall footings, could be structurally tied together to create a stiffer structure. It should be noted that this measure would not mitigate the anticipated seismic settlement; however, it may reduce the damage associated with the anticipated seismic settlement, particularly the effects of differential settlement on a structure.

Seasonal rainfall, water run-off, and the normal practice of watering trees and landscaping areas around the proposed structures, should not be permitted to flood and or saturate foundation subgrade soils. To prevent the buildup of water within the footing areas, continuous footing drains (with cleanouts) should be provided at the bases of the footings. The footing drains should consist of a minimum 4-inch diameter rigid perforated PVC pipe, sloped to drain, with perforations placed near the bottom and enveloped in all directions by washed rock and wrapped with filter fabric to limit the migration of silt and clay into the drain.

Lateral Earth Pressures and Retaining Walls

We understand that a below grade stormwater vault is planned for this project. We have developed criteria for the design of retaining or below grade walls for the stormwater vault. Our design parameters are based on retention of the native soils. The parameters are also based on level, well-drained wall backfill conditions. Walls may be designed as "restrained" retaining walls based on "at-rest" earth pressures, plus any surcharge on top of the walls as described below, if the walls are braced to restrain movement and/or movement is not acceptable. Unrestrained walls may be designed based on "active" earth pressure, if the walls are not part of the buildings and some movement of the retaining walls is acceptable. Acceptable lateral movement equal to at least 0.2 percent of the wall height would warrant the use of "active" earth pressure values for design. We recommend that walls supporting horizontal backfill and not subjected to hydrostatic forces be designed using a triangular earth pressure distribution equivalent to that exerted by a fluid with a density of 38 pcf for yielding (active condition) walls, and 60 pcf for non-yielding (at-rest condition) walls.

The stated lateral earth pressures do not include the effects of hydrostatic pressure generated by water accumulation behind the retaining walls or loads imposed by construction equipment, foundations, back slopes or roadways (surcharge loads). Groundwater was encountered in each of the borings at 7 to 8 feet below the ground surface. Portions of the vault that will extend below the groundwater level will need to be designed to resist hydrostatic pressures and buoyant forces. Equivalent fluid densities for buoyant soil pressure under yielding conditions would be 20 pcf and 30 pcf for nonyielding conditions. The allowable buoyant passive pressure would be 100 pcf with a factor of safety of 2.0.

Floor Slabs and Exterior Flatwork

Before the placement of concrete floors or pavements on the site, or before any floor supporting fill is placed, the loose soils and undocumented fill must be removed to expose medium dense or firmer undisturbed native soil. The subgrade should then be proof-rolled to confirm that the subgrade contains no soft or deflecting areas. Areas of yielding soils should be excavated and backfilled with structural fill.

Any additional fill used to increase the elevation of the floor slab should meet the requirements of structural fill. Fill soils should be placed in horizontal lifts not exceeding 8 inches loose thickness, moisture-conditioned as necessary, (moisture content of soil shall not vary by more than ±2 percent of optimum moisture) and the material should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557.

Floor slabs may be designed using a modulus of subgrade reaction value of k = 200 pounds per cubic inch (pci) for slabs supported on medium dense or firmer native soils or on structural fill extending to medium dense or firmer native soil.

In areas where it is desired to reduce floor dampness, such as areas covered with moisture sensitive floor coverings, we recommend that concrete slab-on-grade floors be underlain by a water vapor retarder system. According to ASTM guidelines, the water vapor retarder should consist of a vapor retarder sheeting underlain by a minimum of 4-inches of compacted clean (less than 5 percent passing the U.S. Standard No. 200 Sieve), open-graded angular rock of ¾-inch maximum size. The vapor retarder sheeting should be protected from puncture damage.

It is recommended that the utility trenches within the building pads be compacted, as specified in our report, to minimize the transmission of moisture through the utility trench backfill. Special attention to the drainage and irrigation adjacent to the buildings is recommended. Grading should establish drainage away from the structures and this drainage pattern should be maintained. Water should not be allowed to collect adjacent to the structures. Excessive irrigation within landscaped areas adjacent to the structure should not be allowed to occur. In addition, ventilation of the structure may be prudent to reduce the accumulation of interior moisture.

Erosion and Sediment Control

Erosion and sediment control (ESC) is used to minimize the transportation of sediment to wetlands, streams, lakes, drainage systems, and adjacent properties. Erosion and sediment control measures should be implemented and these measures should be in general accordance with local regulations. As a minimum, the following basic recommendations should be incorporated into the design of the erosion and sediment control features of the site:

1) Phase the soil, foundation, utility and other work, requiring excavation or the disturbance of the site soils, to take place during the dry season (generally May through September). However, provided precautions are taken using Best Management Practices (BMP's), grading activities can be undertaken during the wet season (generally October through April), but it should also be known that this may increase the overall cost of the project.

2) All site work should be completed and stabilized as quickly as possible.

3) Additional perimeter erosion and sediment control features may be required to reduce the possibility of sediment entering the surface water. This may include additional silt fences, silt fences with a higher Apparent Opening Size (AOS), construction of a berm, or other filtration systems.

4) Any runoff generated by dewatering discharge should be treated through construction of a sediment trap if there is sufficient space. If space is limited, other filtration methods will need to be incorporated.

Groundwater Influence on Structures and Earthwork Construction

The soil borings were checked for the presence of groundwater during exploratory operations. Groundwater was encountered in all of our borings at approximately 7 to 8 feet bgs. It should be recognized that groundwater elevations may fluctuate with time. The groundwater level will be dependent upon seasonal precipitation, irrigation, land use, and climatic conditions, as well as other factors. Therefore, groundwater levels at the time of the field investigation may be different from those encountered during the construction phase of the project. The evaluation of such factors is beyond the scope of this report.

If groundwater is encountered during construction, we should observe the conditions to determine if dewatering will be needed. Design of temporary dewatering systems to remove groundwater should be the responsibility of the contractor. If earthwork is performed during or soon after periods of precipitation, the subgrade soils may become saturated. These soils may "pump," and the materials may not respond to densification techniques. Typical remedial measures include: disking and aerating the soil during dry weather; mixing the soil with drier materials; removing and replacing the soil with an approved fill material. A qualified geotechnical engineering firm should be consulted prior to implementing remedial measures to observe the unstable subgrade conditions and provide appropriate recommendations.

Drainage

The ground surface should slope away from building pads and pavement areas, toward appropriate drop inlets or other surface drainage devices. It is recommended that adjacent exterior grades be sloped a

minimum of 2 percent for a minimum distance of 5 feet away from structures. Roof drains should be tightlined away from foundations. Roof drains should not be connected to the footing drains.

Pavement areas should be inclined at a minimum of 1 percent and drainage gradients should be maintained to carry all surface water to collection facilities and suitable outlets. These grades should be maintained for the life of the project.

Specific recommendations for and design of storm water disposal systems or septic disposal systems are beyond the scope of our services and should be prepared by other consultants that are familiar with design and discharge requirements.

Utility Trench Backfill

Utility trenches should be excavated according to accepted engineering practices following OSHA (Occupational Safety and Health Administration) standards, by a contractor experienced in such work. The responsibility for the safety of open trenches should be borne by the contractor. Traffic and vibration adjacent to trench walls should be minimized; cyclic wetting and drying of excavation side slopes should be avoided.

All utility trench backfill should consist of suitable on-site material or imported granular material. Utility trench backfill placed in or adjacent to buildings and exterior slabs should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. The upper 5 feet of utility trench backfill placed in pavement areas should be compacted to at least 95 percent of the maximum dry density based on ASTM Test Method D1557. Below 5 feet, utility trench backfill in pavement areas should be compacted to at least 90 percent of the maximum dry density based on ASTM Test Method D1557. Pipe bedding should be in accordance with the pipe manufacturer's recommendations.

The contractor is responsible for removing all water-sensitive soils from the trenches regardless of the backfill location and compaction requirements. The contractor should use appropriate equipment and methods to avoid damage to the utilities and/or structures during fill placement and compaction.

Pavement Design

Based on our explorations, the near surface soils at the site are interpreted as loose to medium dense silty sand and sand soils to depths of approximately 4.5 to 7.0 feet bgs. Due to the loose nature of the anticipated pavement subgrade soils, we recommend that subgrade modification techniques be considered. Subgrade modification typically includes the over-excavation of unsuitable materials, the placement of a geotextile fabric at the bottom of the over-excavated area, and then the placement of structural fill, with the structural fill consisting of clean crushed rock, rock spalls, or Controlled Density Fill (CDF). We recommend the use of a high-strength geotextile separation fabric, such as Mirafi 600X

or equivalent, for the geotextile. Subgrade modification such as this is intended to disperse surcharge loads and therefore aid in pavement performance.

Where loose soils are encountered in the pavement subgrade, we recommend over-excavation of the loose soil to at least 12 inches below the planned pavement subgrade elevation. The exposed grade after the over-excavation should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. We recommend that a high-strength geotextile separation fabric, such as Mirafi 600X or equivalent, then be placed over the compacted soil. After the fabric is placed, the area should be filled to the planned slab subgrade elevation with structural fill. The structural fill should be compacted to at least 95 percent of the maximum dry density as determined by ASTM Test Method D1557. In-place density tests should be performed to verify proper moisture content and adequate compaction.

In areas where the pavement subgrade soil consists of firm and unyielding native soils, a proof roll of the pavement subgrade soil may be performed in lieu of the compaction and in-place density tests. It should be noted that subgrade soils that have relatively high silt contents may be highly sensitive to moisture conditions. The subgrade strength and performance characteristics of a silty subgrade material may be dramatically reduced if this material becomes wet.

Traffic loads were not provided, however, based on our knowledge of the proposed project, we expect the traffic to range from light duty (passenger automobiles) to heavy duty (delivery and fire trucks). Pavement design life of 20 years was assumed for our analysis. Recommendations for an asphaltic concrete flexible pavement section and Portland Cement Concrete (PCC) rigid pavement section are provided in Tables 1 and 2 below.

Table 1: ASPHALTIC CONCRETE (FLEXIBLE) PAVEMENT

Asphaltic Concrete	Aggregate Base	Compacted Subgrade**
3.0 in.	6.0 in.	12.0 in.

Table 2: PORTLAND CEMENT CONCRETE (RIGID) PAVEMENT
4000 psi with FIBER MESH

Min. PCC Depth	Aggregate Base	Compacted Subgrade**
6.0 in.	4.0 in.	12.0 in.

*** A proof roll may be performed in lieu of in-place density tests*

The asphaltic concrete depth listed in Table 1 for the flexible pavement section should be a surface course type asphalt, such as Washington Department of Transportation (WSDOT) ½-inch Hot Mix Asphalt (HMA). The pavement specification in Appendix C provides additional recommendations, including aggregate base material.

Testing and Inspection

A representative of Krazan & Associates, Inc. should be present at the site during the earthwork activities to confirm that actual subsurface conditions are consistent with the exploratory fieldwork. This activity is an integral part of our services as acceptance of earthwork construction is dependent upon compaction testing and stability of the material. This representative can also verify that the intent of these recommendations is incorporated into the project design and construction. We should also be present during the construction of stormwater management system to evaluate the soils. Krazan & Associates, Inc. will not be responsible for grades or staking, since this is the responsibility of the Prime Contractor. Furthermore, Krazan & Associates is not responsible for the contractor's procedures, methods, scheduling or management of the work site.

LIMITATIONS

Geotechnical engineering is one of the newest divisions of Civil Engineering. This branch of Civil Engineering is constantly improving as new technologies and understanding of earth sciences improves. Although your site was analyzed using the most appropriate current techniques and methods, undoubtedly there will be substantial future improvements in this branch of engineering. In addition to improvements in the field of geotechnical engineering, physical changes in the site either due to excavation or fill placement, new agency regulations or possible changes in the proposed structure after the time of completion of the soils report may require the soils report to be professionally reviewed. In light of this, the owner should be aware that there is a practical limit to the usefulness of this report without critical review. Although the time limit for this review is strictly arbitrary, it is suggested that two years be considered a reasonable time for the usefulness of this report.

Foundation and earthwork construction is characterized by the presence of a calculated risk that soil and groundwater conditions have been fully revealed by the original foundation investigation. This risk is derived from the practical necessity of basing interpretations and design conclusions on limited sampling of the earth. Our report, design conclusions and interpretations should not be construed as a warranty of the subsurface conditions. Actual subsurface conditions may differ, sometimes significantly, from those indicated in this report. The recommendations made in this report are based on the assumption that soil conditions do not vary significantly from those disclosed during our field investigation. The findings and conclusions of this report can be affected by the passage of time, such as seasonal weather conditions, manmade influences, such as construction on or adjacent to the site, natural events such as earthquakes, slope instability, flooding, or groundwater fluctuations. If any variations or undesirable conditions are encountered during construction, the geotechnical engineer should be notified so that supplemental recommendations can be made.

The conclusions of this report are based on the information provided regarding the proposed construction. If the proposed construction is relocated or redesigned, the conclusions in this report may not be valid. The geotechnical engineer should be notified of any changes so that the recommendations can be reviewed and reevaluated.

Misinterpretations of this report by other design team members can result in project delays and cost overruns. These risks can be reduced by having Krazan & Associates, Inc. involved with the design teams' meetings and discussions after submitting the report. Krazan & Associates, Inc. should also be retained for reviewing pertinent elements of the design team's plans and specifications. Contractors can also misinterpret this report. To reduce this, risk Krazan & Associates. Inc. should participate in pre-bid and preconstruction meetings, and provide construction observations during the site work.

This report is a geotechnical engineering investigation with the purpose of evaluating the soil conditions in terms of foundation design. The scope of our services did not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands. Any statements or absence of statements, in this report or on any soils log regarding odors, unusual or suspicious items, or conditions observed are strictly for descriptive purposes and are not intended to convey engineering judgment regarding potential hazardous and/or toxic assessments.

The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments. We emphasize that this report is valid for this project as outlined above, and should not be used for any other site. Our report is prepared for the exclusive use of our client. No other party may rely on the product of our services unless we agree in advance to such reliance in writing.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC.

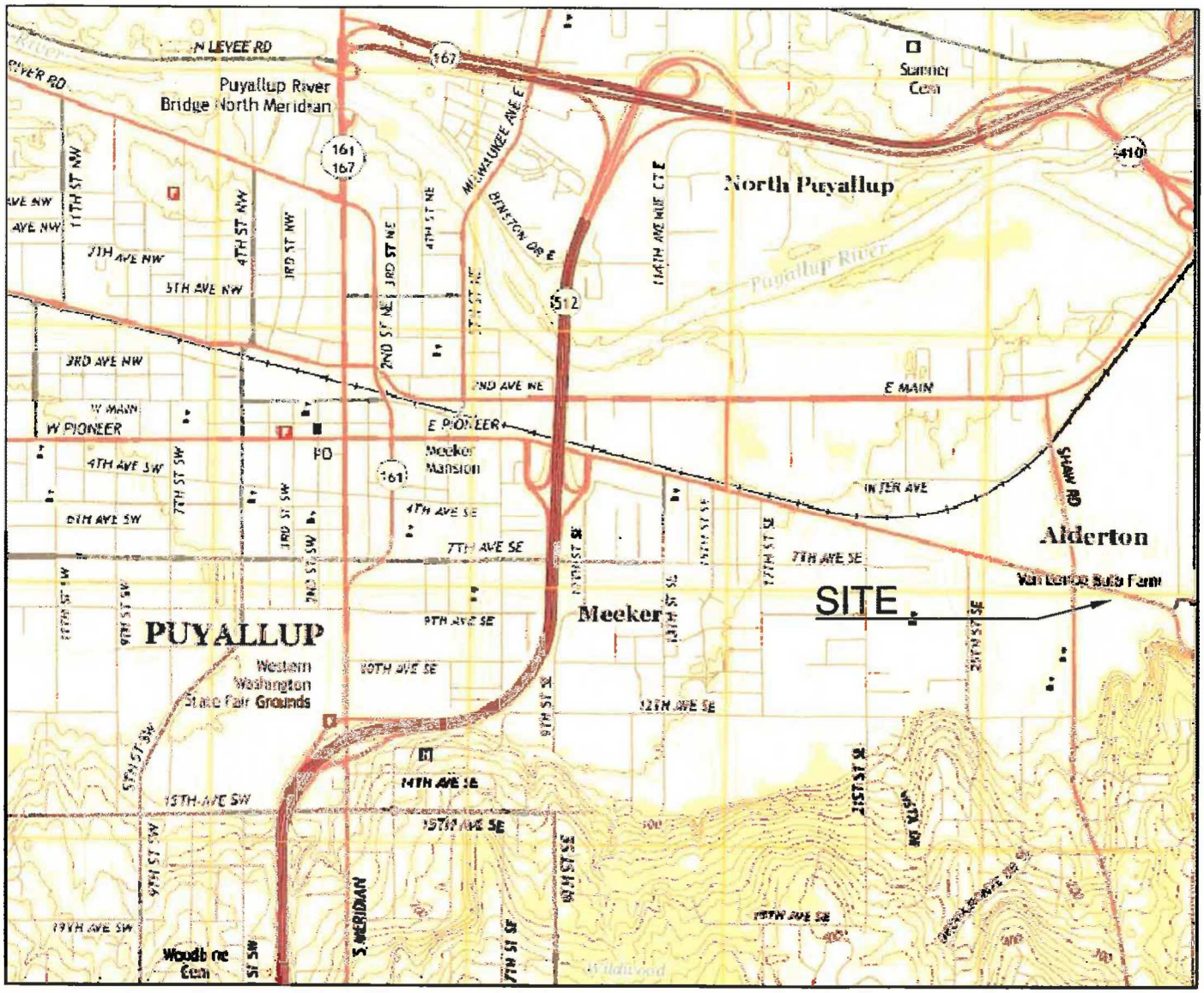
04/11/19

Theresa R. Nunan

Michael D. Rundquist, P.E.
Senior Project Manager

Theresa R. Nunan
Project Engineer

TRN:MDR



Reference: USGS topographic map website, Puyallup, WA, dated 2017.

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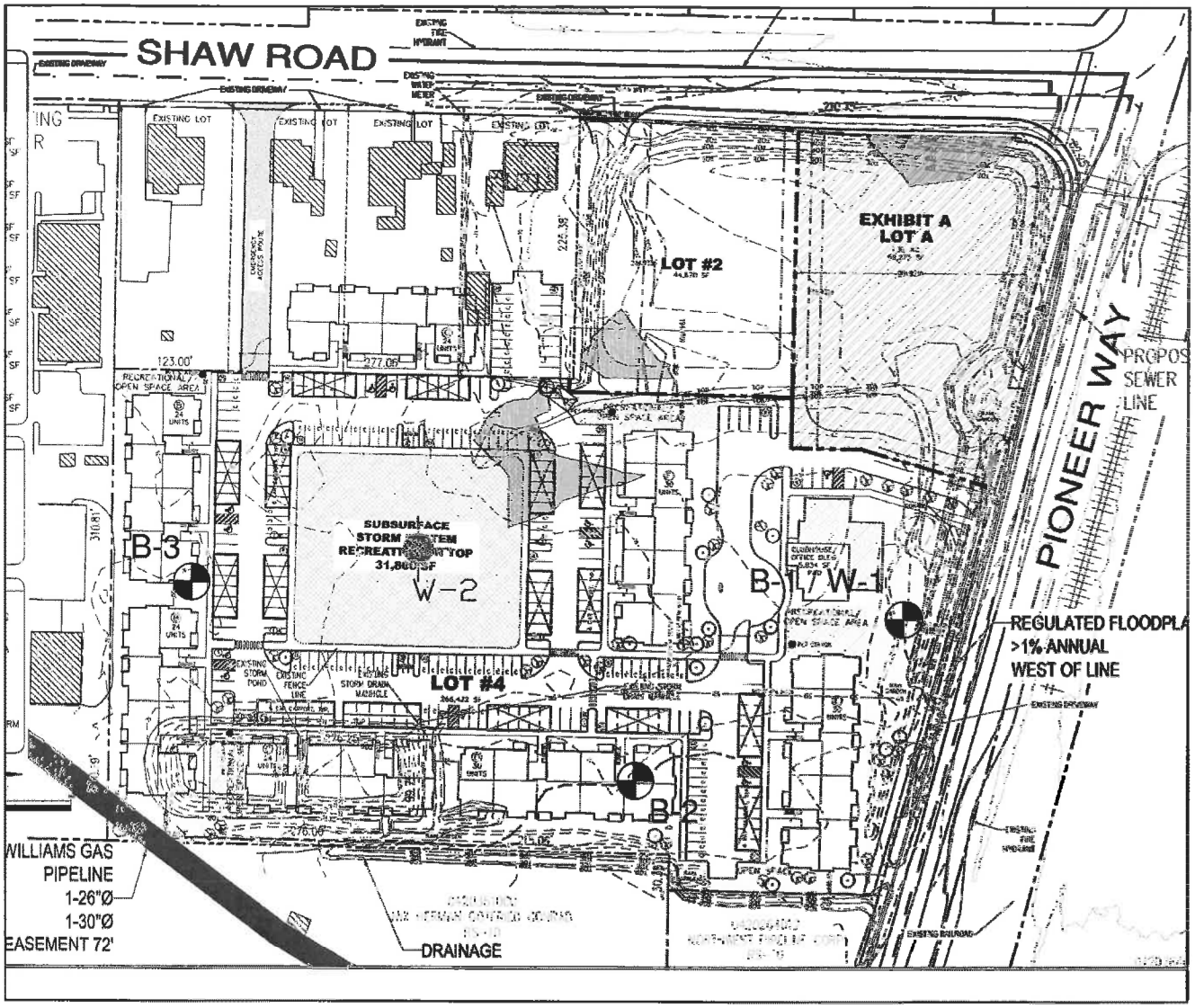
Vicinity Map

East Town Crossing	Figure 1
Shaw Rd & E Pioneer Way, Puyallup, WA	
Project Number: 062-19007	Drawn By: T. Nunan Date: April 2019
Krazan & ASSOCIATES, INC.	Not to Scale



LEGEND

- B-1 Number and Approximate Location of Borings
- W-1 Approximate Location of Monitoring Well

N

Reference: Plan Sheet titled "Overall Site Plan", prepared by Abbey Road Group dated December 7, 2018.

Site Plan

East Town Crossing	Figure 2
Shaw Rd & E Pioneer Way, Puyallup, WA	
Project Number: 062-19007	Drawn By: T. Nunan Date: April 2019
Krazan & ASSOCIATES, INC.	Not to Scale

APPENDIX A

FIELD INVESTIGATION AND LABORATORY TESTING

Field Investigation

The field investigation consisted of a surface reconnaissance and a subsurface exploration program. Exploratory borings and monitoring wells were drilled and sampled for subsurface exploration at this site. The soil explorations reached depths of approximately 38.5 feet below the existing ground surface. The approximate exploratory boring locations are shown on the Site Plan (Figure 2). The logs of the soil explorations and monitoring wells are presented in this appendix. The depths shown on the attached logs are from the existing ground surface at the time of our exploration.

The drilled borings were advanced using a subcontracted drilling rig. Soil samples were obtained by using the Standard Penetration Test (SPT) as described in ASTM Test Method D1586. The Standard Penetration Test and sampling method consists of driving a standard 2-inch outside-diameter, split barrel sampler into the subsoil with a 140-pound hammer free falling a vertical distance of 30 inches. The summation of hammer-blows required to drive the sampler the final 12-inches of an 18-inch sample interval is defined as the Standard Penetration Resistance, or N-value. The blow count is presented graphically on the boring logs in this appendix. The resistance, or "N" value, provides a measure of the relative density of granular soils or of the relative consistency of cohesive soils.

The soils encountered were logged in the field during the exploration and are described in general accordance with the Unified Soil Classification System (USCS). All samples were returned to our laboratory for evaluation.

Laboratory Testing

The laboratory testing program was developed primarily to determine the index properties of the soils. Test results were used for soil classification and as criteria for determining the engineering suitability of the surface and subsurface materials encountered.

Krazan & ASSOCIATES, INC.

Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.**	**B-1**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat	
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers	
Notes: Monitoring Well W-1 installed in borehole.	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual	
Ground Surface Elevation: 72 +/- feet MSL	**Groundwater Depth:** 8 feet	**Groundwater Elev.:**	**Total Depth of Boring:** 21.5 ft.	

Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
		SPT	1-1	1 6 9	15		Brown Silty SAND (SM), trace gravel and very thin roots, with occassional 6 to 8-inch thick stiff sandy clay layers, medium dense, moist	
							Brownsih Grey Poorly Graded SAND (SP), fine grained, medium dense, moist	
	5	SPT	1-2A 1-2B	4 5 5	10		Alternating 4 to 12-inch thick layers of brown Sandy SILT (ML) and Silty SAND (SM), medium stiff/loose, moist to wet	% Si/Cl = 78.5 % MC = 35.4
		SPT	1-3A 1-3B	1 1/12"	1/12"		Dark Brownish Grey Silty CLAY (CL) with marsh grass, seams of peat and thin roots, very soft, wet - - - Becomes Clayey SILT (ML), with fine sand and thin roots, very soft	LL = 35 PI = 1 % F. Sa = 19.8 % Si/Cl = 79.1 % MC = 51.2
	10	SPT	1-4	1 2 6	8		Dark Grey/Black Silty SAND (SM), fine to medium grained, loose, wet	
	15	SPT	1-5	5 4 4	8		- - - Same	
	20	SPT	1-6	4 12 12	24		- - - Becomes Poorly Graded SAND (SP-SM) with Silt, fine to medium grained, medium dense, wet	
	25						**End of Boring at 21.5 Feet**	

Krazan & ASSOCIATES, INC.

Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Roac Group	**Boring No.**	**B-2**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat	
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers	
Notes:	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb Manual	
Ground Surface Elevation: 73 +/- feet MSL	**Groundwater Depth:** 8 feet	**Groundwater Elev.:**	**Total Depth of Boring:** 38.5 ft.	

Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
							5 inches Grass and Topsoil	
		SPT	2-1	2 2 5	7		Brown Silty SAND (SM), fine grained, with occassional sandy clay seams, loose, moist	
	5	SPT	2-2	3 4 2	6		- - - Same	% Si/Cl = 42.9 % MC = 29.3
		SPT	2-3	4 8 11	19		Brownish Grey Sandy SILT (ML), fine grained, with occassional 1 to 2-inch thick seams dark grey fine sand, moist to wet, stiff	% Si/Cl = 88.2 % MC = 37.0
	10	SPT	2-4	5 8 8	16		Dark Grey/Black Silty SAND (SM), fine to medium grained, medium dense, wet	% Si/Cl = 14.5 % MC = 25.0
	15	SPT	2-5	28 12 12	24		- - - Becomes Sand (SP-SM) with Silt, fine to medium grained, medium dense	% Grav = 0 % Sa = 90.8 % Si/Cl = 8.9 % MC = 22.6
							- - - At 18 feet, drilling choppy due to lots of gravel	
	20	SPT	2-6	18 40 20/8"	60/8"		Dark Grey/Black Poorly Graded GRAVEL (GP-GM) with sand and silt, very dense, wet	
	25							

Krazan & ASSOCIATES, INC.

Project: East Town Crossing		**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.** B-2
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA				**Drilling Company:** Geologic Drill Partners
Project Manager: Theresa Nunan	**Date**	**Started:** 3.11.2019		**Equipment:** Track Bobcat
Field Engineer: Theresa Nunan		**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers
Notes:		**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual
Ground Surface Elevation: 73 +/- feet MSL		**Groundwater Depth:** 8 feet	**Groundwater Elev.:**	**Total Depth of Boring:** 38.5 ft.

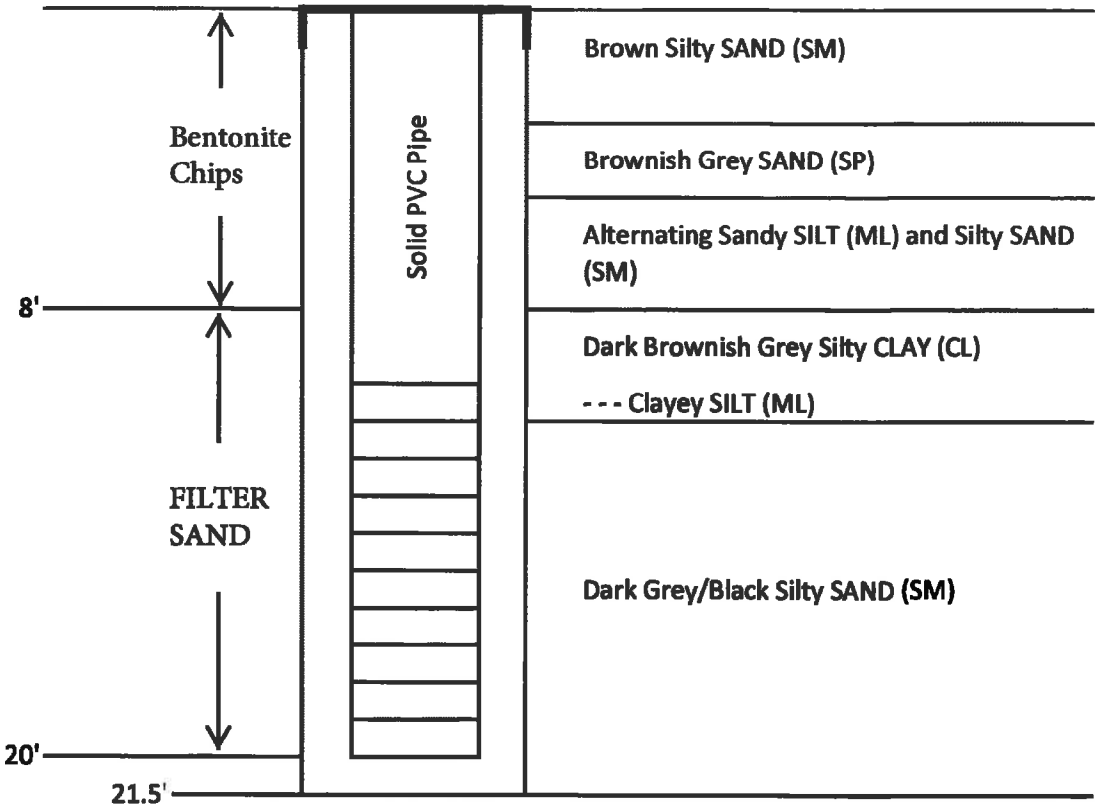
Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
	25	SPT	2-7	10 9 14	23		Dark Grey SAND (SP-SM) with Silt, trace gravel, fine to coarse grained, with occassional 3 to 4-inch thick seams gravel (GP-GM) with silt, medium dense, wet	
	30	SPT	2-8	4 **4** 15	**19**		- - - Same	% Grav = 9.0 % Sa = 82.5 % Si/Cl = 8.5 % MC = 18.8
	35	SPT	2-9	6 5 10	15		At 33 feet, alternating 4 to 12-inch thick layers of Dark Grey/Black SAND (SP-SM) with gravel and silt AND Dark Grey/Black GRAVEL (GP-GM) with sand and silt, medium dense, wet	% Si/Cl = 5.6 % MC = 18.9
		SPT	2-10	37 20 17	37		- - - Becomes dense	% Grav = 44.8 % Sa = 47.4 % Si/Cl = 7.8 % MC = 9.4
	40						**End of Boring at 38.5 Feet**	
	45							
	50							

Krazan & ASSOCIATES, INC.

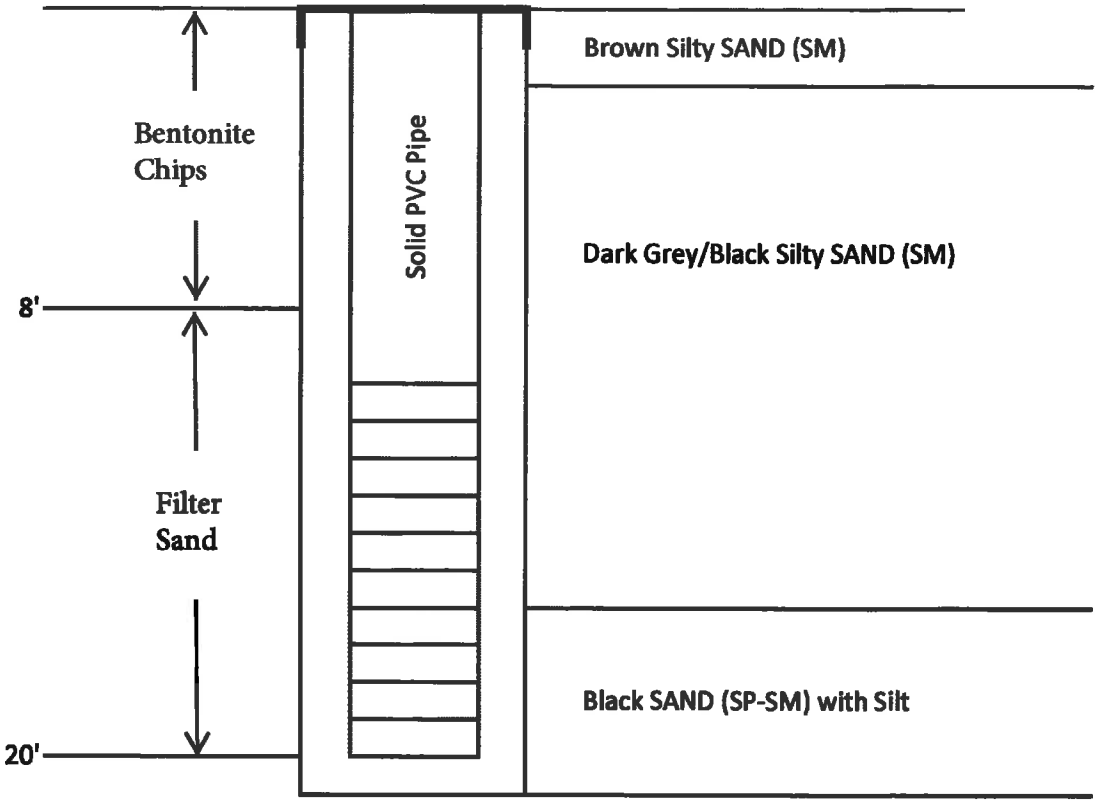
Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.**	**B-3**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** Track Bobcat	
Field Engineer: Theresa Nunan	**Completed:** 3.11.2019		**Drilling Method:** Hollow Stem Augers	
Notes:	**Backfilled:** 3.11.2019		**Hammer Type:** 140-lb. Manual	
Ground Surface Elevation: 74 +/- feet MSL	**Groundwater Depth:** 7 feet		**Total Depth of Boring:** 21.5 ft.	

Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
		SPT	3-1	2 4 5	9		Brown Silty SAND (SM), trace gravel and very thin roots, with occassional 2 to 3-inch thick stiff sandy clay layers, loose, moist	
	5	SPT	3-2	4 6 6	12		Brownish Grey Sandy SILT (ML), fine grained, with occassional 0.5 to 2-inch thick seams dark grey fine sand, stiff, moist to wet, stiff	
		SPT	3-3	5 5 5	10		Dark Grey/Black Silty SAND (SM), fine to medium grained, medium dense, wet	
	10	SPT	3-4	3 5 7	12		--- Becomes Sand (SP-SM) with Silt, fine to medium grained, medium dense, wet	
	15	SPT	3-5	6 10 7	17		Dark Grey/Black Silty SAND (SM), fine to medium grained, with a 4-inch thick seam of peat at 20 feet, medium dense, wet	
	20	SPT	3-6	4 6 8	14		**End of Boring at 21.5 Feet**	
	25							

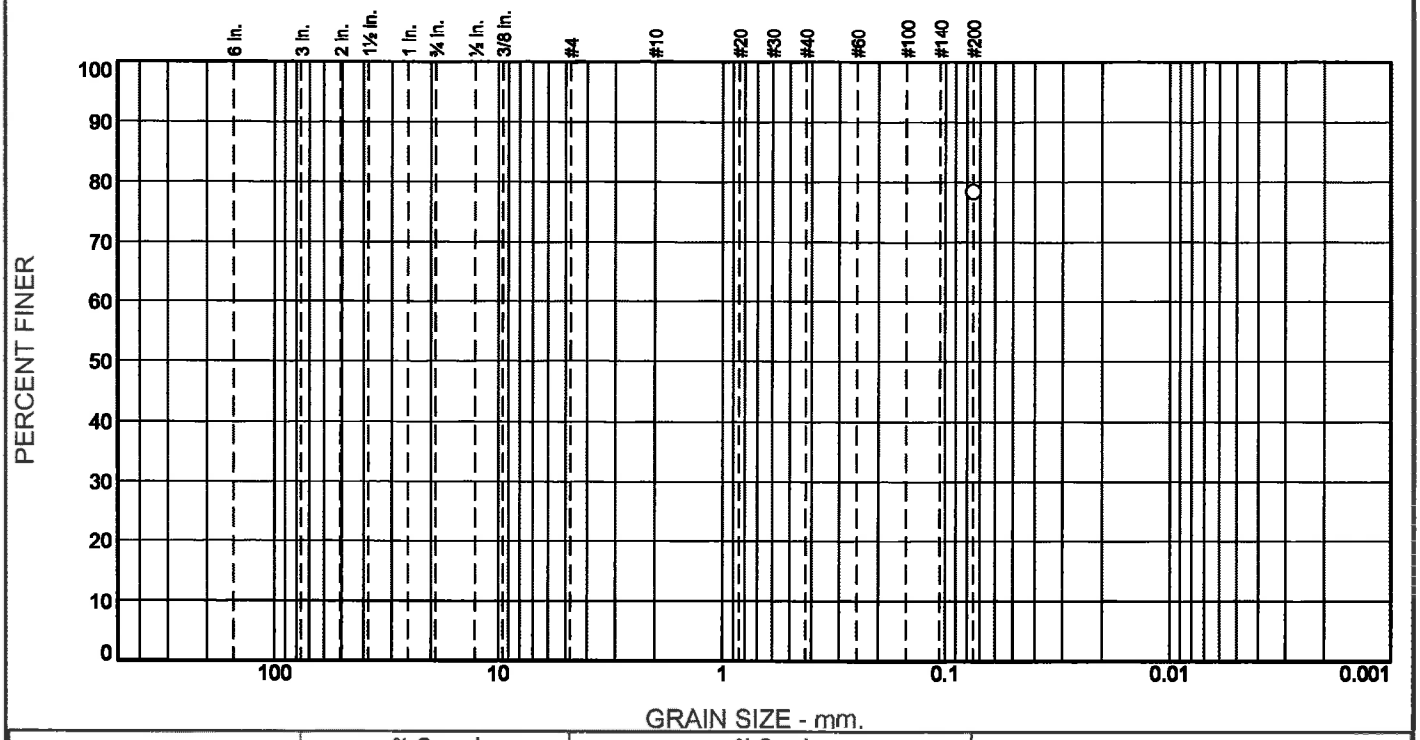
Monitoring Well
MW-1



Monitoring Well
MW-2



Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						78.5

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	78.5		

* (no specification provided)

Material Description

Brown Sandy SILT

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= ML AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L131
Sample Date:3-11-19
Moisture Content = 35.4 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-1 Sample 1-2B
Sample Number: 19L131 **Depth:** 5'-6.5'

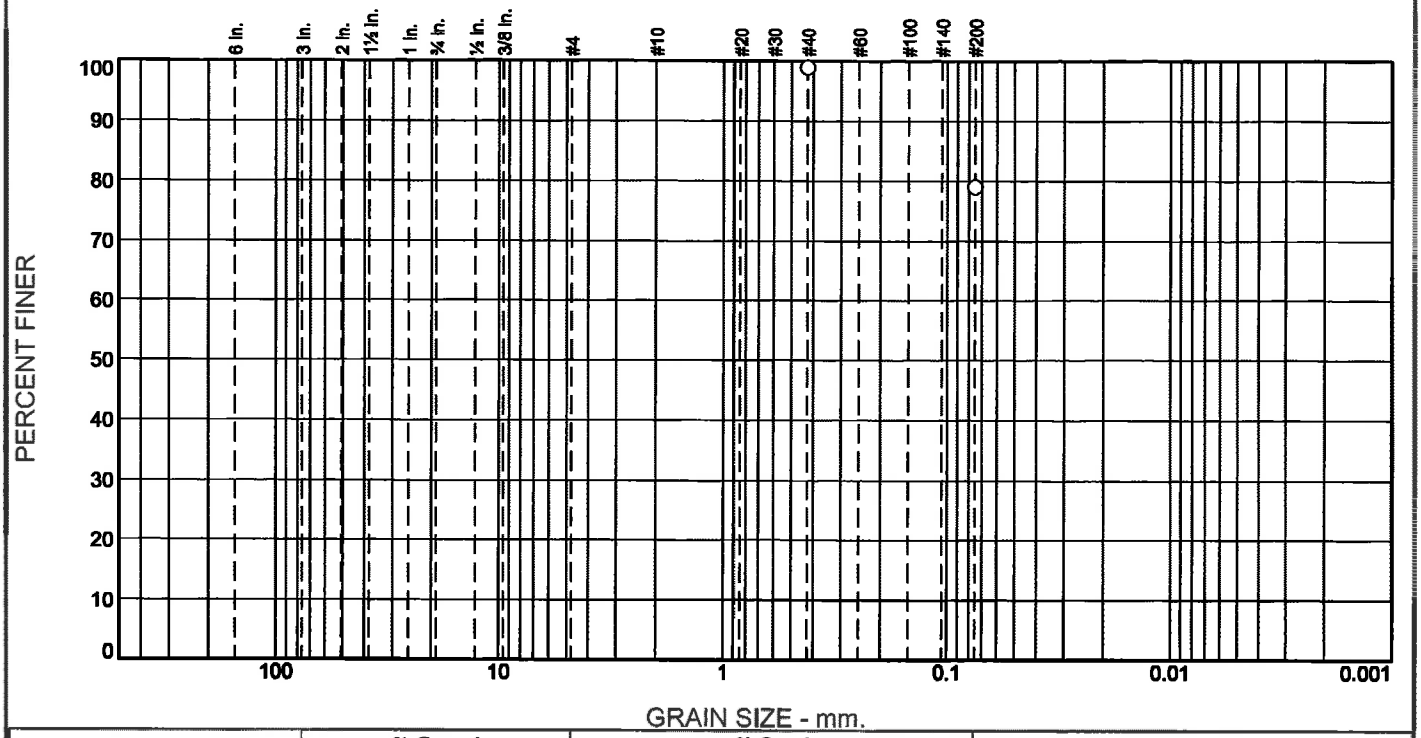
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
					19.8	79.1

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#40	98.9		
#200	79.1		

* (no specification provided)

Material Description

Grey Clayey SILT **with fine sand**

Atterberg Limits (ASTM D 4318)

PL= 33.5 LL= 34.9 PI= 1.4

Classification

USCS (D 2487)= ML AASHTO (M 145)=

Coefficients

D_{90}= 0.1948 D_{85}= 0.1258 D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L120
Sample Date:3-11-19
Moisture Content = 51.2 %

Date Received: 3-15-19 **Date Tested:** 3-15-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-1 Sample 1-3B
Sample Number: 19L120 **Depth:** 7.5'-9'

Date Sampled: 3-11-19

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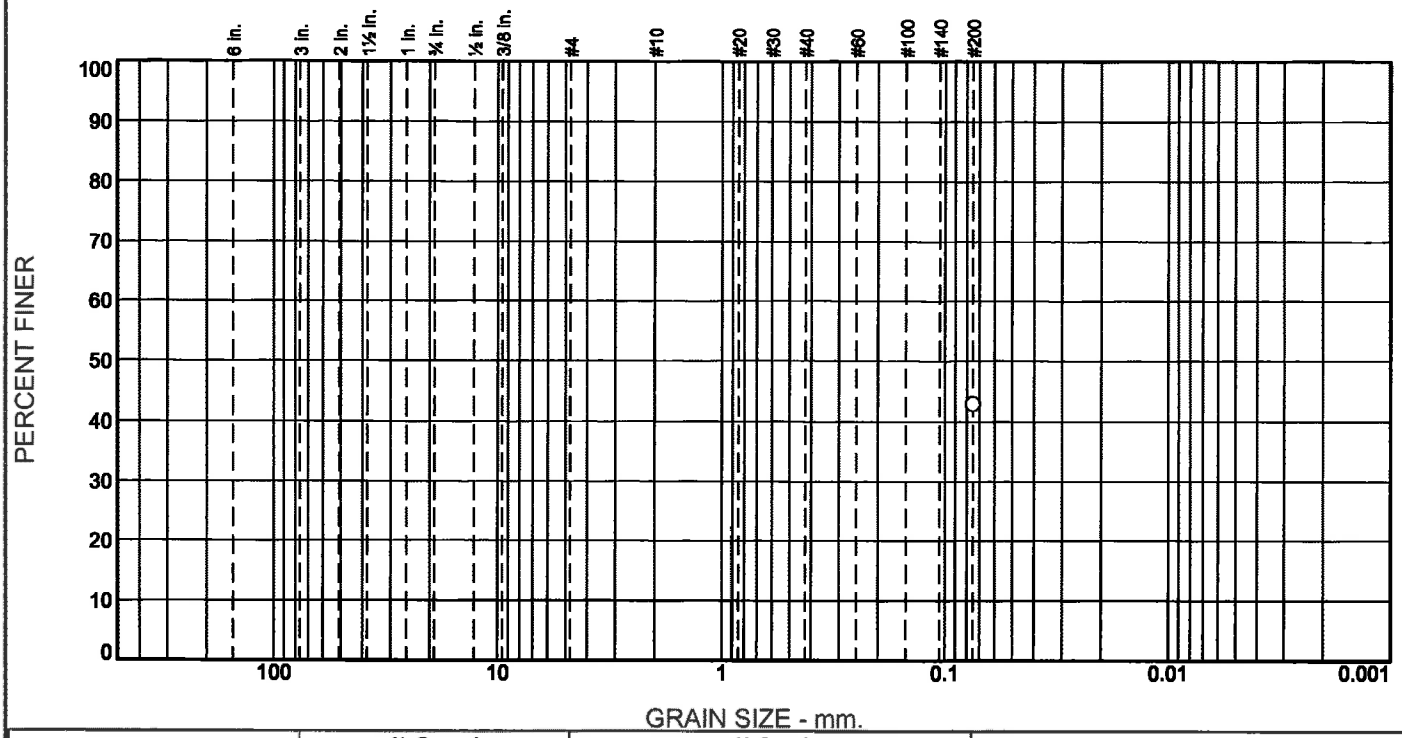
Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						42.9

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	42.9		

* (no specification provided)

Material Description

Brown silty sand.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L132
Sample Date:3-11-19
Moisture Content = 29.3 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-2
Sample Number: 19L132 **Depth:** 5'-6.5'

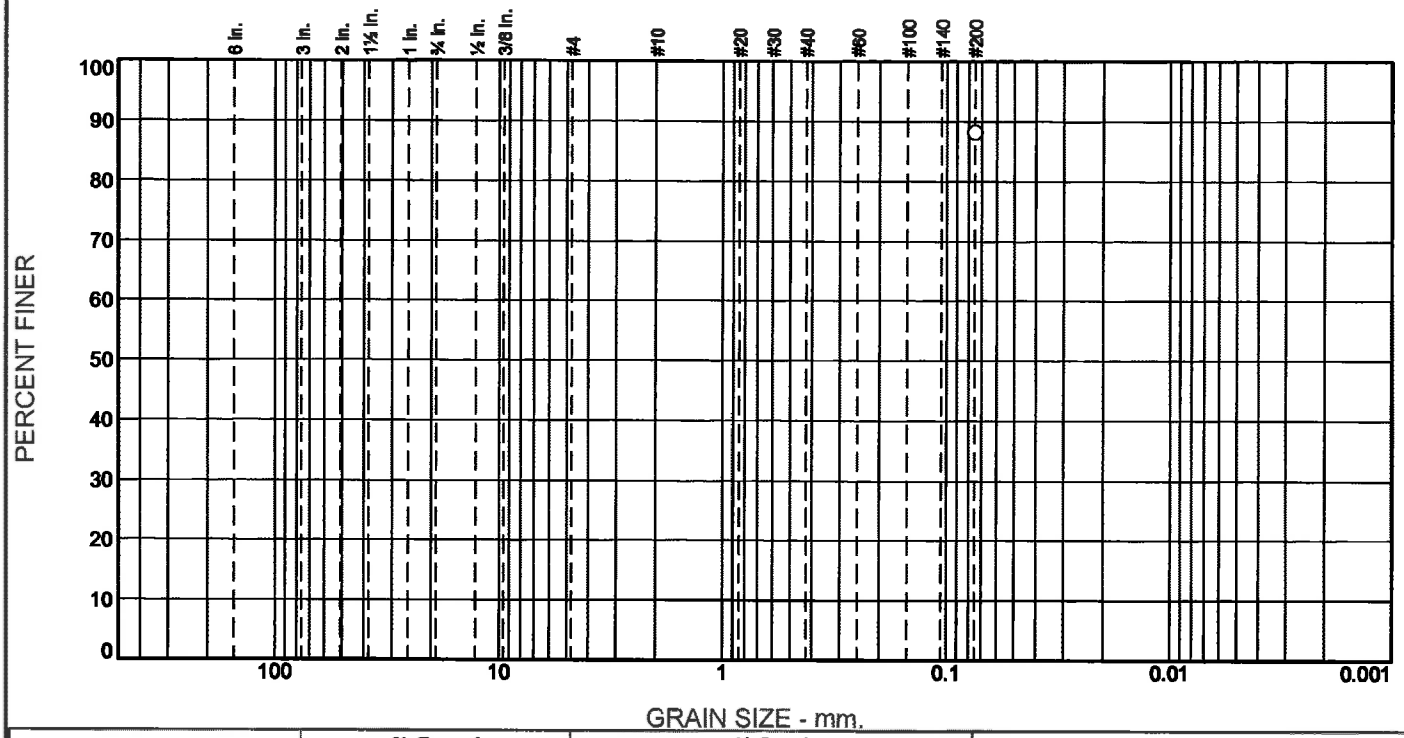
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						88.2

TEST RESULTS

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	88.2		

* (no specification provided)

Material Description

Brown sandy silt.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= ML AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L133
Sample Date:3-11-19
Moisture Content = 37.0%

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-3
Sample Number: 19L133 **Depth:** 7.5'-9'

Date Sampled: 3-11-19

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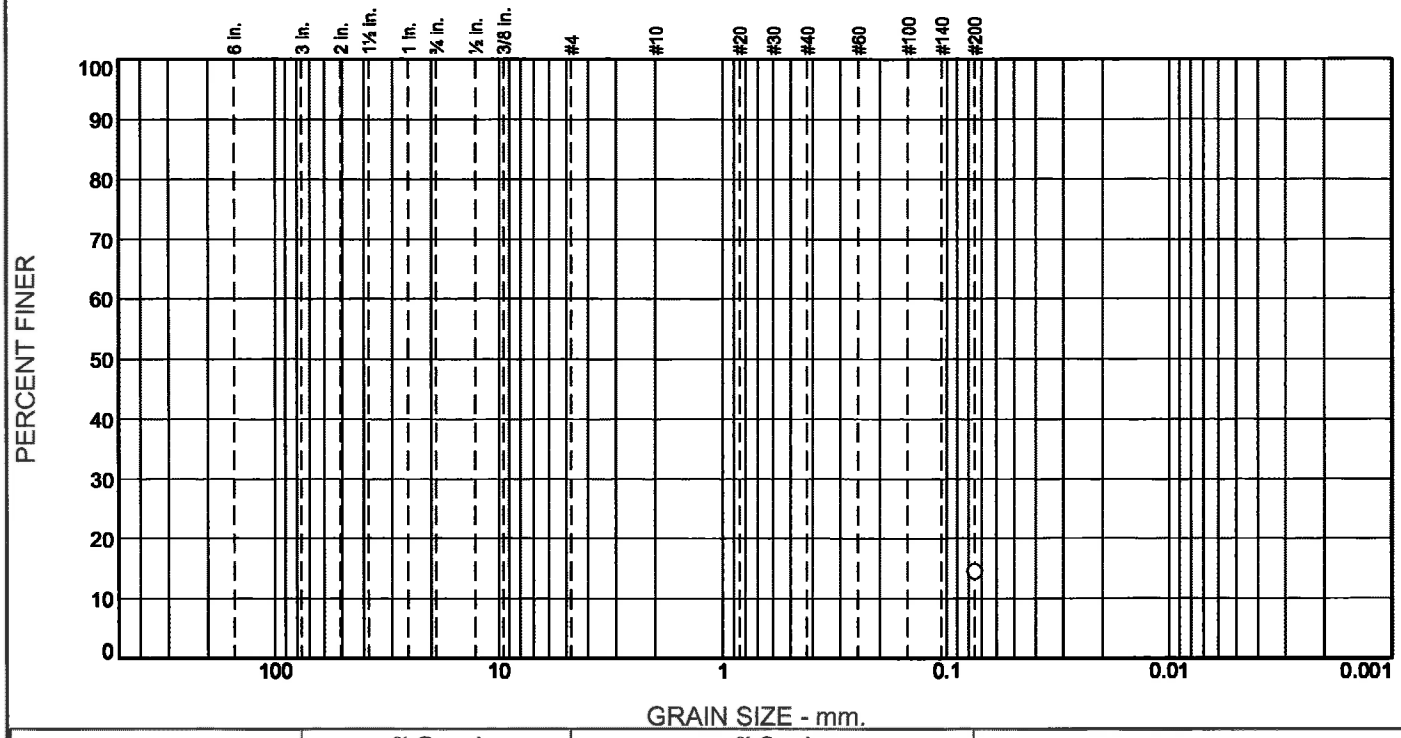
Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						14.5

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	14.5		

* (no specification provided)

Material Description

Dark Grey/Black silty sand.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

USCS (D 2487)= SM AASHTO (M 145)=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L134
sample Date:3-11-19
Moisture Content = 25.0 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-4
Sample Number: 19L134 **Depth:** 10'-11.5'

Date Sampled: 3-11-19

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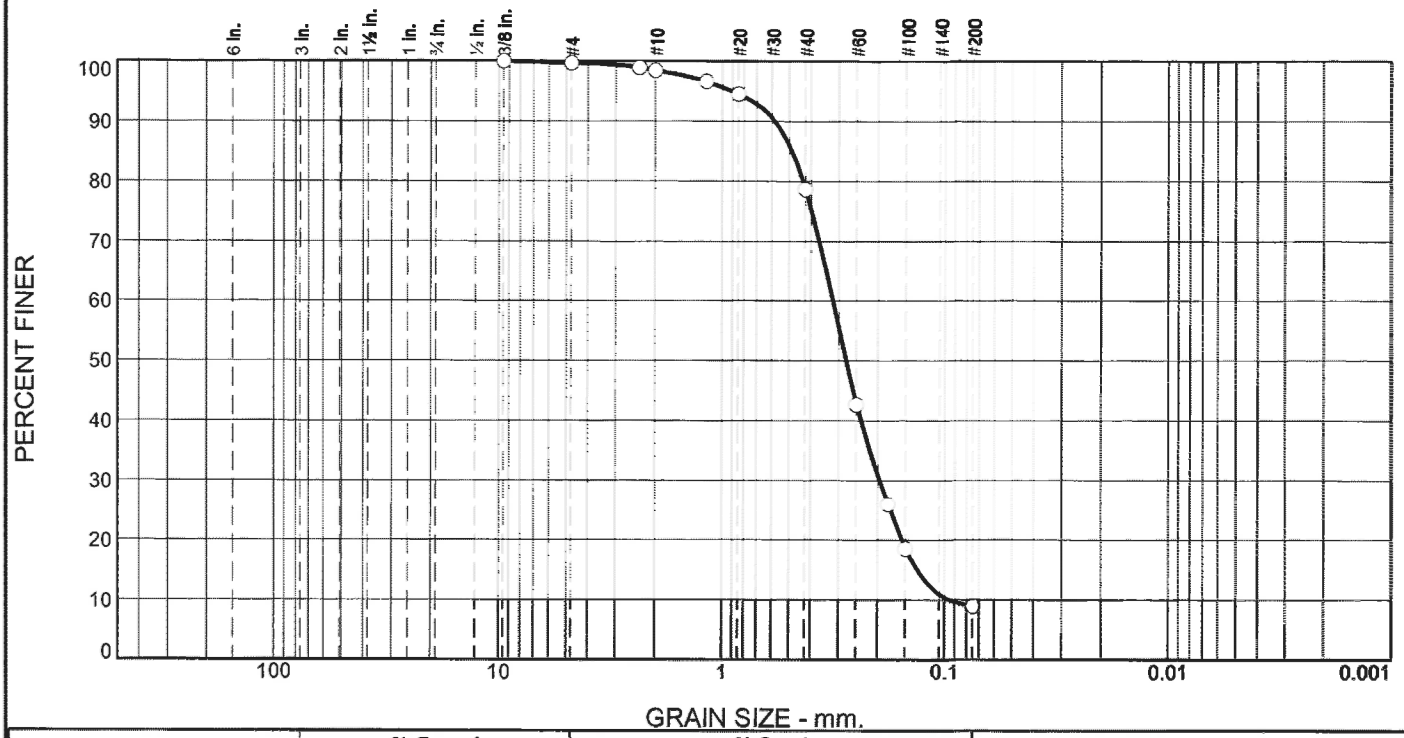
Client: Abbey Road Group Land Development Services Company,LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	0.0	0.3	1.2	19.8	69.8	8.9

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
.375	100.0		
#4	99.7		
#8	**98.9**		
#10	**98.5**		
#16	**96.6**		
#20	**94.5**		
#40	**78.7**		
#60	**42.7**		
#80	**26.0**		
#100	**18.5**		
#200	**8.9**		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

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

Coefficients

D_{90}= 0.5827 D_{85}= 0.4892 D_{60}= 0.3205
D_{50}= 0.2792 D_{30}= 0.1966 D_{15}= 0.1334
D_{10}= 0.0956 C_u= 3.35 C_c= 1.26

Remarks

Sample ID:19L121
Sample Date:3-11-19
Moisture Content = 22.6 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials laboratory Manager

Location: B-2 Sample 2-5
Sample Number: 19L121 **Depth:** 15'-16.5'

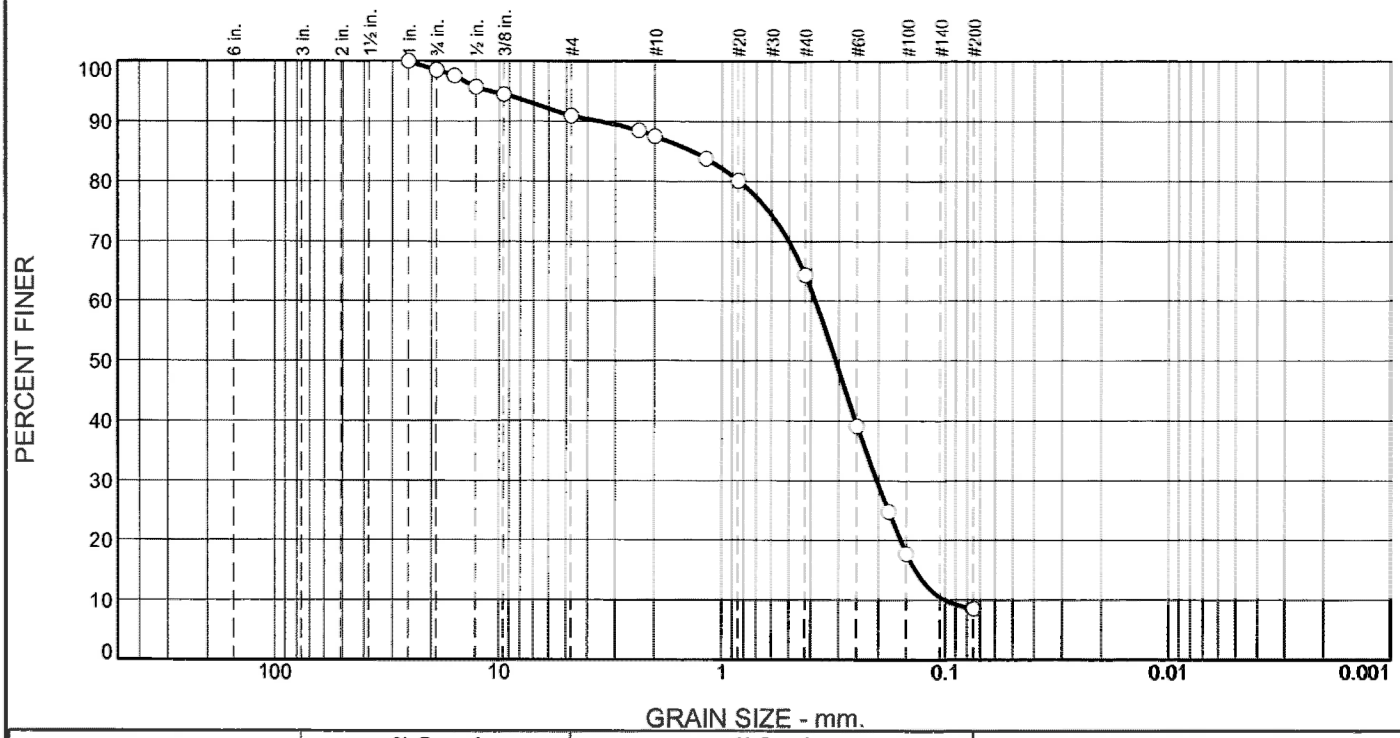
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	1.4	7.6	3.5	23.3	55.7	8.5

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	98.6		
.625	97.6		
.5	**95.7**		
.375	**94.5**		
#4	**91.0**		
#8	**88.5**		
#10	**87.5**		
#16	**83.8**		
#20	**80.2**		
#40	**64.2**		
#60	**39.1**		
#80	**24.7**		
#100	**17.7**		
#200	**8.5**		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

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

Coefficients

D_{90}= 3.5671 D_{85}= 1.3567 D_{60}= 0.3839
D_{50}= 0.3115 D_{30}= **0.2039** D_{15}= 0.1371
D_{10}= 0.1011 C_u= **3.80** C_c= 1.07

Remarks

Sample ID:19L122
Sample Date:3-11-19
Moisture Content = 18.8 %

Date Received: 3-15-19 **Date Tested:** 3-22-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-8
Sample Number: 19L122 **Depth:** 30'-31.5'

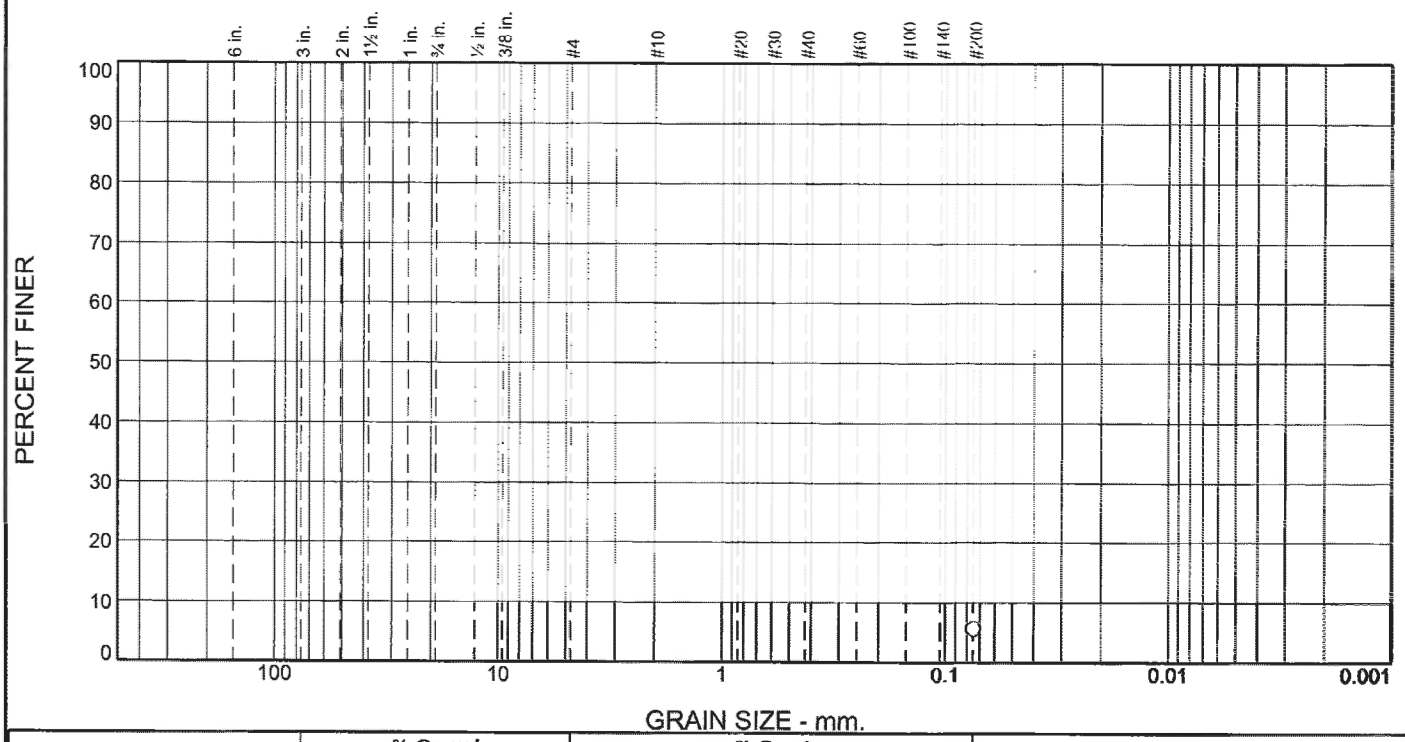
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land **Development Services Company.LLC.**
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
						5.6

TEST RESULTS			
Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#200	5.6		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

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

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:19L135
Sample Date:3-11-19
Moisture Content = 18.9 %

Date Received: 3-15-19 **Date Tested:** 3-11-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-9
Sample Number: 19L135 **Depth:** 35'-36.5'

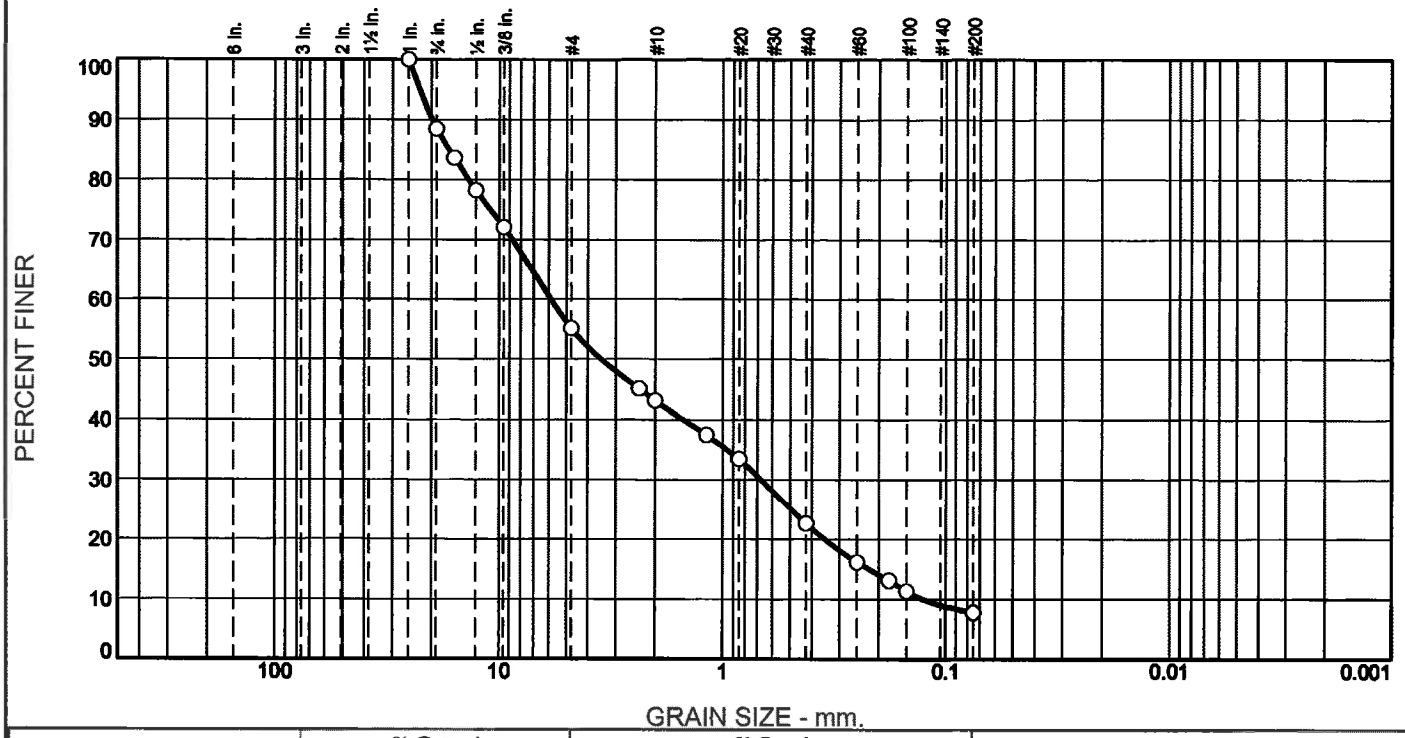
Date Sampled: 3-11-19

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines
	Coarse	Fine	Coarse	Medium	Fine	
0.0	11.5	33.3	12.0	20.5	14.9	7.8

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1	100.0		
.75	88.5		
.625	83.7		
.5	78.3		
.375	72.1		
#4	55.2		
#8	45.1		
#10	43.2		
#16	37.5		
#20	33.5		
#40	22.7		
#60	16.2		
#80	13.2		
#100	11.4		
#200	7.8		

* (no specification provided)

Material Description

Dark Grey/Black sand with silt and gravel.

Atterberg Limits (ASTM D 4318)

PL= NP LL= NV PI= NP

Classification

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

Coefficients

D_{90}= 19.9452 D_{85}= 16.7747 D_{60}= 5.8717
D_{50}= 3.4968 D_{30}= 0.6741 D_{15}= 0.2194
D_{10}= 0.1253 C_u= 46.85 C_c= 0.62

Remarks

Sample ID:19L123
Sample Date:3-11-19
Moisture Content = 9.4 %

Date Received: 3-11-19 **Date Tested:** 3-11-19

Tested By: M.Thomas

Checked By: M.Thomas

Title: Materials Laboratory Manager

Location: B-2 Sample 2-10 **Date Sampled:** 3-11-19
Sample Number: 19L123 **Depth:** 37'-38.5'

Krazan

Client: Abbey Road Group Land Development Services Company.LLC.
Project: East Town Crossing

Project No: 062-19007 **Figure**

APPENDIX B

EARTHWORK SPECIFICATIONS

GENERAL

When the text of the report conflicts with the general specifications in this appendix, **the recommendations in the report have precedence**.

SCOPE OF WORK: These specifications and applicable plans pertain to and include all earthwork associated with the site rough grading, including but not limited to the furnishing of all labor, tools, and equipment necessary for site clearing and grubbing, stripping, preparation of foundation materials for receiving fill, excavation, processing, placement and compaction of fill and backfill materials to the lines and grades shown on the project grading plans, and disposal of excess materials.

PERFORMANCE: The Contractor shall be responsible for the satisfactory completion of all earthwork in accordance with the project plans and specifications. This work shall be inspected and tested by a representative of Krazan and Associates, Inc., hereinafter known as the Geotechnical Engineer and/or Testing Agency. Attainment of design grades when achieved shall be certified by the project Civil Engineer. Both the Geotechnical Engineer and Civil Engineer are the Owner's representatives. If the contractor should fail to meet the technical or design requirements embodied in this document and on the applicable plans, he shall make the necessary readjustments until all work is deemed satisfactory as determined by both the Geotechnical Engineer and Civil Engineer. No deviation from these specifications shall be made except upon written approval of the Geotechnical Engineer, Civil Engineer, or project Architect.

No earthwork shall be performed without the physical presence or approval of the Geotechnical Engineer. The Contractor shall notify the Geotechnical Engineer at least 2 working days prior to the commencement of any aspect of the site earthwork.

The Contractor agrees that he shall assume sole and complete responsibility for job site conditions during the course of construction of this project, including safety of all persons and property; that this requirement shall apply continuously and not be limited to normal working hours; and that the Contractor shall defend, indemnify and hold the Owner and the Engineers harmless from any and all liability, real or alleged, in connection with the performance of work on this project, except for liability arising from the sole negligence of the Owner or the Engineers.

TECHNICAL REQUIREMENTS: All compacted materials shall be densified to a density of not less than 95 percent of maximum dry density as determined by ASTM Test Method D1557 as specified in the technical portion of the Geotechnical Engineering Report. The results of these tests and compliance with these specifications shall be the basis upon which satisfactory completion of work will be judged by the Geotechnical Engineer.

SOIL AND FOUNDATION CONDITIONS: The Contractor is presumed to have visited the site and to have familiarized himself with existing site conditions and the contents of the data presented in the soil report.

The Contractor shall make his own interpretation of the data contained in said report, and the Contractor shall not be relieved of liability under the contractor for any loss sustained as a result of any variance between conditions indicated by or deduced from said report and the actual conditions encountered during the progress of the work.

DUST CONTROL: The work includes dust control as required for the alleviation or prevention of any dust nuisance on or about the site or the borrow area, or off-site if caused by the Contractor's operation either during the performance of the earthwork or resulting from the conditions in which the Contractor leaves the site. The Contractor shall assume all liability, including Court costs of codefendants, for all claims related to dust or windblown materials attributable to his work.

SITE PREPARATION

General site clearing should include removal of any organics, asphaltic concrete, abandoned utilities, structures including foundations, basement walls and floors, rubble, and rubbish. After stripping operations and removal of any loose and/or debris-laden fill, the exposed subgrade should be visually inspected and/or proof rolled to identify any soft/loose areas.

SUBGRADE PREPARATION: Subgrade should be prepared as described in our site preparation section of this report.

EXCAVATION: All excavation shall be accomplished to the tolerance normally defined by the Civil Engineer as shown on the project grading plans. All over excavation below the grades specified shall be backfilled at the Contractor's expense and shall be compacted in accordance with the applicable technical requirements.

FILL AND BACKFILL MATERIAL: No material shall be moved or compacted without the presence of the Geotechnical Engineer. Material from the required site excavation may be utilized for construction site fills provided prior approval is given by the Geotechnical Engineer. All materials utilized for constructing site fills shall be free from vegetable or other deleterious matter as determined by the Geotechnical Engineer.

PLACEMENT, SPREADING, AND COMPACTION: The placement and spreading of approved fill materials and the processing and compaction of approved fill and native materials shall be the responsibility of the Contractor. However, compaction of fill materials by flooding, ponding, or jetting shall not be permitted unless specifically approved by local code, as well as the Geotechnical Engineer.

Both cut and fill shall be surface compacted to the satisfaction of the Geotechnical Engineer prior to final acceptance.

SEASONAL LIMITS: No fill material shall be placed, spread, or rolled while it is frozen or thawing or during unfavorable wet weather conditions. When the work is interrupted by heavy rains, fill operations shall not be resumed until the Geotechnical Engineer indicates that the moisture content and density of previously placed fill are as specified.

APPENDIX C

PAVEMENT SPECIFICATIONS

1. **DEFINITIONS** – The term "pavement" shall include asphalt concrete surfacing, untreated aggregate base, and aggregate subbase. The term "subgrade" is that portion of the area on which surfacing, base, or subbase is to be placed.

2. **SCOPE OF WORK** – This portion of the work shall include all labor, materials, tools, and equipment necessary for and reasonably incidental to the completion of the pavement shown on the plans and as herein specified, except work specifically notes as "Work Not Included."

3. **PREPARATION OF THE SUBGRADE** – Subgrade should be prepared as described in our site preparation and pavement design sections of this report.

4. **AGGREGATE BASE** – The aggregate base shall be spread and compacted on the prepared subgrade in conformity with the lines, grades, and dimensions shown on the plans. The aggregate base should conform to WSDOT Standard Specification for Crushed Surfacing Base Course or Top Course (Item 9-03.9(3)). The base material shall be compacted to a minimum compaction of 95% as determined by ASTM D1557. Each layer of subbase shall be tested and approved by the Geotechnical Engineer prior to the placement of successive layers.

5. **ASPHALTIC CONCRETE SURFACING** – Asphaltic concrete surfacing shall consist of a mixture of mineral aggregate and paving grade asphalt, mixed at a central mixing plant and spread and compacted on a prepared base in conformity with the lines, grades, and dimensions shown on the plans. The drying, proportioning, and mixing of the materials shall conform to WSDOT Specifications.

The prime coat, spreading and compaction equipment, as well as the process of spreading and compacting the mixture, shall conform to WSDOT Specifications, with the exception that no surface course shall be placed when the atmospheric temperature is below 50 degrees F. The surfacing shall be rolled with combination steel-wheel and pneumatic rollers, as described in WSDOT Specifications. The surface course shall be placed with an approved self-propelled mechanical spreading and finishing machine.

6. **TACK COAT** – The tack (mixing type asphaltic emulsion) shall conform to and be applied in accordance with the requirements of WSDOT Specifications.

Steep Slope Addendum Letter

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

July 31, 2020

KA Project No. 062-190007

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Gil Hulsmann
Email: Gil.Hulsmann@AbbeyRoadGroup.com
Phone: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation Addendum Letter**
East Town Crossing
Parcel Nos. 0420264053, 0420264054, 0420351066
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington 98371

Dear Mr. Hulsmann,

Per your request, we have prepared this letter to provide our opinion regarding the nearby steep slopes. We previously prepared a geotechnical report titled "Geotechnical Engineering Investigation – East Town Crossing – Parcel Nos. 0420264053, 0420264054, 0420351066 – SE Corner of E. Shaw Road & E. Pioneer Way – Puyallup, Washington", dated April 11, 2019.

Based on our communication with you, it is our understanding that the City of Puyallup has requested to provide our opinion on the hazards and risks to the site due to the site being within 300 feet of steep slopes.

We have reviewed Washington State Department of Natural Resources (DNR), City of Puyallup, and Pierce County published landslide hazard maps and web data. We have also reviewed the Landslide Inventory, Susceptibility, and Exposure Analysis of Pierce County, Washington (DNR), prepared by Katherine A. Mickelson et al., and dated July 2017.

Based on our review, we understand that steep slopes are located roughly 300 feet to the south and east from the site. These nearby slopes are mapped moderate to high for shallow landslide susceptibility, and moderate for deep susceptibility. However, there are no historic landslides or debris mapped at the nearby slopes. The closest landslide mapped is located roughly 1 mile southeast of the site.

There is an existing developed property between the nearby southern slope and the southern boundary of the site. There is a partially developed property between the nearby eastern slope and the eastern boundary of the site. In our opinion, these properties to the south and east create a buffer between the nearby slopes

and the site. Based on our review of available published documents and maps, it is our opinion that there is minimum to no risk to the planned development from the nearby slopes.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,

KRAZAN & ASSOCIATES, INC.

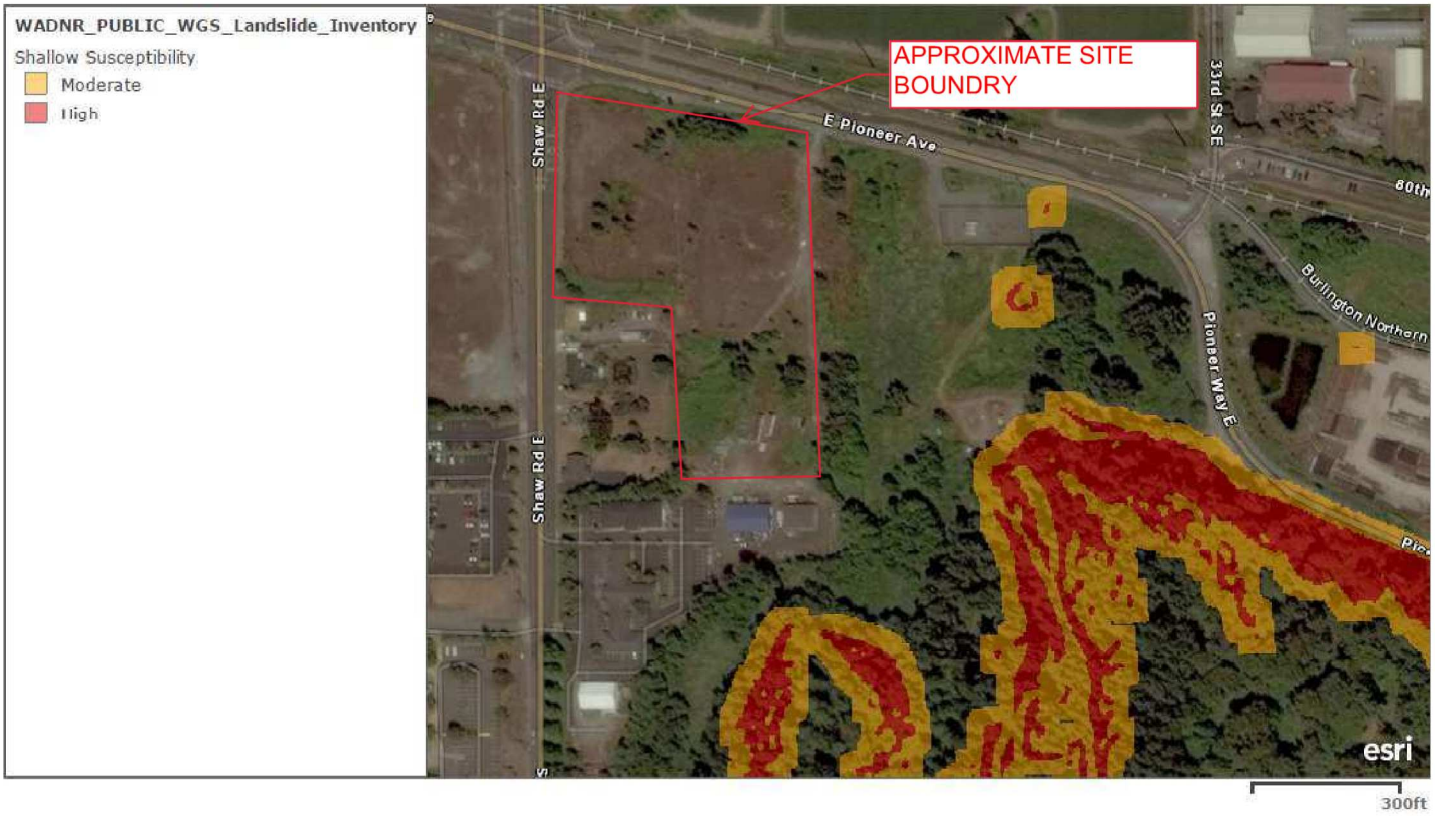
07/31/20

Vijay Chaudhary, P.E.
Project Engineer

Theresa Nunan

Theresa R. Nunan
Project Manager

Attachments: WA DNR Landslide Inventory Maps (Figures A, B, and C)



USDA FSA, GeoEye, Maxar | Esri Community Maps Contributors, King County, WA State Parks GIS, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

N

Krazan

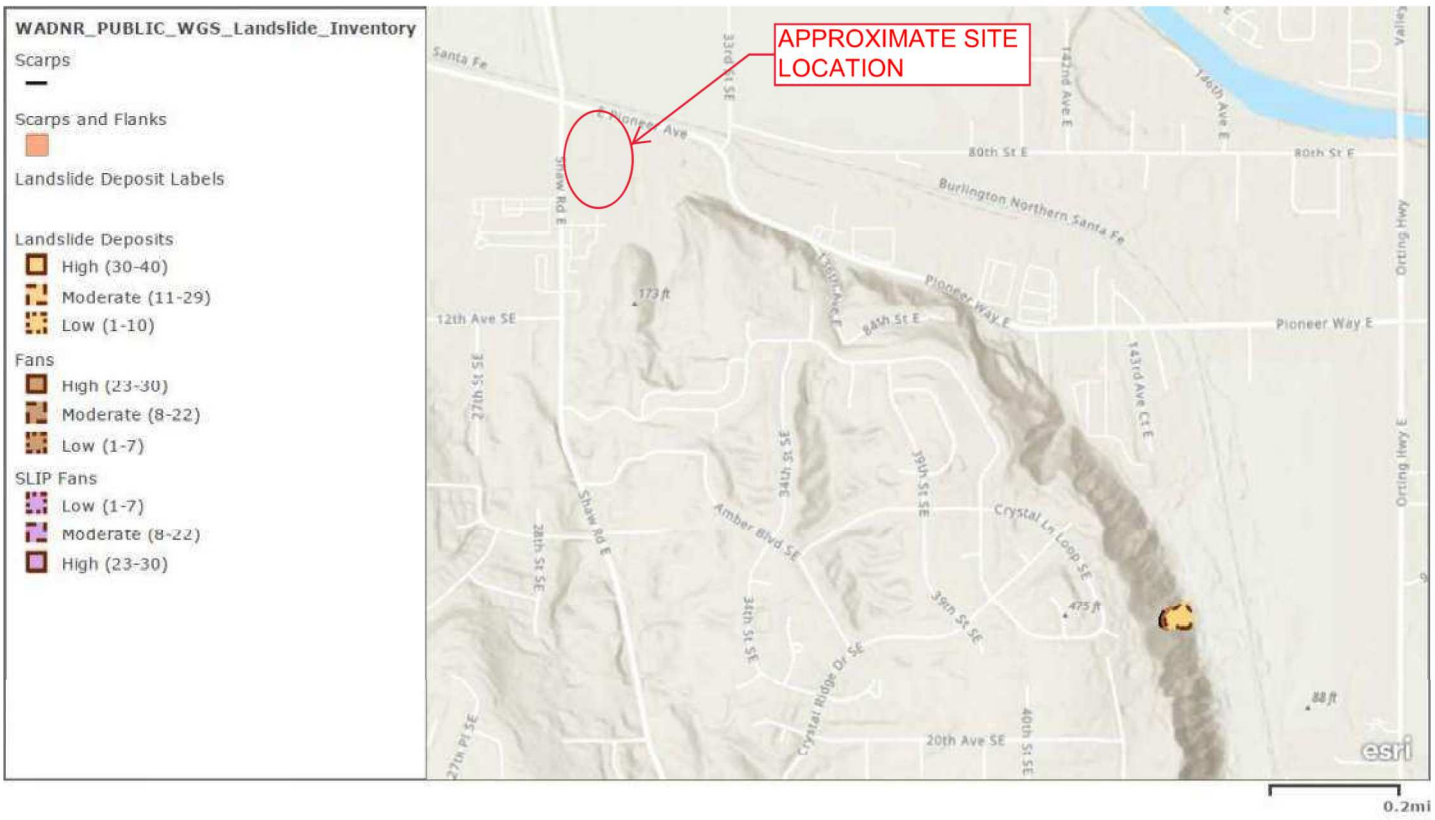
East Town Crossing		
Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: A	Not to scale

USDA FSA, GeoEye, Maxar | Esri Community Maps Contributors, King County, WA State Parks GIS, BuildingFootprintUSA, Esri, HERE, Garmin, SafeGraph, INCREMENT P, METI/NASA, USGS, Bureau of Land Management, EPA, NPS, US Census Bureau, USDA

N

Krazan

East Town Crossing		
Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: B	Not to scale



N

Krazan

East Town Crossing

Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: C	Not to scale

March 19, 2021

KA Project No. 062-190007

Abbey Road Group Land Development Services Company, LLC
PO Box 1224
Puyallup, Washington 98371

Attn: Gil Hulsmann
Email: Gil.Hulsmann@AbbeyRoadGroup.com
Phone: (253) 435-3699 (ext. 101)

Reference: **Geotechnical Engineering Investigation Addendum Letter**
East Town Crossing
SE Corner of E. Shaw Road and E. Pioneer Way
Puyallup, Washington

Dear Mr. Hulsmann,

Per your request, we have prepared this letter to provide the results of two (2) Large-Scale Pilot Infiltration Tests (PITs) we conducted at the above-referenced site. We previously prepared a geotechnical report titled "Geotechnical Engineering Investigation – East Town Crossing – Parcel Nos. 0420264053, 0420264054, 0420351066 – SE Corner of E. Shaw Road & E. Pioneer Way – Puyallup, Washington", dated April 11, 2019, as well as an addendum letter dated July 31, 2020 that addressed the nearby steep slopes.

Large-Scale PITs

Two (2) test pits, designated P-1 and P-2, were excavated near Monitoring Wells MW-1 and MW-2, respectively, on March 4, 2021 at the approximate locations indicated on the Site Plan, Figure 1, in order to conduct large-scale infiltration tests in accordance with the 2014 Stormwater Management Manual for Western Washington (SWMMWW). The infiltration test locations were selected in the field by the client and excavated using a client provided excavator and operator. The bottom of each pit was excavated 10-feet wide by 10-feet long, which met the minimum required horizontal surface area of 100 square feet (sf). Each test pit was initially excavated to a depth of 2 feet below the existing ground surface (bgs), which exposed silty sand (SM) soils at the pit bottom. Water was observed seeping from the sides of pit P-1 during excavation, and was observed ponded at the ground surface at several locations in the vicinity of pit P-1. Test pits P-1 and P-2 encountered undocumented fill to a depth of 1.8 feet and 0.5 feet bgs, respectively, followed by native brown silty sand (SM) with trace gravel and occasional sandy silt and sandy clay seams and layers to the bottom of the test pits. The soils exposed at the PIT test depth were similar to those encountered in the geotechnical borings conducted during our original exploration of the site.

The infiltration test procedure includes a pre-soak period, followed by steady-state and then falling head infiltration rate testing. Each pit was filled with water to a depth of 12 inches above the bottom of the pit for the pre-soak period. After two (2) hours of pre-soak, the water hose was turned off as even just a slight trickle caused the water level in the pit to continue to rise. Water level readings were obtained for an additional 4 hours in pit P-2 with no change in the water level, while the water level in pit P-1 increased ¾-inches which we attributed to seepage from the sides of this pit which were observed during its excavation. Since the water in pits P-1 and P-2 was not infiltrating, we left the pits open overnight, and returned to the site to record the water level. Since it had commenced to rain just prior to our leaving the site, a 5-gallon bucket was left at the location of pit P-2 to obtain an estimate of the amount of rain that fell overnight. We recorded 0.6 inches of rain in the bucket the following morning. On the morning of March 5, 2021, the water level in pit P-1 had risen another 1.2 inches, while the water level in pit P-2 rose about 0.3 inches. Figure 2 includes photos of pits P-1 and P-2 taken on March 5, 2021. The pits were not over-excavated due to the presence of water. The contractor had excavated three test pits within the northwestern corner of the site on March 4, 2021. We observed about 8 to 10 inches of water in the bottom of two of the test pits on March 5, 2021.

Evaluation of Infiltration Feasibility: One of the Site Suitability Criteria (SSC) presented in Section 3.3.7, Volume III, 2014 SWMMWW, **SSC-5 Depth to Bedrock, Water Table, or Impermeable Layer**, states that the base of all infiltration basins or trench systems shall be greater than or equal to 5 feet above the seasonal high-water mark, bedrock (or hardpan), or other low permeability layer. Based on the results of our field exploration and large-scale PITs, the soils at the site contain high silt content and are considered a very low to relatively impermeable layer. Based on the results of our general site assessment and field testing, the low permeability soils encountered at the site do not meet the requirements of Site Suitability Criteria SSC-5 and it is therefore our opinion that onsite infiltration of stormwater using basin or trench system is not considered feasible for the proposed development. **However,** consideration may be given to the use of permeable pavement and other Best Management Practices (BMPs), depending on the final site grading plan.

Limitations

This letter has been prepared for the exclusive use of the Abbey Road Group and their assigns, for the specific application to the site. The geotechnical information presented herein is based upon professional interpretation utilizing standard engineering practices and a degree of conservatism deemed proper for this project. We emphasize that this letter is valid for this project as outlined above, and should not be used for any other site.

This letter does not include any environmental site assessment for the presence or absence of hazardous and/or toxic materials in the soil, groundwater or atmosphere, or the presence of wetlands or other biological conditions. The information presented herein is based upon professional interpretation using standard industry practices and engineering conservatism that we consider proper for this project. It is not warranted that such information and interpretation cannot be superseded by future geotechnical developments.

Within the limitations of scope, schedule and budget, our services have been performed in accordance with generally accepted geotechnical engineering practices in effect in this area at the time this letter was prepared. No other warranty, expressed or implied, is made.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,

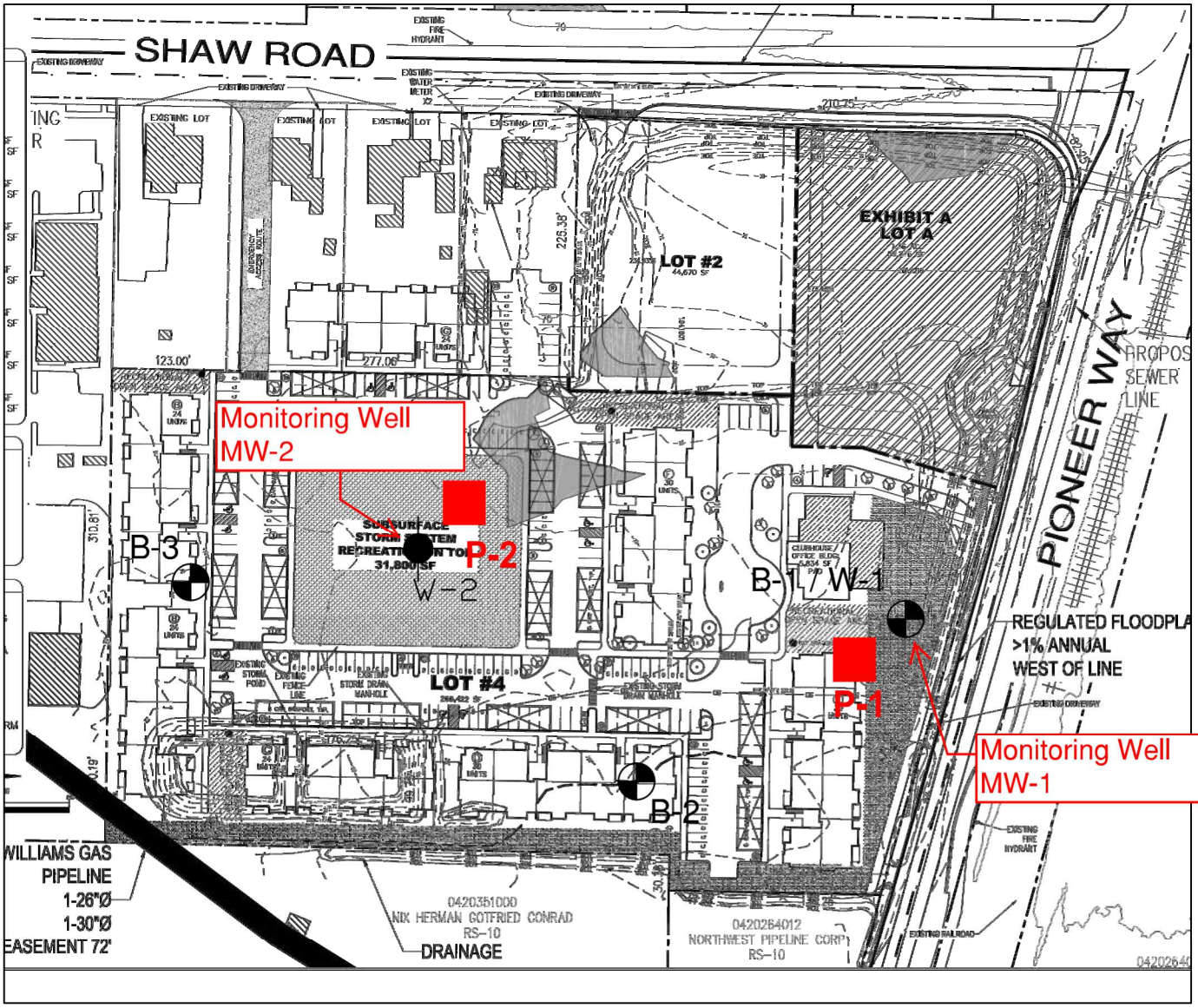
KRAZAN & ASSOCIATES, INC.

3/19/21

Theresa R. Nunan
Project Manager

Vijay Chaudhary, P.E.
Assistant Regional Engineering Manager

Attachments: Figure 1 – Site Plan
Figure 2 – Photos



LEGEND

- B-1 — Number and Approximate Location of Borings
- W-1 — Approximate Location of Monitoring Well
- P-1 — Approximate Location of Pilot Infiltration Test

N

Reference: Plan Sheet titled "Overall Site Plan", prepared by Abbey Road Group dated December 7, 2018.

Site Plan

East Town Crossing	Figure 1
Shaw Rd & E Pioneer Way, Puyallup, WA	
Project Number: 062-19007	Drawn By: T. Nunan Date: March 2021
Krazan & ASSOCIATES, INC.	Not to Scale

Water in Pit P-1 on March 5, 2021.

Water in Pit P-2 on March 5, 2021.

Water in Test Pit on March 5, 2021. Test pit was excavated in NE portion of site on March 4, 2021.

Figure 2 - Photos (March 5, 2021)

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

December 10, 2021 KA Project No. 062-21033

Abbey Road Group, LLC
P.O. Box 11489
Olympia, WA 98508

Attn: Mr. Gil Hulsmann
Tel: 253-435-3699 x1510
Email: gil.hulsmann@abbeyroadgroup.com

Reference: Laboratory Testing – Recycled Glass
East Town Crossing Project
SE Corner of E Shaw Road & E Pioneer Way
Puyallup, Washington

Dear Mr. Hulsmann,

The gradation and proctor test results for the two recycled glass samples, one designated "clean" and the other designated "with fines", supplied by Dan Lloyd Construction are attached to this letter. The gradation tests were conducted on the samples 'as received' and again after completing the Proctor compaction tests. As can be seen in the summary of test results, Table 1 attached to this letter, the glass pierces broke down significantly due to the compaction efforts.

If you have any questions, or if we may be of further assistance, please do not hesitate to contact our office at (253) 939-2500.

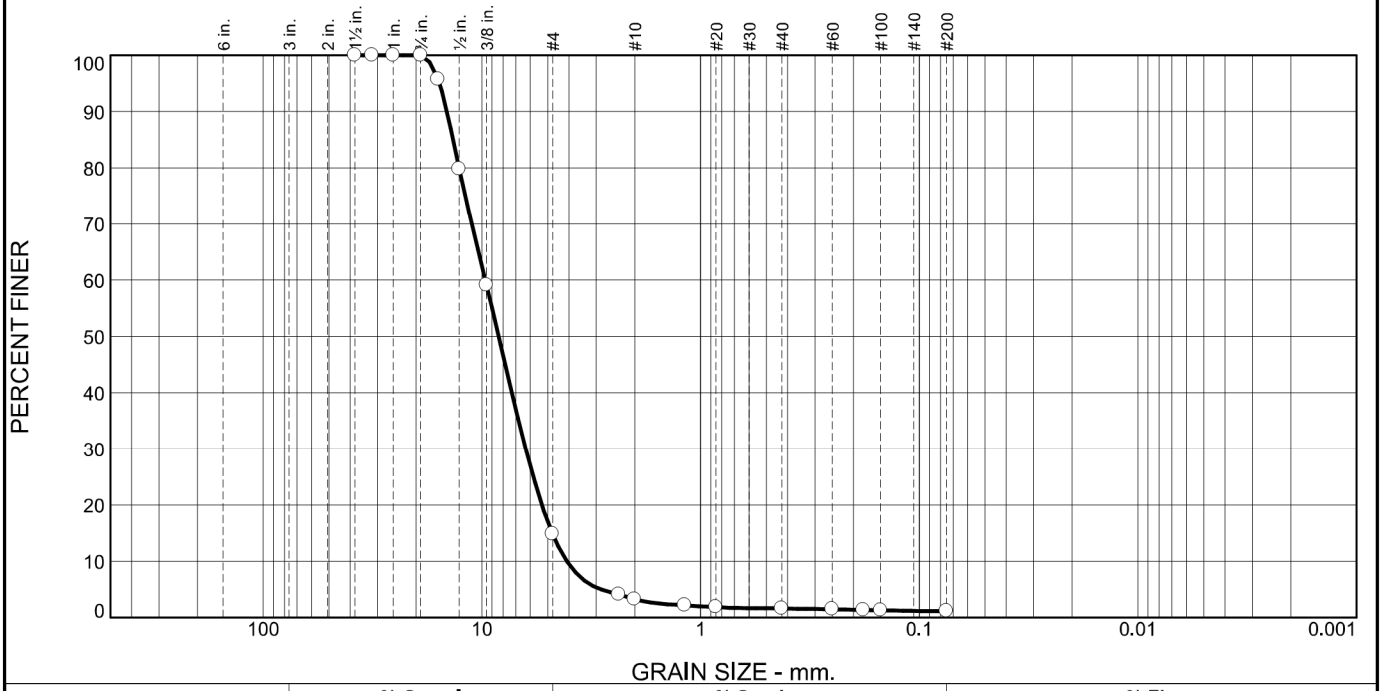
Respectfully submitted,

KRAZAN & ASSOCIATES, INC.

Theresa R. Nunan
Project Manager

Attachments: Recycled Glass Gradation and Proctor Test Results – "Clean" Sample
Recycled Glass Gradation and Proctor Test Results – "With Fines" Sample
Table 1 – Summary of Recycled Glass Test Results

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	85	12	1	1	1	

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	96		
.5	80		
.375	59		
#4	15		
#8	4		
#10	3		
#16	2		
#20	2		
#40	2		
#60	1		
#80	1		
#100	1		
#200	1.2		

* (no specification provided)

Material Description

Recycled Glass Clean - Before Compaction.
Sampled by the supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GP **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 14.4630 D_{85}= 13.5519 D_{60}= 9.6467
D_{50}= 8.3902 D_{30}= 6.2995 D_{15}= 4.7699
D_{10}= 4.0959 C_u= 2.36 C_c= 1.00

Remarks

Sample ID:21L892
Sample Date:11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21
Tested By: M.Thomas
Checked By: T.Nunan
Title: Project Manager

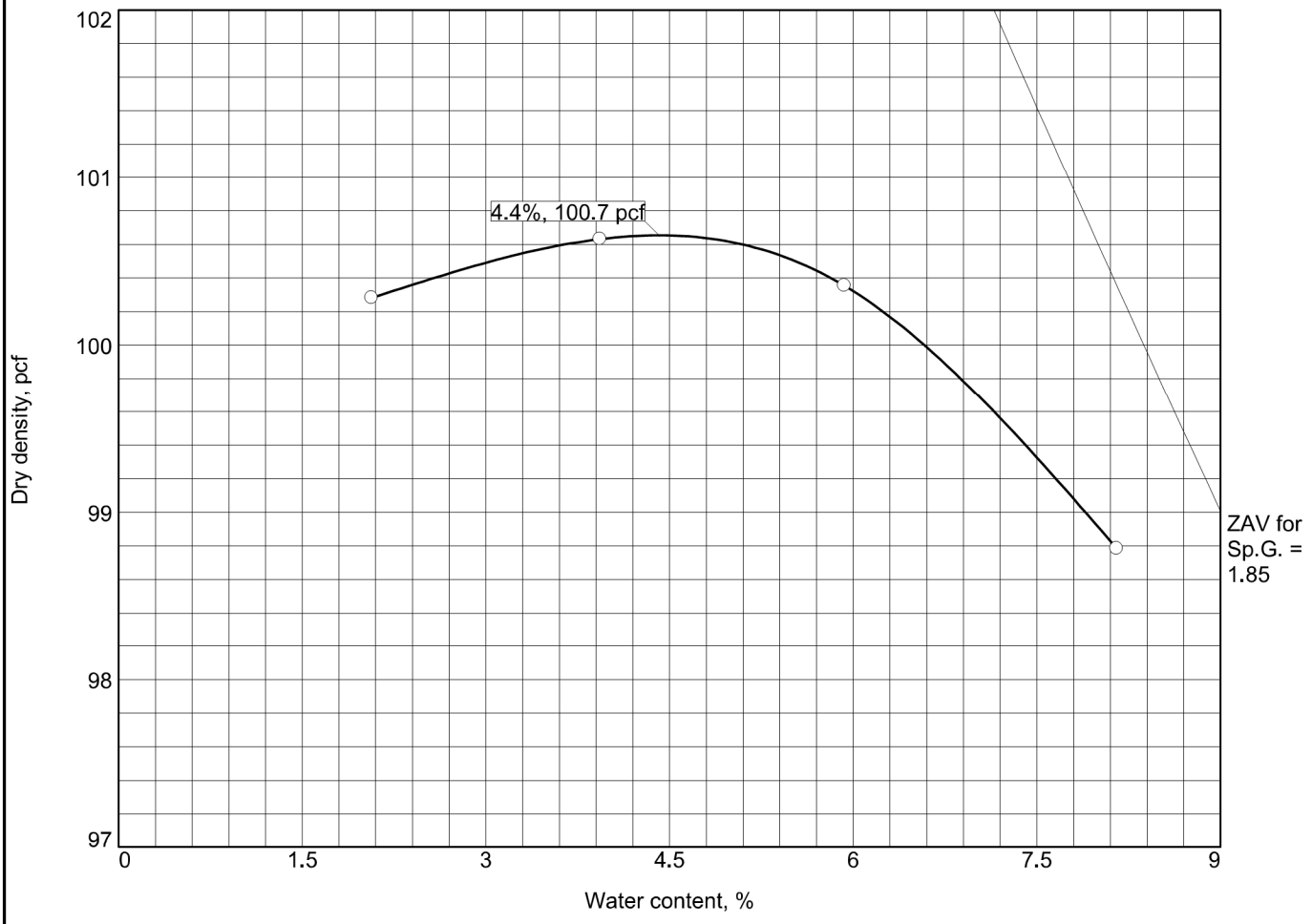
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L892

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

COMPACTION TEST REPORT



Test specification: ASTM D 1557 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	GP	A-1-a		1.85	NV	NP	0	1.2

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 100.7 pcf Optimum moisture = 4.4 %	Recycled Glass Clean. Sampled by the supplier.

Project No. 062-21033 **Client:** Abbey Road Group Land Development Services

Project: East Town Crossing Lab Testing - Recycled Glass

○**Source of Sample:** Dan Lloyd Construction **Sample Number:** 21L892

Remarks:

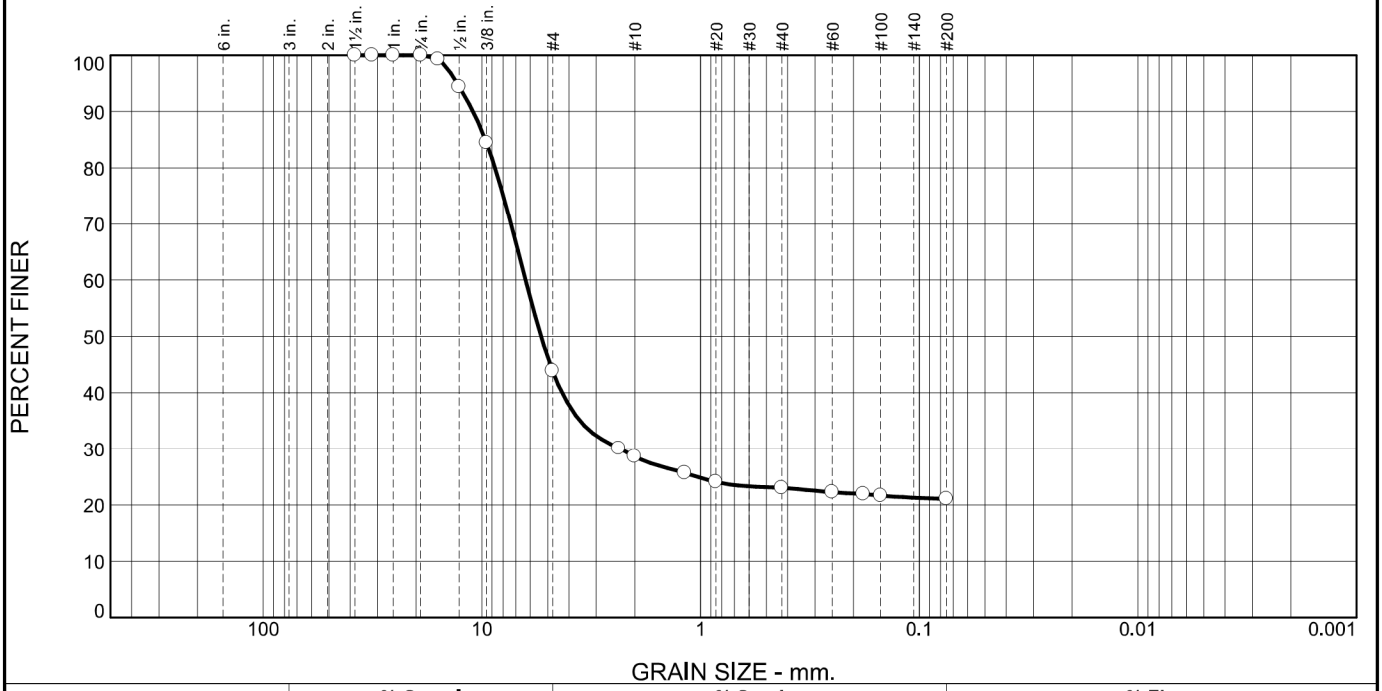
Sample ID:21L892
Sample Date:11-29-21
Void Ratio:0.14
Porosity:12%

Krazan

Figure

Tested By: M.Thomas **Checked By:** T.Nunan.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	56	15	6	2	21	

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	99		
.5	94		
.375	84		
#4	44		
#8	30		
#10	29		
#16	26		
#20	24		
#40	23		
#60	22		
#80	22		
#100	22		
#200	21		

* (no specification provided)

Material Description

Recycled Glass Clean - After Compaction
Sampled by the supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

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

Coefficients

D_{90}= 10.9683 D_{85}= 9.6367 D_{60}= 6.3112
D_{50}= 5.3536 D_{30}= 2.3352 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:21L893
Sample Date: 11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21
Tested By: M.Thomas
Checked By: I.Teriong
Title: Project Manager

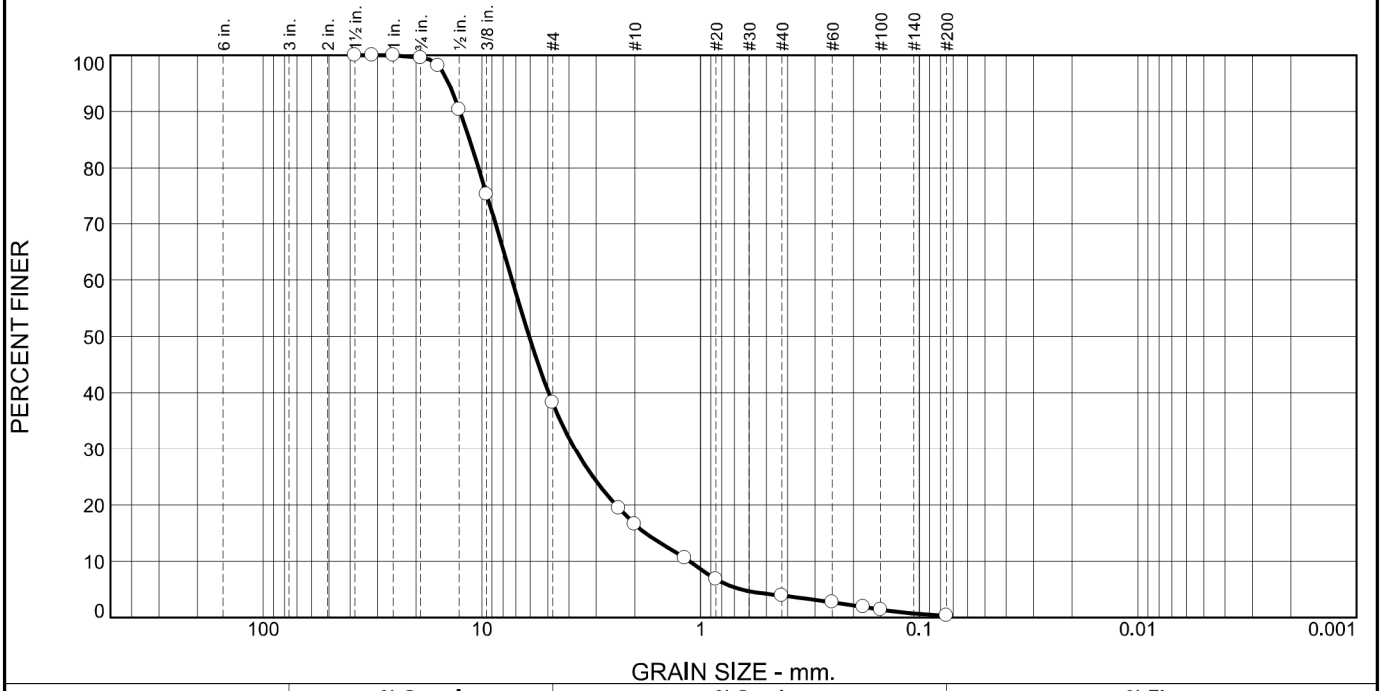
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L892

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	62	21	13	4	0	

Test Results (C-136 & c-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	98		
.5	90		
.375	75		
#4	38		
#8	19		
#10	17		
#16	11		
#20	7		
#40	4		
#60	3		
#80	2		
#100	1		
#200	0.4		

* (no specification provided)

Material Description

Recycled Glass With Fines - Before Compaction.
Sampled by the supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= GW **AASHTO (M 145)=** A-1-a

Coefficients

D_{90}= 12.6020 D_{85}= 11.3802 D_{60}= 7.2823
D_{50}= 6.0733 D_{30}= 3.7592 D_{15}= 1.7859
D_{10}= 1.1229 C_u= 6.49 C_c= 1.73

Remarks

Sample ID:21L893
Sample Date:11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21

Tested By: M.Thomas

Checked By: T.Nunan

Title: Project Manager

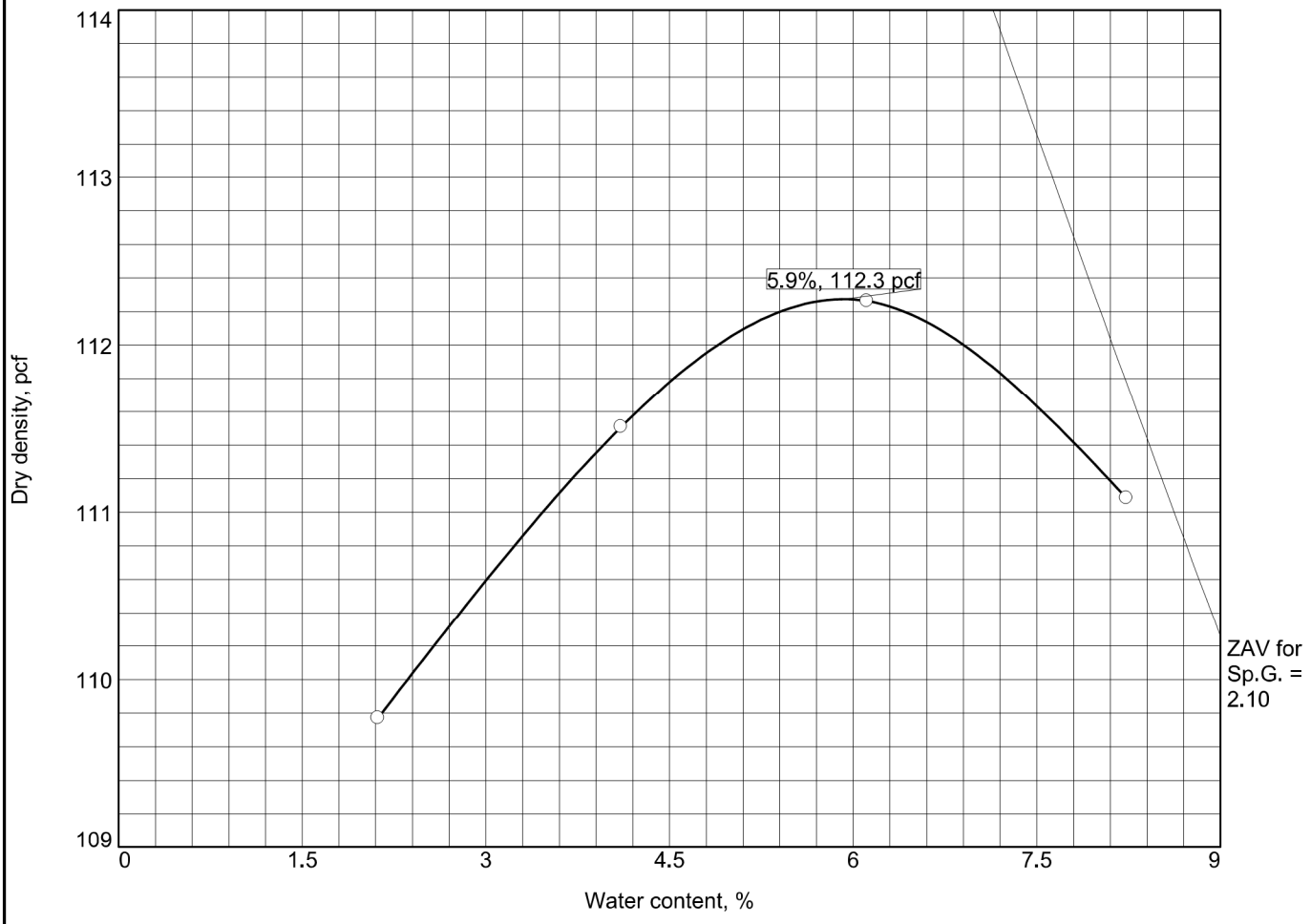
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L893

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

COMPACTION TEST REPORT



Test specification: ASTM D 1557 Method C Modified

Elev/ Depth	Classification		Nat. Moist.	Sp.G.	LL	PI	% > 3/4 in.	% < No.200
	USCS	AASHTO						
	GW	A-1-a		2.1	NV	NP	0	0.4

TEST RESULTS	MATERIAL DESCRIPTION
Maximum dry density = 112.3 pcf Optimum moisture = 5.9 %	Recycled Glass With Fines. Sampled by the supplier.

Project No. 062-21033 **Client:** Abbey Road Group Land Development Services

Project: East Town Crossing Lab Testing - Recycled Glass

○**Source of Sample:** Dan Lloyd Construction **Sample Number:** 21L893

Remarks:

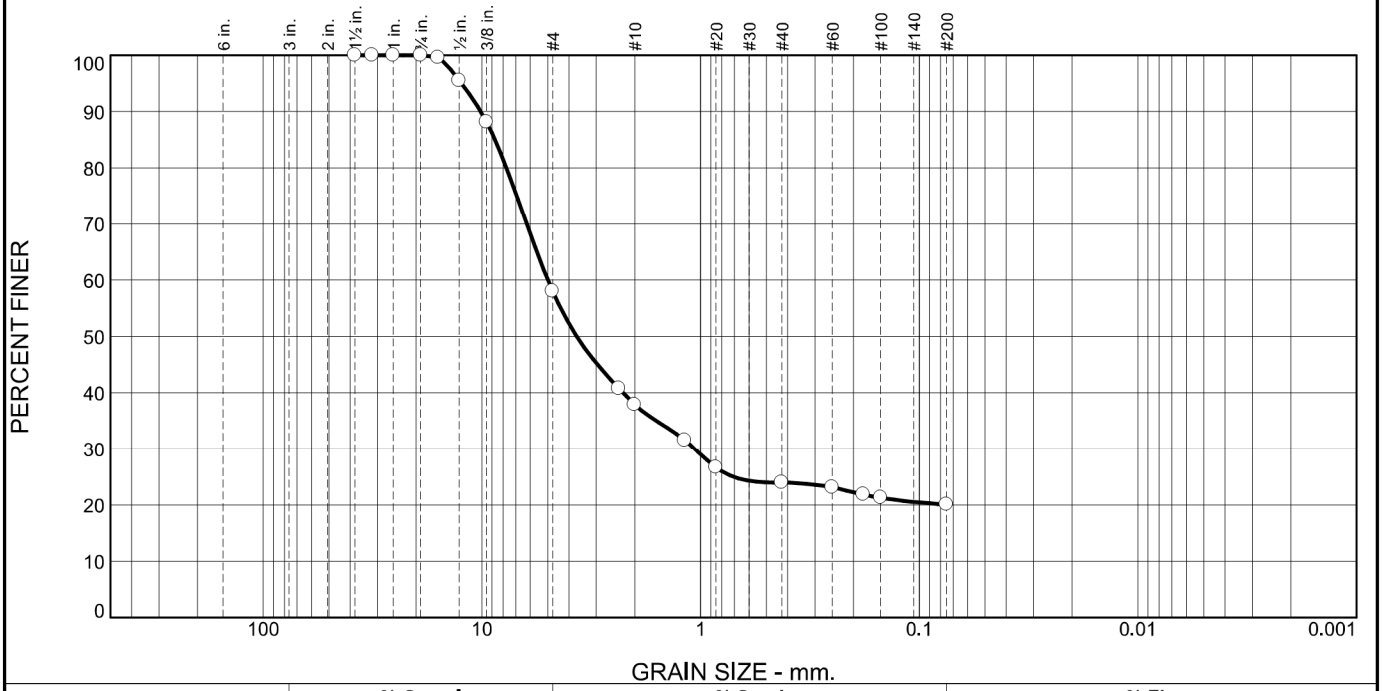
Sample ID:21L893
Sample Date:11-29-21
Void Ratio:0.16
Porosity:14%

Krazan

Figure

Tested By: M.Thomas **Checked By:** T.Nunan.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0	0	42	20	14	4	20	

Test Results (C-136 & C-117)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100		
1.25	100		
1	100		
.75	100		
.625	100		
.5	95		
.375	88		
#4	58		
#8	41		
#10	38		
#16	32		
#20	27		
#40	24		
#60	23		
#80	22		
#100	21		
#200	20		

* (no specification provided)

Material Description

Recycled Glass With Fines - After Compaction.
Sampled by the Supplier.

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

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

Coefficients

D_{90}= 10.1195 D_{85}= 8.7171 D_{60}= 4.9887
D_{50}= 3.6862 D_{30}= 1.0651 D_{15}=
D_{10}= C_u= C_c=

Remarks

Sample ID:21L893
Sample Date:11-29-21

Date Received: 11-29-21 **Date Tested:** 12-1-21

Tested By: M.Thomas

Checked By: T.Nunan

Title: Project Manager

Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L893

Krazan

Client: Abbey Road Group Land Development Services Company LLC
Project: East Town Crossing Lab Testing - Recycled Glass

Project No: 062-21033 **Figure**

Appendix C – Maintenance and Operations

#3 – Maintenance Checklist for Closed Detention Systems (Tanks/Vaults):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Storage Area	Plugged Air Vents	One-half of the cross-section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning. Remove blockage or replace air vent if damaged.
Storage Area	Debris and Sediment	Accumulated sediment depth exceeds 10 percent of the diameter of the storage area for one-half length of storage vault or any point depth exceeds 15 percent of diameter.	All sediment and debris removed from storage area.
Storage Area	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability.)	All joint between tank/pipe sections are sealed.
Storage Area	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10 percent of its design shape. (Review required by engineer to determine structural stability.)	Tank/pipe repaired or replaced to design.
Storage Area	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound.	Vault replaced or repaired to design specifications and is structurally sound.
Storage Area	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than one-half inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	No cracks more than one-fourth inch wide at the joint of the inlet/outlet pipe. No water or soil entering vault through joints or walls.
Crest Gauge	Crest Gauge Missing/Broken	Crest gauge is not functioning properly, has been vandalized, or is missing.	Crest gauge present and functioning. *Repair/replace crest gauge if missing or broken.*
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole access cover/ lid is in place and secure.
Manhole	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half inch of thread (may not apply to self-locking lids).	Mechanism opens with proper tools.
Manhole	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
Manhole	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.

If you are unsure whether a problem exists, contact a professional engineer.

Tanks and vaults are a confined space. Visual inspections should be performed aboveground. If entry is required, it should be performed by qualified personnel.

#5 – Maintenance Checklist for Catch Basins:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	"Dump no pollutants" (or similar) stencil or stamp not visible	Stencil or stamp should be visible and easily read.	Warning signs (e.g., "Dump No Waste-Drains to Stream" or "Only rain down the drain"/ "Puget Sound starts here") painted or embossed on or adjacent to all storm drain inlets.
General	Trash and Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inlet capacity by more than 10 percent.	No trash or debris located immediately in front of catch basin or on grate opening.
General	Trash and Debris	Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
General	Trash and Debris	Trash or debris in any inlet or outlet pipe blocking more than one-third of its height.	Inlet and outlet pipes free of trash or debris.
General	Trash and Debris	Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
General	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin.
General	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than one-fourth inch.	No holes and cracks in the top slab allowing material to run into the basin.
General	Structure Damage to Frame and/or Top Slab	Frame not sitting flush on top slab, i.e., separation of more than three-fourth inch of the frame from the top slab. Frame not securely attached.	Frame is sitting flush on the riser rings or top slab and firmly attached.
General	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
General	Fractures or Cracks in Basin Walls/ Bottom	Grout fillet has separated or cracked wider than one-half-inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
General	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
General	Vegetation	Vegetation growing across and blocking more than 10 percent of the basin opening.	No vegetation blocking opening to basin.

#5 – Maintenance Checklist for Catch Basins:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Vegetation	Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart.	No vegetation or root growth present.
General	Contamination and Pollution	Any evidence of oil, gasoline, contaminants or other pollutants.	No contaminants or pollutants present. *(Coordinate removal/cleanup with Pierce County Surface Water Management 253-798-2725 and/or Dept. of Ecology Spill Response 800-424-8802.)*
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is in place and secured.
Catch Basin Cover	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than one-half-inch of thread.	Mechanism opens with proper tools.
Catch Basin Cover	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Grates	Grate Opening Unsafe	Grate with opening wider than seven-eighths of an inch.	Grate opening meets design standards.
Grates	Trash and Debris	Trash and debris that is blocking more than 20 percent of grate surface inletting capacity.	Grate free of trash and debris.
Grates	Damaged or Missing	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

If you are unsure whether a problem exists, contact a professional engineer.

#20 – Maintenance Checklist for Grounds (Landscaping):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Weeds (nonpoisonous)	Weeds growing in more than 20 percent of the landscaped area (trees and shrubs only). Any evidence of noxious weeds as defined in the Pierce County Noxious Weeds List.	Weeds present in less than 5 percent of the landscaped area.
General	Insect Hazard	Any presence of poison ivy or other poisonous vegetation or insect nests.	No poisonous vegetation or insect nests present in landscaped area.
General	Trash or Litter	See Detention Ponds (Checklist #1).	See Detention Ponds (Checklist #1).
General	Erosion of Ground Surface	Noticeable rills are seen in landscaped areas.	Causes of erosion are identified and steps taken to slow down/spread out the water. Eroded areas are filled, contoured, and seeded.
Trees and shrubs	Damage	Limbs or parts of trees or shrubs that are split or broken which affect more than 25 percent of the total foliage of the tree or shrub.	Trim trees/shrubs to restore shape. Replace trees/shrubs with severe damage.
Trees and shrubs	Damage	Trees or shrubs that have been blown down or knocked over.	Tree replanted, inspected for injury to stem or roots. Replace if severely damaged.
Trees and shrubs	Damage	Trees or shrubs which are not adequately supported or are leaning over, causing exposure of the roots.	Stakes and rubber-coated ties placed around young trees/shrubs for support.

#22 – Maintenance Checklist for Conveyance Systems (Pipes and Ditches):

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Pipes	Sediment & Debris	Accumulated sediment that exceeds 20 percent of the diameter of the pipe.	Pipe cleaned of all sediment and debris.
Pipes	Vegetation	Vegetation that reduces free movement of water though pipes.	Vegetation does not impede free movement of water through pipes. *Prohibit use of sand and sealant application and protect from construction runoff.*
Pipes	Damaged (Rusted, Bent or Crushed)	Protective coating is damaged: rust is causing more than 50 percent deterioration to any part of pipe.	Pipe repaired or replaced.
Pipes	Damaged (Rusted, Bent or Crushed)	Any dent that significantly impedes flow (i.e. decreases the cross section area of pipe by more than 20 percent).	Pipe repaired or replaced.
Pipes	Damaged (Rusted, Bent or Crushed)	Pipe has major cracks or tears allowing groundwater leakage.	Pipe repaired or replaced.
Open Ditches	Trash & Debris	Dumping of yard wastes such as grass clippings and branches. Unsightly accumulation of non-degradable materials such as glass, plastic, metal, foam, and coated paper.	No trash or debris present. Trash and debris removed and disposed of as prescribed by the County.
Open Ditches	Sediment Buildup	Accumulated sediment that exceeds 20 percent of the design depth.	Ditch cleaned of all sediment and debris so that it matches design.
Open Ditches	Vegetation	Vegetation (e.g. weedy shrubs or saplings) that reduces free movements of water through ditches.	Water flows freely though ditches. Grassy vegetation should be left alone.
Open Ditches	Erosion Damage to Slopes	Erosion damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion.	No erosion damage present. Slopes stabilized using appropriate erosion control measure(s); e.g., rock reinforcement, planting of grass, compaction.
Open Ditches	Erosion Damage to Slopes	Any erosion observed on a compacted berm embankment.	*If erosion is occurring on compacted berms a professional engineer should be consulted to resolve source of erosion.*
Open Ditches	Rock Lining Out of Place or Missing (If Applicable)	Native soil is exposed beneath the rock lining.	Rocks replaced to design standards.

If you are unsure whether a problem exists, contact a professional engineer.

#35 – Maintenance Checklist for Trees:

Drainage System Feature	Defect or Problem	Condition When Maintenance Is Needed	Results Expected When Maintenance Is Performed
Tree	Excess or unhealthy growth	Health of tree at risk, or tree in conflict with other infrastructure.	Tree pruned according to industry standards to promote tree health and longevity.
Tree	NA	Young tree (i.e., within first three years).	Tree provided with supplemental irrigation and fertilization (as needed) during first three growing seasons.
Tree	NA	Evidence of pest activity affecting tree health.	Pest management activities implemented to reduce or eliminate pest activity, and to restore tree health.
Tree	Dead or Declining	Dead, damaged or declining.	Tree is replaced per planting plan or acceptable substitute.
Tree	Dead or Declining	Dead, damaged or declining.	Tree is replaced per planting plan or acceptable substitute.

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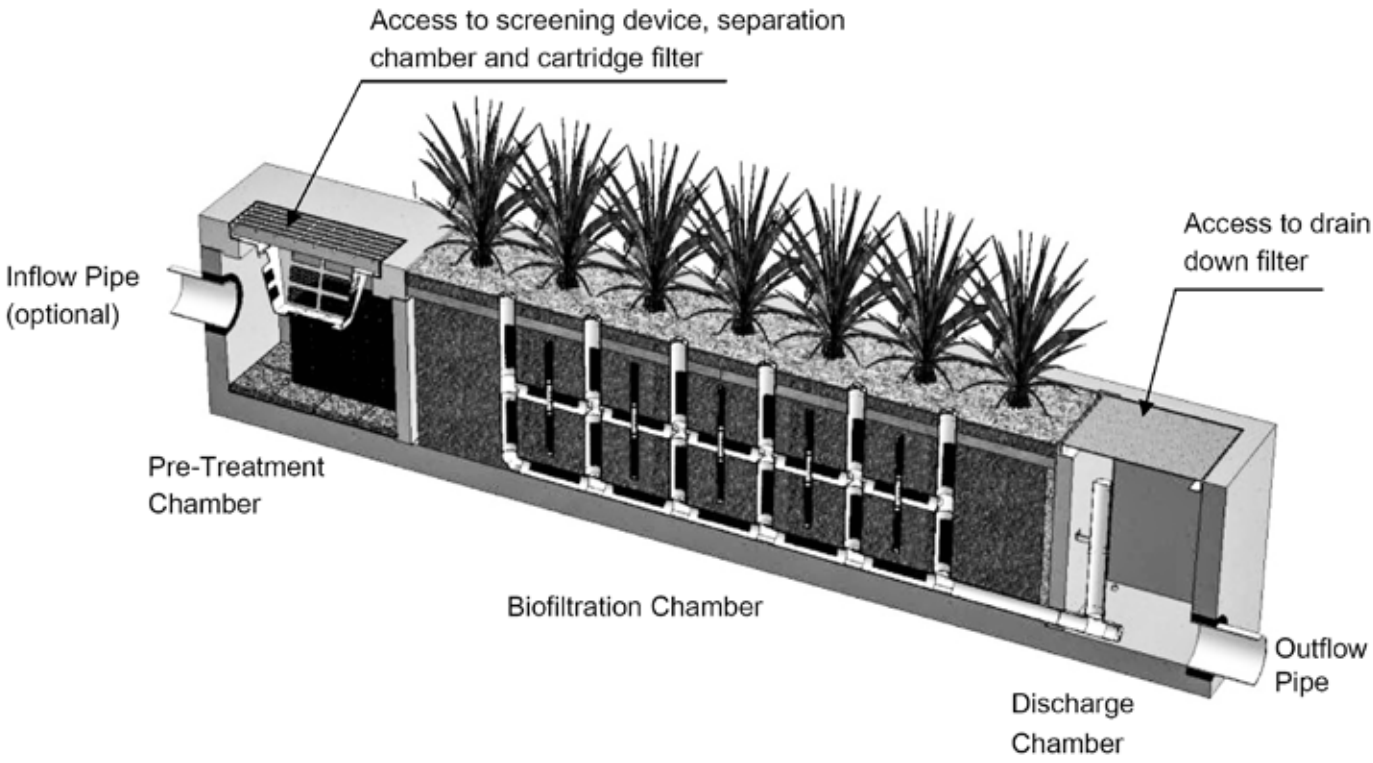
Modular Wetlands® Linear
Operation & Maintenance Manual

MODULAR WETLANDS®

Maintenance Summary

- Remove Trash from Screening Device – average maintenance interval is 6 to 12 months.
  - *(5 minute average service time).*
- Remove Sediment from Separation Chamber – average maintenance interval is 12 to 24 months.
  - *(10 minute average service time).*
- Replace Cartridge Filter Media – average maintenance interval 12 to 24 months.
  - *(10-15 minute per cartridge average service time).*
- Replace Drain Down Filter Media – average maintenance interval is 12 to 24 months.
  - *(5 minute average service time).*
- Trim Vegetation – average maintenance interval is 6 to 12 months.
  - *(Service time varies).*



System Diagram

Maintenance Procedures

Screening Device

1. Remove grate or manhole cover to gain access to the screening device in the Pre- Treatment Chamber. Vault type units do not have screening device. Maintenance can be performed without entry.
2. Remove all pollutants collected by the screening device. Removal can be done manually or with the use of a vacuum truck.
3. Screening device can easily be removed from the Pre-Treatment Chamber to gain access to separation chamber and media filters below. Replace grate or manhole cover when completed.

Separation Chamber

1. Perform maintenance procedures of screening device listed above before maintaining the separation chamber.
2. With a pressure washer, spray down pollutants accumulated on walls and cartridge filters.
3. Vacuum out Separation Chamber and remove all accumulated pollutants. Replace screening device, grate or manhole cover when completed.

Cartridge Filters

1. Perform maintenance procedures on screening device and separation chamber before maintaining cartridge filters.
2. Enter separation chamber.
3. Unscrew the two bolts holding the lid on each cartridge filter and remove lid.
4. Remove each of 4 to 8 media cages holding the media in place.
5. Spray down the cartridge filter to remove any accumulated pollutants.
6. Vacuum out old media and accumulated pollutants.
7. Reinstall media cages and fill with new media from manufacturer or outside supplier. Manufacturer will provide specification of media and sources to purchase.
8. Replace the lid and tighten down bolts. Replace screening device, grate or manhole cover when completed.

Drain Down Filter

1. Remove hatch or manhole cover over discharge chamber and enter chamber. Entry into chambers may require confined space training based on state and local regulations.
2. Unlock and lift drain down filter housing and remove old media block. Replace with new media block. Lower drain down filter housing and lock into place.
3. Exit chamber and replace hatch or manhole cover.

Maintenance Notes

1. Following maintenance and/or inspection, it is recommended the maintenance operator prepare a maintenance/ inspection record. The record should include any maintenance activities performed, amount and description of debris collected, and condition of the system and its various filter mechanisms.
2. The owner should keep maintenance/inspection record(s) for a minimum of five years from the date of maintenance. These records should be made available to the governing municipality for inspection upon request at any time.
3. Transport all debris, trash, organics and sediments to approved facility for disposal in accordance with local and state requirements.
4. Entry into chambers may require confined space training based on state and local regulations.
5. No fertilizer shall be used in the Biofiltration Chamber.
6. Irrigation should be provided as recommended by manufacturer and/or landscape architect. Amount of irrigation required is dependent on plant species. Some plants may require irrigation.

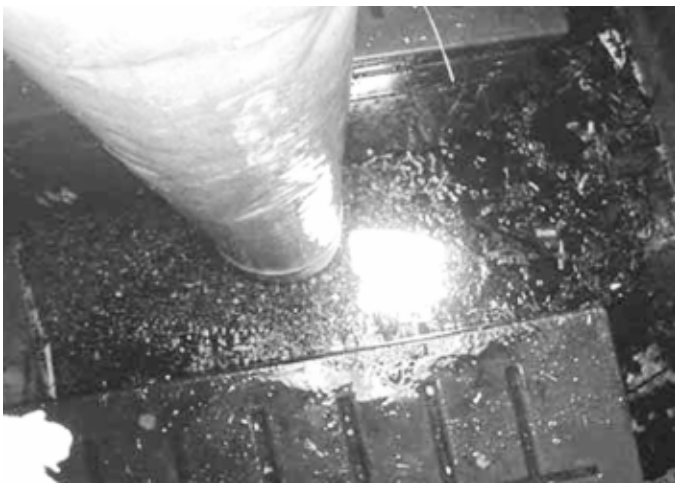
Maintenance Procedure Illustration

Screening Device

The screening device is located directly under the manhole or grate over the Pre-Treatment Chamber. It's mounted directly underneath for easy access and cleaning. Device can be cleaned by hand or with a vacuum truck.

Separation Chamber

The separation chamber is located directly beneath the screening device. It can be quickly cleaned using a vacuum truck or by hand. A pressure washer is useful to assist in the cleaning process.



Cartridge Filters

The cartridge filters are located in the Pre-Treatment chamber connected to the wall adjacent to the biofiltration chamber. The cartridges have removable tops to access the individual media filters. Once the cartridge is open media can be easily removed and replaced by hand or a vacuum truck.

Drain Down Filter

The drain down filter is located in the Discharge Chamber. The drain filter unlocks from the wall mount and hinges up. Remove filter block and replace with new block.

Trim Vegetation

Vegetation should be maintained in the same manner as surrounding vegetation and trimmed as needed. No fertilizer shall be used on the plants. Irrigation per the recommendation of the manufacturer and or landscape architect. Different types of vegetation requires different amounts of irrigation.

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Inspection Report
Modular Wetlands Linear

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

Inspection Checklist

Modular Wetland System Type (Curb, Grate or UG Vault): _____ Size (22', 14' or etc.): _____

Structural Integrity:	**Yes**	**No**	**Comments**
Damage to pre-treatment access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Damage to discharge chamber access cover (manhole cover/grate) or cannot be opened using normal lifting pressure?			
Does the MWS unit show signs of structural deterioration (cracks in the wall, damage to frame)?			
Is the inlet/outlet pipe or drain down pipe damaged or otherwise not functioning properly?			
Working Condition:			
Is there evidence of illicit discharge or excessive oil, grease, or other automobile fluids entering and clogging the unit?			
Is there standing water in inappropriate areas after a dry period?			
Is the filter insert (if applicable) at capacity and/or is there an accumulation of debris/trash on the shelf system?			
Does the depth of sediment/trash/debris suggest a blockage of the inflow pipe, bypass or cartridge filter? If yes, specify which one in the comments section. Note depth of accumulation in in pre-treatment chamber.			Depth:
Does the cartridge filter media need replacement in pre-treatment chamber and/or discharge chamber?			Chamber:
Any signs of improper functioning in the discharge chamber? Note issues in comments section.			
Other Inspection Items:			
Is there an accumulation of sediment/trash/debris in the wetland media (if applicable)?			
Is it evident that the plants are alive and healthy (if applicable)? Please note Plant Information below.			
Is there a septic or foul odor coming from inside the system?			

Waste:	**Yes**	**No**
Sediment / Silt / Clay		
Trash / Bags / Bottles		
Green Waste / Leaves / Foliage		

Recommended Maintenance	
No Cleaning Needed	
Schedule Maintenance as Planned	
Needs Immediate Maintenance	

Plant Information	
Damage to Plants	
Plant Replacement	
Plant Trimming	

Additional Notes: _____

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Cleaning and Maintenance Report
Modular Wetlands Linear

Project Name _____

Project Address _____
(city) (Zip Code)

Owner / Management Company _____

Contact _____ Phone ( ) –

Inspector Name _____ Date ____/____/____ Time _____ AM / PM

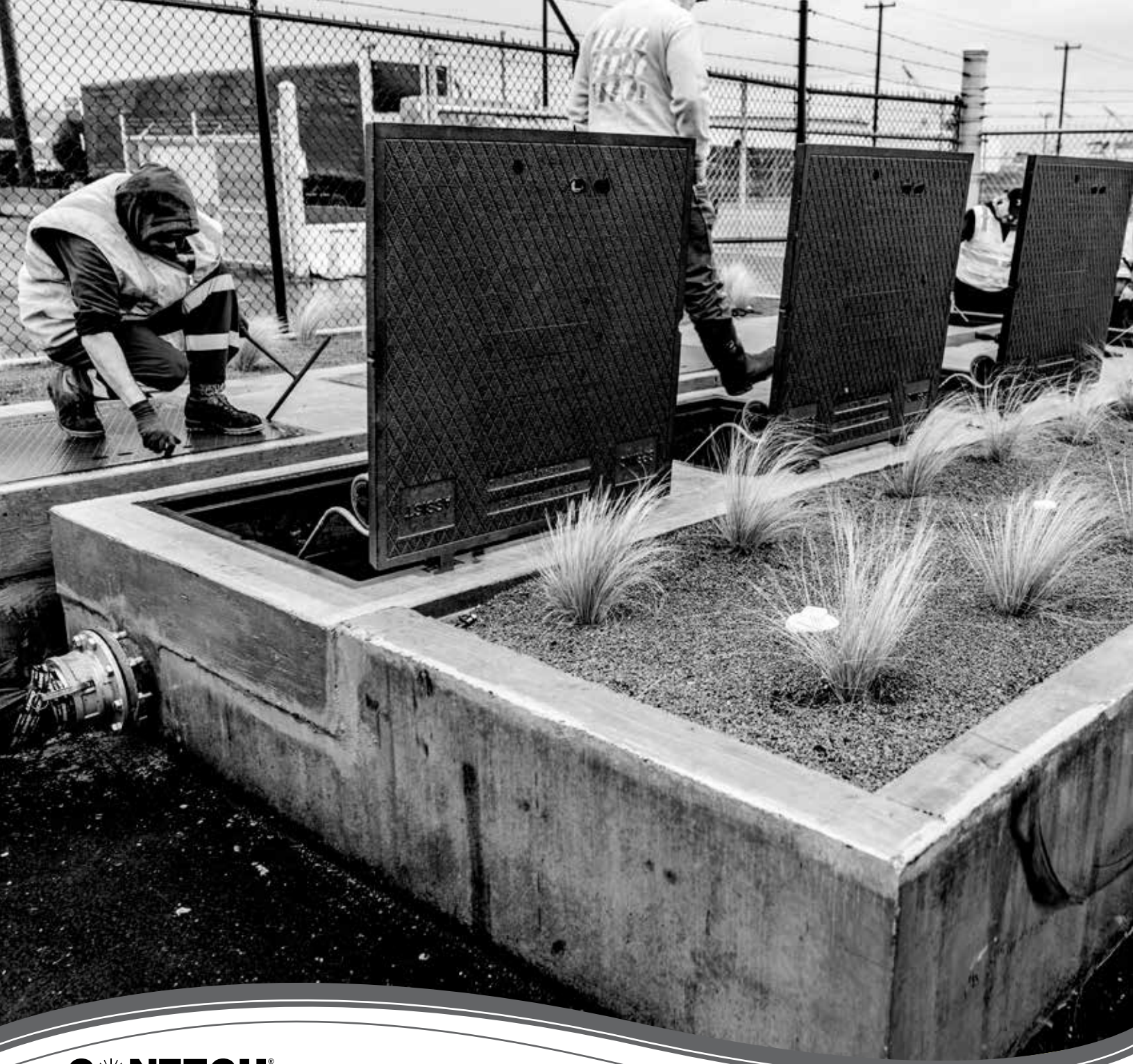
For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

Type of Inspection ☐ Routine ☐ Follow Up ☐ Complaint ☐ Storm Storm Event in Last 72-hours? ☐ No ☐ Yes

Weather Condition _____ Additional Notes _____

Site Map #	GPS Coordinates of Insert	Manufacturer / Description / Sizing	Trash Accumulation	Foliage Accumulation	Sediment Accumulation	Total Debris Accumulation	Condition of Media 25/50/75/100 (will be changed @ 75%)	Operational Per Manufactures' Specifications (If not, why?)
	Lat: Long:	MWS Catch Basins						
		MWS Sedimentation Basin						
		Media Filter Condition						
		Plant Condition						
		Drain Down Media Condition						
		Discharge Chamber Condition						
		Drain Down Pipe Condition						
		Inlet and Outlet Pipe Condition						

Comments:



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SUPPORT

DRAWINGS AND SPECIFICATIONS ARE AVAILABLE AT WWW.CONTECHES.COM

Modular Wetlands Maintenance Guide 08/22

Appendix D – WWHM Calculations

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	ETC
Site Name:	
Site Address:	
City:	
Report Date:	6/29/2023
Gage:	38 IN CENTRAL
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2021/08/18
Version:	4.2.18

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Flat	10.56
Pervious Total	10.56
Impervious Land Use	acre
Impervious Total	0
Basin Total	10.56

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Mod	5.2
Pervious Total	5.2

Impervious Land Use	acre
ROADS MOD	2.83
ROOF TOPS FLAT	1.43
SIDEWALKS MOD	0.67
Impervious Total	4.93
Basin Total	10.13

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Bypass

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	0.03
Pervious Total	0.03

Impervious Land Use	acre
ROADS MOD	0.15
SIDEWALKS MOD	0.25
Impervious Total	0.4
Basin Total	0.43

Element Flows To:

Surface	Interflow	Groundwater

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

Width: 133.888690752879 ft.
Length: 133.888690752879 ft.
Depth: 7 ft.
Discharge Structure
Riser Height: 6 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.500 ft.
Notch Height: 2.400 ft.
Orifice 1 Diameter: 1.391 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

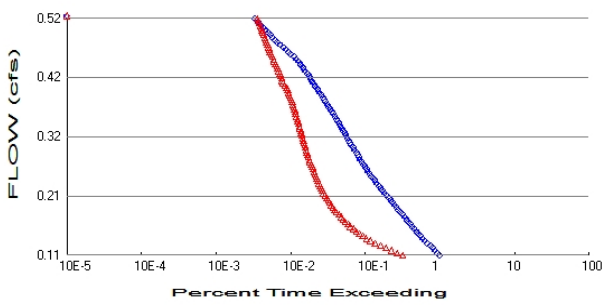
Vault Hydraulic Table

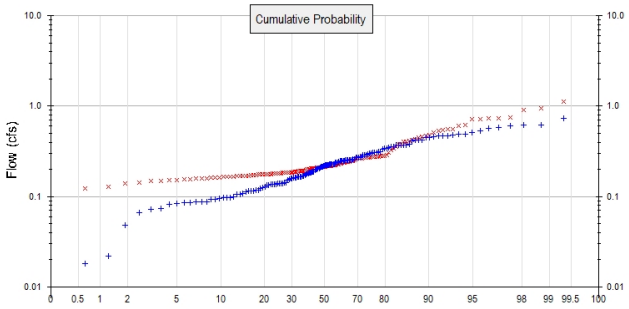
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.411	0.000	0.000	0.000
0.0778	0.411	0.032	0.014	0.000
0.1556	0.411	0.064	0.020	0.000
0.2333	0.411	0.096	0.025	0.000
0.3111	0.411	0.128	0.029	0.000
0.3889	0.411	0.160	0.032	0.000
0.4667	0.411	0.192	0.035	0.000
0.5444	0.411	0.224	0.038	0.000
0.6222	0.411	0.256	0.041	0.000
0.7000	0.411	0.288	0.043	0.000
0.7778	0.411	0.320	0.046	0.000
0.8556	0.411	0.352	0.048	0.000
0.9333	0.411	0.384	0.050	0.000
1.0111	0.411	0.416	0.052	0.000
1.0889	0.411	0.448	0.054	0.000
1.1667	0.411	0.480	0.056	0.000
1.2444	0.411	0.512	0.058	0.000
1.3222	0.411	0.544	0.060	0.000
1.4000	0.411	0.576	0.062	0.000
1.4778	0.411	0.608	0.063	0.000
1.5556	0.411	0.640	0.065	0.000
1.6333	0.411	0.672	0.067	0.000
1.7111	0.411	0.704	0.068	0.000
1.7889	0.411	0.736	0.070	0.000
1.8667	0.411	0.768	0.071	0.000
1.9444	0.411	0.800	0.073	0.000
2.0222	0.411	0.832	0.074	0.000
2.1000	0.411	0.864	0.076	0.000
2.1778	0.411	0.896	0.077	0.000
2.2556	0.411	0.928	0.078	0.000
2.3333	0.411	0.960	0.080	0.000
2.4111	0.411	0.992	0.081	0.000
2.4889	0.411	1.024	0.082	0.000
2.5667	0.411	1.056	0.084	0.000
2.6444	0.411	1.088	0.085	0.000
2.7222	0.411	1.120	0.086	0.000
2.8000	0.411	1.152	0.087	0.000

2.8778	0.411	1.184	0.089	0.000
2.9556	0.411	1.216	0.090	0.000
3.0333	0.411	1.248	0.091	0.000
3.1111	0.411	1.280	0.092	0.000
3.1889	0.411	1.312	0.093	0.000
3.2667	0.411	1.344	0.094	0.000
3.3444	0.411	1.376	0.096	0.000
3.4222	0.411	1.408	0.097	0.000
3.5000	0.411	1.440	0.098	0.000
3.5778	0.411	1.472	0.099	0.000
3.6556	0.411	1.504	0.122	0.000
3.7333	0.411	1.536	0.180	0.000
3.8111	0.411	1.568	0.257	0.000
3.8889	0.411	1.600	0.347	0.000
3.9667	0.411	1.632	0.447	0.000
4.0444	0.411	1.664	0.555	0.000
4.1222	0.411	1.696	0.669	0.000
4.2000	0.411	1.728	0.788	0.000
4.2778	0.411	1.760	0.911	0.000
4.3556	0.411	1.792	1.037	0.000
4.4333	0.411	1.824	1.166	0.000
4.5111	0.411	1.856	1.295	0.000
4.5889	0.411	1.888	1.426	0.000
4.6667	0.411	1.920	1.580	0.000
4.7444	0.411	1.952	1.745	0.000
4.8222	0.411	1.984	1.915	0.000
4.9000	0.411	2.016	2.090	0.000
4.9778	0.411	2.048	2.271	0.000
5.0556	0.411	2.080	3.206	0.000
5.1333	0.411	2.112	3.457	0.000
5.2111	0.411	2.144	3.716	0.000
5.2889	0.411	2.176	3.980	0.000
5.3667	0.411	2.208	4.251	0.000
5.4444	0.411	2.240	4.527	0.000
5.5222	0.411	2.272	4.810	0.000
5.6000	0.411	2.304	5.098	0.000
5.6778	0.411	2.336	5.392	0.000
5.7556	0.411	2.368	5.691	0.000
5.8333	0.411	2.400	5.996	0.000
5.9111	0.411	2.432	6.306	0.000
5.9889	0.411	2.464	6.621	0.000
6.0667	0.411	2.496	6.941	0.000
6.1444	0.411	2.528	7.537	0.000
6.2222	0.411	2.560	8.306	0.000
6.3000	0.411	2.592	9.171	0.000
6.3778	0.411	2.624	10.05	0.000
6.4556	0.411	2.656	10.88	0.000
6.5333	0.411	2.688	11.59	0.000
6.6111	0.411	2.720	12.14	0.000
6.6889	0.411	2.752	12.52	0.000
6.7667	0.411	2.784	12.88	0.000
6.8444	0.411	2.816	13.18	0.000
6.9222	0.411	2.848	13.48	0.000
7.0000	0.411	2.880	13.76	0.000
7.0778	0.411	2.912	14.03	0.000
7.1556	0.000	0.000	14.29	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 10.56
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 5.23
Total Impervious Area: 5.33

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.222529
5 year	0.346189
10 year	0.413381
25 year	0.481771
50 year	0.52242
100 year	0.555845

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.226076
5 year	0.337869
10 year	0.433687
25 year	0.584091
50 year	0.720673
100 year	0.881287

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.163	0.217
1903	0.136	0.240
1904	0.222	0.278
1905	0.107	0.175
1906	0.048	0.151
1907	0.342	0.224
1908	0.253	0.175
1909	0.250	0.192
1910	0.345	0.225
1911	0.225	0.208

1912	0.741	0.356
1913	0.355	0.184
1914	0.087	0.608
1915	0.143	0.172
1916	0.222	0.258
1917	0.074	0.128
1918	0.238	0.197
1919	0.176	0.159
1920	0.226	0.200
1921	0.253	0.190
1922	0.254	0.238
1923	0.204	0.166
1924	0.093	0.244
1925	0.116	0.149
1926	0.216	0.205
1927	0.140	0.177
1928	0.172	0.171
1929	0.353	0.271
1930	0.227	0.276
1931	0.210	0.169
1932	0.164	0.178
1933	0.159	0.192
1934	0.466	0.617
1935	0.216	0.212
1936	0.188	0.206
1937	0.300	0.244
1938	0.183	0.167
1939	0.011	0.189
1940	0.203	0.280
1941	0.097	0.278
1942	0.305	0.535
1943	0.157	0.217
1944	0.288	0.421
1945	0.254	0.219
1946	0.138	0.207
1947	0.087	0.159
1948	0.479	0.224
1949	0.410	0.540
1950	0.116	0.168
1951	0.143	0.286
1952	0.624	0.749
1953	0.563	0.512
1954	0.203	0.178
1955	0.166	0.166
1956	0.081	0.155
1957	0.288	0.167
1958	0.602	0.727
1959	0.372	0.712
1960	0.099	0.174
1961	0.374	0.446
1962	0.201	0.192
1963	0.096	0.140
1964	0.106	0.434
1965	0.419	0.474
1966	0.117	0.162
1967	0.180	0.216
1968	0.184	0.189
1969	0.183	0.175

1970	0.287	0.211
1971	0.452	0.463
1972	0.293	0.553
1973	0.373	0.325
1974	0.202	0.233
1975	0.474	0.719
1976	0.251	0.263
1977	0.085	0.150
1978	0.422	0.242
1979	0.116	0.209
1980	0.239	0.240
1981	0.229	0.216
1982	0.094	0.183
1983	0.374	0.246
1984	0.153	0.228
1985	0.248	0.271
1986	0.223	0.172
1987	0.425	0.404
1988	0.269	0.176
1989	0.242	0.155
1990	0.274	0.188
1991	0.215	0.282
1992	0.307	0.269
1993	0.298	0.226
1994	0.446	0.203
1995	0.086	0.180
1996	0.489	0.553
1997	0.188	0.181
1998	0.223	0.215
1999	0.018	0.217
2000	0.170	0.201
2001	0.087	0.162
2002	0.310	0.281
2003	0.270	0.210
2004	0.248	0.233
2005	0.457	0.477
2006	0.138	0.203
2007	0.139	0.250
2008	0.236	0.181
2009	0.162	0.159
2010	0.138	0.215
2011	0.112	0.205
2012	0.162	0.193
2013	0.126	0.183
2014	0.094	0.178
2015	0.180	0.271
2016	0.072	0.200
2017	0.343	0.406
2018	0.624	0.956
2019	0.582	0.909
2020	0.190	0.211
2021	0.309	0.218
2022	0.128	0.265
2023	0.260	0.340
2024	0.488	0.378
2025	0.229	0.185
2026	0.374	0.278
2027	0.135	0.225

2028	0.117	0.117
2029	0.254	0.169
2030	0.471	0.264
2031	0.155	0.124
2032	0.085	0.166
2033	0.136	0.188
2034	0.134	0.163
2035	0.531	1.120
2036	0.276	0.182
2037	0.066	0.247
2038	0.220	0.217
2039	0.022	0.383
2040	0.122	0.183
2041	0.165	0.202
2042	0.516	0.733
2043	0.249	0.226
2044	0.336	0.208
2045	0.229	0.153
2046	0.268	0.412
2047	0.198	0.182
2048	0.256	0.176
2049	0.229	0.224
2050	0.164	0.190
2051	0.238	0.270
2052	0.137	0.207
2053	0.245	0.266
2054	0.312	0.304
2055	0.097	0.178
2056	0.108	0.238
2057	0.168	0.143
2058	0.213	0.254
2059	0.376	0.278

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.7407	1.1202
2	0.6242	0.9561
3	0.6236	0.9093
4	0.6024	0.7495
5	0.5816	0.7327
6	0.5631	0.7271
7	0.5309	0.7192
8	0.5164	0.7118
9	0.4890	0.6168
10	0.4883	0.6079
11	0.4787	0.5527
12	0.4743	0.5526
13	0.4706	0.5398
14	0.4659	0.5352
15	0.4575	0.5124
16	0.4519	0.4775
17	0.4462	0.4735
18	0.4248	0.4633
19	0.4223	0.4464
20	0.4190	0.4340
21	0.4102	0.4214
22	0.3765	0.4122

23	0.3745	0.4065
24	0.3744	0.4044
25	0.3743	0.3835
26	0.3734	0.3779
27	0.3724	0.3564
28	0.3549	0.3396
29	0.3534	0.3249
30	0.3449	0.3035
31	0.3429	0.2860
32	0.3415	0.2819
33	0.3365	0.2811
34	0.3117	0.2796
35	0.3102	0.2781
36	0.3088	0.2780
37	0.3069	0.2777
38	0.3054	0.2776
39	0.3002	0.2758
40	0.2975	0.2713
41	0.2930	0.2708
42	0.2884	0.2707
43	0.2878	0.2701
44	0.2870	0.2692
45	0.2757	0.2656
46	0.2741	0.2649
47	0.2701	0.2638
48	0.2694	0.2629
49	0.2684	0.2583
50	0.2597	0.2535
51	0.2557	0.2497
52	0.2544	0.2474
53	0.2539	0.2461
54	0.2537	0.2444
55	0.2531	0.2441
56	0.2530	0.2422
57	0.2511	0.2399
58	0.2502	0.2396
59	0.2494	0.2384
60	0.2485	0.2384
61	0.2483	0.2332
62	0.2452	0.2329
63	0.2422	0.2277
64	0.2391	0.2256
65	0.2383	0.2255
66	0.2378	0.2251
67	0.2363	0.2248
68	0.2293	0.2242
69	0.2291	0.2237
70	0.2289	0.2237
71	0.2286	0.2191
72	0.2271	0.2183
73	0.2263	0.2174
74	0.2246	0.2172
75	0.2232	0.2171
76	0.2227	0.2168
77	0.2221	0.2159
78	0.2220	0.2156
79	0.2198	0.2153
80	0.2163	0.2151

81	0.2155	0.2120
82	0.2146	0.2112
83	0.2132	0.2111
84	0.2101	0.2102
85	0.2041	0.2094
86	0.2032	0.2081
87	0.2027	0.2077
88	0.2021	0.2067
89	0.2010	0.2065
90	0.1976	0.2056
91	0.1897	0.2049
92	0.1880	0.2048
93	0.1876	0.2034
94	0.1836	0.2030
95	0.1833	0.2016
96	0.1829	0.2014
97	0.1803	0.1997
98	0.1800	0.1996
99	0.1758	0.1971
100	0.1725	0.1928
101	0.1698	0.1924
102	0.1684	0.1922
103	0.1661	0.1916
104	0.1647	0.1904
105	0.1645	0.1903
106	0.1641	0.1892
107	0.1632	0.1888
108	0.1622	0.1883
109	0.1618	0.1877
110	0.1587	0.1849
111	0.1571	0.1836
112	0.1555	0.1833
113	0.1526	0.1831
114	0.1430	0.1827
115	0.1430	0.1825
116	0.1398	0.1822
117	0.1388	0.1808
118	0.1384	0.1806
119	0.1381	0.1799
120	0.1376	0.1784
121	0.1370	0.1783
122	0.1361	0.1782
123	0.1357	0.1775
124	0.1345	0.1770
125	0.1339	0.1764
126	0.1278	0.1758
127	0.1263	0.1750
128	0.1222	0.1747
129	0.1175	0.1745
130	0.1166	0.1739
131	0.1162	0.1723
132	0.1158	0.1721
133	0.1157	0.1706
134	0.1115	0.1691
135	0.1083	0.1689
136	0.1068	0.1680
137	0.1060	0.1675
138	0.0991	0.1670

139	0.0966	0.1664
140	0.0966	0.1660
141	0.0963	0.1656
142	0.0941	0.1634
143	0.0936	0.1623
144	0.0932	0.1615
145	0.0869	0.1592
146	0.0869	0.1588
147	0.0867	0.1587
148	0.0856	0.1553
149	0.0847	0.1553
150	0.0845	0.1526
151	0.0814	0.1506
152	0.0741	0.1495
153	0.0717	0.1491
154	0.0659	0.1434
155	0.0478	0.1400
156	0.0221	0.1275
157	0.0180	0.1238
158	0.0114	0.1168

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1113	54547	17617	32	Pass
0.1154	50553	14775	29	Pass
0.1196	47041	12354	26	Pass
0.1237	43839	10443	23	Pass
0.1279	40869	8870	21	Pass
0.1320	37462	7446	19	Pass
0.1362	35013	6526	18	Pass
0.1403	32753	5767	17	Pass
0.1445	30587	5140	16	Pass
0.1486	28565	4633	16	Pass
0.1528	26736	4212	15	Pass
0.1569	25152	3865	15	Pass
0.1611	23324	3488	14	Pass
0.1653	22000	3249	14	Pass
0.1694	20748	2986	14	Pass
0.1736	19568	2786	14	Pass
0.1777	18471	2608	14	Pass
0.1819	17446	2449	14	Pass
0.1860	16155	2261	13	Pass
0.1902	15169	2120	13	Pass
0.1943	14338	2027	14	Pass
0.1985	13523	1926	14	Pass
0.2026	12786	1844	14	Pass
0.2068	12061	1763	14	Pass
0.2109	11401	1699	14	Pass
0.2151	10582	1606	15	Pass
0.2192	10000	1530	15	Pass
0.2234	9424	1473	15	Pass
0.2276	8931	1428	15	Pass
0.2317	8404	1378	16	Pass
0.2359	7950	1327	16	Pass
0.2400	7457	1276	17	Pass
0.2442	7041	1240	17	Pass
0.2483	6637	1208	18	Pass
0.2525	6299	1177	18	Pass
0.2566	6022	1140	18	Pass
0.2608	5756	1109	19	Pass
0.2649	5495	1079	19	Pass
0.2691	5199	1040	20	Pass
0.2732	4955	1007	20	Pass
0.2774	4714	980	20	Pass
0.2815	4533	957	21	Pass
0.2857	4358	935	21	Pass
0.2898	4191	911	21	Pass
0.2940	3956	890	22	Pass
0.2982	3771	873	23	Pass
0.3023	3587	859	23	Pass
0.3065	3432	832	24	Pass
0.3106	3285	815	24	Pass
0.3148	3152	799	25	Pass
0.3189	3050	783	25	Pass
0.3231	2928	764	26	Pass
0.3272	2816	752	26	Pass

0.3314	2691	737	27	Pass
0.3355	2565	725	28	Pass
0.3397	2470	709	28	Pass
0.3438	2374	693	29	Pass
0.3480	2282	678	29	Pass
0.3521	2143	659	30	Pass
0.3563	2044	645	31	Pass
0.3604	1958	634	32	Pass
0.3646	1873	623	33	Pass
0.3688	1790	610	34	Pass
0.3729	1711	595	34	Pass
0.3771	1619	583	36	Pass
0.3812	1563	567	36	Pass
0.3854	1487	549	36	Pass
0.3895	1417	531	37	Pass
0.3937	1353	516	38	Pass
0.3978	1282	506	39	Pass
0.4020	1230	490	39	Pass
0.4061	1164	460	39	Pass
0.4103	1107	439	39	Pass
0.4144	1064	427	40	Pass
0.4186	1013	421	41	Pass
0.4227	971	407	41	Pass
0.4269	927	399	43	Pass
0.4311	872	384	44	Pass
0.4352	815	369	45	Pass
0.4394	777	360	46	Pass
0.4435	740	341	46	Pass
0.4477	698	332	47	Pass
0.4518	651	325	49	Pass
0.4560	610	314	51	Pass
0.4601	556	303	54	Pass
0.4643	518	290	55	Pass
0.4684	482	286	59	Pass
0.4726	439	280	63	Pass
0.4767	396	272	68	Pass
0.4809	367	259	70	Pass
0.4850	339	255	75	Pass
0.4892	311	251	80	Pass
0.4933	297	239	80	Pass
0.4975	276	232	84	Pass
0.5017	254	228	89	Pass
0.5058	240	222	92	Pass
0.5100	225	218	96	Pass
0.5141	206	208	100	Pass
0.5183	195	204	104	Pass
0.5224	181	197	108	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

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.

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
Vault 1 POC	☐	1834.51			☐	0.00			
Total Volume Infiltrated		1834.51	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

Model Default Modifications

Total of 0 changes have been made.

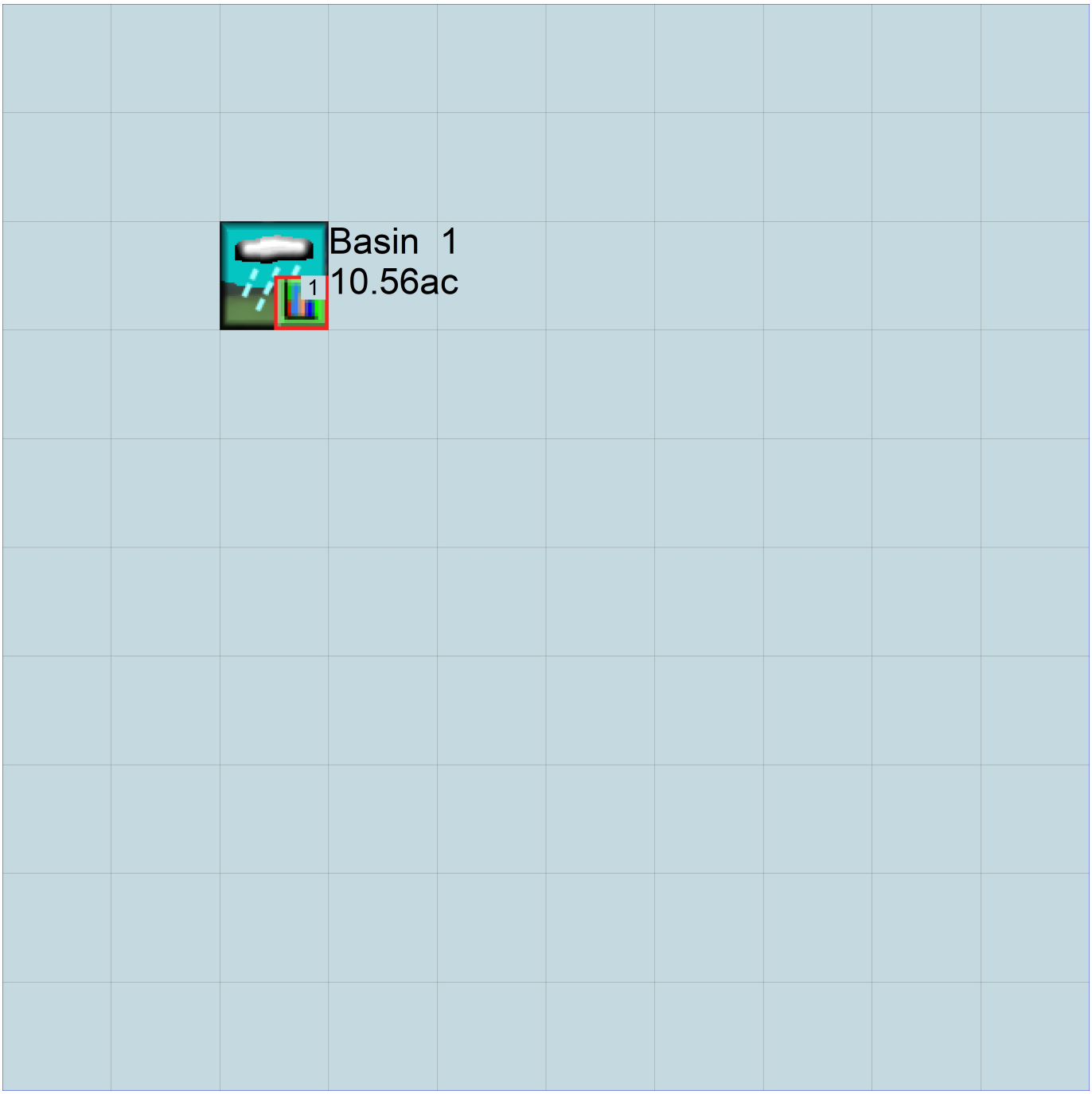
PERLND Changes

No PERLND changes have been made.

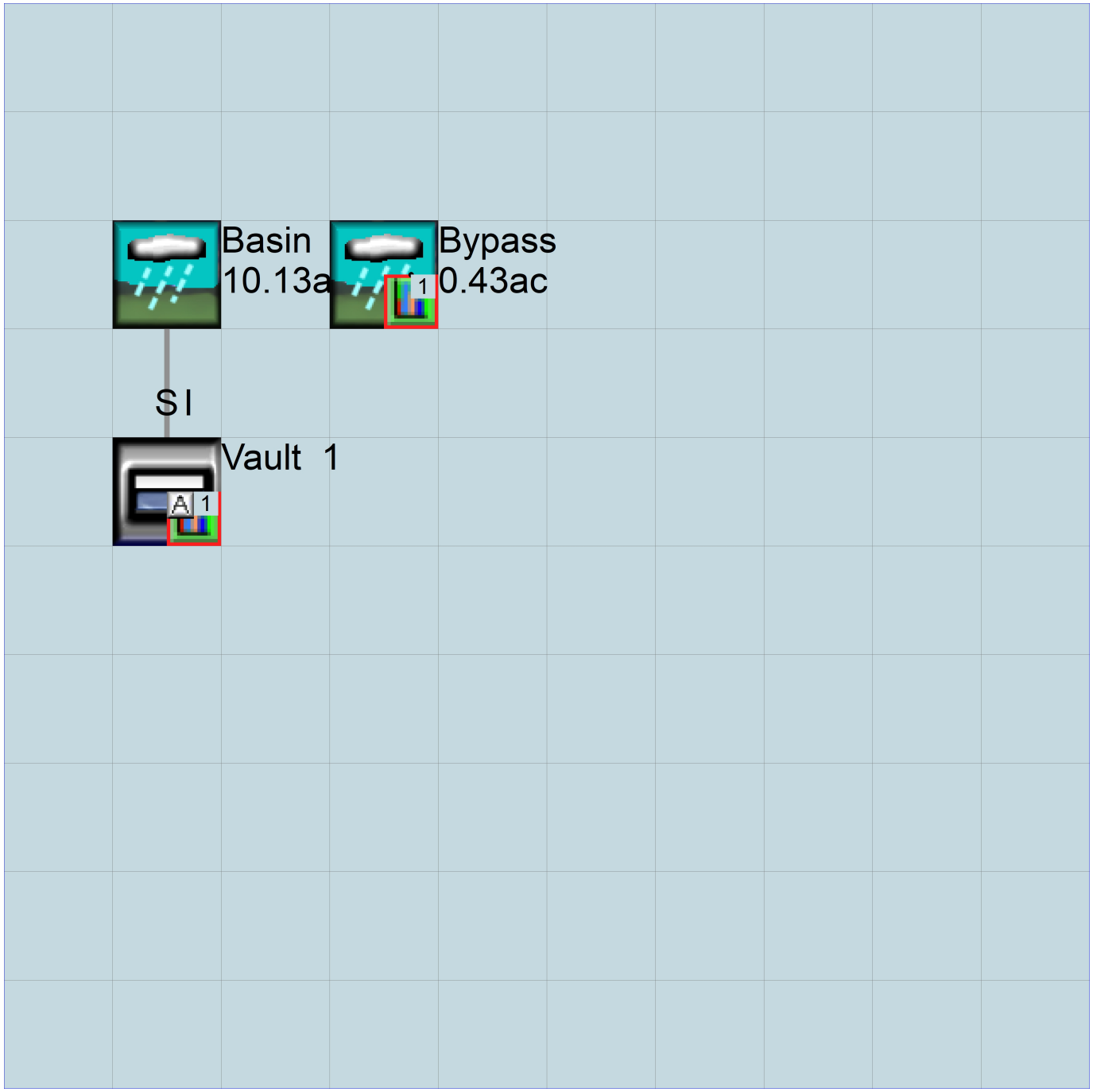
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                   UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   ETC.wdm
MESSU       25   PreETC.MES
            27   PreETC.L61
            28   PreETC.L62
            30   POCETC1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      10
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                       in  out           ***
   10     C, Forest, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   10         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   10         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO
```

```
  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   10         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   10              0       4.5      0.08       400      0.05       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   10             0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   10           0.2       0.5      0.35         6       0.5       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   10             0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
  END IWAT-STATE1
```

```
END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  10                       10.56     COPY   501     12
PERLND  10                       10.56     COPY   501     13

******Routing******
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1



<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                 ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                           in  out                           ***
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                      ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                         ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit       for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1              PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
```

```
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1901 10 01        END    2059 09 30
  RUN INTERP OUTPUT LEVEL    3    0
  RESUME     0 RUN     1                    UNIT SYSTEM     1
END GLOBAL

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM         26   ETC.wdm
MESSU       25   MitETC.MES
            27   MitETC.L61
            28   MitETC.L62
            30   POCETC1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND       8
      IMPLND       2
      IMPLND       4
      IMPLND       9
      PERLND      17
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Vault  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
    8     A/B, Lawn, Mod          1    1    1    1   27    0
   17     C, Lawn, Mod            1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
```

```
    8         0    0    1    0    0    0    0    0    0    0    0    0
   17         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
    8         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
    8         0    0    0    0    0    0    0    0    0    0    0
   17         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
    8              0         5       0.8       400       0.1       0.3     0.996
   17              0       4.5      0.03       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    8              0         0         2         2         0         0         0
   17              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    8          0.1       0.5      0.25         0       0.7      0.25
   17          0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
    8              0         0         0         0         3         1         0
   17              0         0         0         0       2.5         1         0
  END PWAT-STATE1

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    2      ROADS/MOD               1    1    1   27    0
    4      ROOF TOPS/FLAT          1    1    1   27    0
    9      SIDEWALKS/MOD           1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    4         0    0    1    0    0    0
    9         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
```

```
    2         0    0    4    0    0    0    1    9
    4         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    2         0    0    0    0    0
    4         0    0    0    0    0
    9         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2           400      0.05       0.1      0.08
    4           400      0.01       0.1       0.1
    9           400      0.05       0.1      0.08
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2             0         0
    4             0         0
    9             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2             0         0
    4             0         0
    9             0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND   8                       5.2     RCHRES   1      2
PERLND   8                       5.2     RCHRES   1      3
IMPLND   2                      2.83     RCHRES   1      5
IMPLND   4                      1.43     RCHRES   1      5
IMPLND   9                      0.67     RCHRES   1      5
Bypass***
PERLND  17                      0.03     COPY   501     12
PERLND  17                      0.03     COPY   601     12
PERLND  17                      0.03     COPY   501     13
PERLND  17                      0.03     COPY   601     13
IMPLND   2                      0.15     COPY   501     15
IMPLND   2                      0.15     COPY   601     15
IMPLND   9                      0.25     COPY   501     15
IMPLND   9                      0.25     COPY   601     15

******Routing******
PERLND   8                       5.2     COPY     1     12
IMPLND   2                      2.83     COPY     1     15
IMPLND   4                      1.43     COPY     1     15
IMPLND   9                      0.67     COPY     1     15
PERLND   8                       5.2     COPY     1     13
RCHRES   1                         1     COPY   501     16
END SCHEMATIC

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
```

```
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1


<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
END NETWORK

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<-----------------><---> User T-series  Engl Metr LKFG            ***
                                        in  out                             ***
    1     Vault  1                1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ****************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                    ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
            FG FG FG FG  possible  exit  *** possible  exit      possible  exit
             *  *  *  *    *  *  *  *  *       *  *  *  *  *        ***
    1        0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><--------->      ***
    1               1      0.03       0.0       0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                       ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
           *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
    1           0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.411529  0.000000  0.000000
  0.077778  0.411529  0.032008  0.014643
  0.155556  0.411529  0.064016  0.020709
  0.233333  0.411529  0.096023  0.025363
  0.311111  0.411529  0.128031  0.029287
  0.388889  0.411529  0.160039  0.032744
  0.466667  0.411529  0.192047  0.035869
  0.544444  0.411529  0.224054  0.038743
  0.622222  0.411529  0.256062  0.041418
  0.700000  0.411529  0.288070  0.043930
  0.777778  0.411529  0.320078  0.046306
  0.855556  0.411529  0.352085  0.048567
```

0.933333	0.411529	0.384093	0.050726
1.011111	0.411529	0.416101	0.052797
1.088889	0.411529	0.448109	0.054790
1.166667	0.411529	0.480117	0.056713
1.244444	0.411529	0.512124	0.058573
1.322222	0.411529	0.544132	0.060376
1.400000	0.411529	0.576140	0.062127
1.477778	0.411529	0.608148	0.063829
1.555556	0.411529	0.640155	0.065487
1.633333	0.411529	0.672163	0.067104
1.711111	0.411529	0.704171	0.068683
1.788889	0.411529	0.736179	0.070227
1.866667	0.411529	0.768187	0.071738
1.944444	0.411529	0.800194	0.073217
2.022222	0.411529	0.832202	0.074667
2.100000	0.411529	0.864210	0.076089
2.177778	0.411529	0.896218	0.077485
2.255556	0.411529	0.928225	0.078857
2.333333	0.411529	0.960233	0.080205
2.411111	0.411529	0.992241	0.081531
2.488889	0.411529	1.024249	0.082835
2.566667	0.411529	1.056256	0.084120
2.644444	0.411529	1.088264	0.085385
2.722222	0.411529	1.120272	0.086631
2.800000	0.411529	1.152280	0.087860
2.877778	0.411529	1.184288	0.089072
2.955556	0.411529	1.216295	0.090268
3.033333	0.411529	1.248303	0.091448
3.111111	0.411529	1.280311	0.092613
3.188889	0.411529	1.312319	0.093763
3.266667	0.411529	1.344326	0.094900
3.344444	0.411529	1.376334	0.096023
3.422222	0.411529	1.408342	0.097133
3.500000	0.411529	1.440350	0.098231
3.577778	0.411529	1.472358	0.099316
3.655556	0.411529	1.504365	0.121950
3.733333	0.411529	1.536373	0.180353
3.811111	0.411529	1.568381	0.257188
3.888889	0.411529	1.600389	0.347137
3.966667	0.411529	1.632396	0.447141
4.044444	0.411529	1.664404	0.555076
4.122222	0.411529	1.696412	0.669322
4.200000	0.411529	1.728420	0.788570
4.277778	0.411529	1.760427	0.911722
4.355556	0.411529	1.792435	1.037830
4.433333	0.411529	1.824443	1.166062
4.511111	0.411529	1.856451	1.295670
4.588889	0.411529	1.888459	1.425978
4.666667	0.411529	1.920466	1.580823
4.744444	0.411529	1.952474	1.745152
4.822222	0.411529	1.984482	1.915124
4.900000	0.411529	2.016490	2.090556
4.977778	0.411529	2.048497	2.271282
5.055556	0.411529	2.080505	3.206205
5.133333	0.411529	2.112513	3.457911
5.211111	0.411529	2.144521	3.716054
5.288889	0.411529	2.176529	3.980477
5.366667	0.411529	2.208536	4.251034
5.444444	0.411529	2.240544	4.527588
5.522222	0.411529	2.272552	4.810011
5.600000	0.411529	2.304560	5.098183
5.677778	0.411529	2.336567	5.391992
5.755556	0.411529	2.368575	5.691331
5.833333	0.411529	2.400583	5.996098
5.911111	0.411529	2.432591	6.306199
5.988889	0.411529	2.464598	6.621543
6.066667	0.411529	2.496606	6.941423
6.144444	0.411529	2.528614	7.537545
6.222222	0.411529	2.560622	8.306321
6.300000	0.411529	2.592630	9.171453

```
  6.377778  0.411529  2.624637  10.05729
  6.455556  0.411529  2.656645  10.88790
  6.533333  0.411529  2.688653  11.59681
  6.611111  0.411529  2.720661  12.14175
  6.688889  0.411529  2.752668  12.52299
  6.766667  0.411529  2.784676  12.88004
  6.844444  0.411529  2.816684  13.18797
  6.922222  0.411529  2.848692  13.48204
  7.000000  0.411529  2.880700  13.76399
  7.077778  0.411529  2.912707  14.03519
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1             PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1             IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1             PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1             IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
END EXT TARGETS

MASS-LINK
<Volume>   <-Grp> <-Member-><--Mult-->     <Target>       <-Grp> <-Member->***
<Name>            <Name> # #<-factor->     <Name>                <Name> # #***
  MASS-LINK        2
PERLND     PWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    2

  MASS-LINK        3
PERLND     PWATER IFWO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    3

  MASS-LINK        5
IMPLND     IWATER SURO       0.083333      RCHRES         INFLOW IVOL
  END MASS-LINK    5

  MASS-LINK       12
PERLND     PWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   12

  MASS-LINK       13
PERLND     PWATER IFWO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   13

  MASS-LINK       15
IMPLND     IWATER SURO       0.083333      COPY           INPUT  MEAN
  END MASS-LINK   15

  MASS-LINK       16
RCHRES     ROFLOW                          COPY           INPUT  MEAN
  END MASS-LINK   16


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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Appendix E: Letter of Map Revision

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION DETERMINATION DOCUMENT

COMMUNITY AND REVISION INFORMATION		PROJECT DESCRIPTION	BASIS OF REQUEST
COMMUNITY	City of Puyallup Pierce County Washington	CHANNELIZATION CULVERT DETENTION BASIN	HYDROLOGIC ANALYSIS 1D HYDRAULIC ANALYSIS UPDATED TOPOGRAPHIC DATA
	COMMUNITY NO.: 530144		
IDENTIFIER	06-171 East Town Crossing	APPROXIMATE LATITUDE & LONGITUDE: 47.184, -122.254 SOURCE: Other DATUM: WGS 84	

ANNOTATED MAPPING ENCLOSURES	ANNOTATED STUDY ENCLOSURES
TYPE: FIRM* NO.: 53053C0342E DATE: March 7, 2017 TYPE: FIRM NO.: 53053C0361E DATE: March 7, 2017	DATE OF EFFECTIVE FLOOD INSURANCE STUDY: March 7, 2017 PROFILE(S): 363P, 365P(NEW), AND 366P(NEW) SUMMARY OF DISCHARGES TABLE: 2

Enclosures reflect changes to flooding sources affected by this revision.
* FIRM - Flood Insurance Rate Map

FLOODING SOURCE(S) & REVISED REACH(ES) See Page 2 for Additional Flooding Sources

Deer Creek - Pioneer - From just downstream of E Pioneer Ave & Shaw Road E to approximately 1,520 feet upstream of E Pioneer Ave & Shaw Road E
Pioneer South Creek - From just downstream of E Pioneer Ave & Shaw Road E to approximately 1,530 feet upstream of E Pioneer Ave & Shaw Road E

SUMMARY OF REVISIONS

Flooding Source	Effective Flooding	Revised Flooding	Increases	Decreases
Deer Creek – Pioneer	No BFEs*	BFEs	YES	NONE
	Zone X (unshaded)	Zone AE	YES	NONE
Pioneer South Creek	No BFEs	BFEs	YES	NONE
	Zone A	Zone AE	YES	NONE

* BFEs - Base (1-percent-annual-chance) Flood Elevations

DETERMINATION

This document provides the determination from the Department of Homeland Security's Federal Emergency Management Agency (FEMA) regarding a request for a Letter of Map Revision (LOMR) for the area described above. Using the information submitted, we have determined that a revision to the flood hazards depicted in the Flood Insurance Study (FIS) report and/or National Flood Insurance Program (NFIP) map is warranted. This document revises the effective NFIP map, as indicated in the attached documentation. Please use the enclosed annotated map panels revised by this LOMR for floodplain management purposes and for all flood insurance policies and renewals in your community.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on our website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

OTHER FLOODING SOURCES AFFECTED BY THIS REVISION

FLOODING SOURCE(S) & REVISED REACH(ES)

Pioneer South Creek Tributary - From confluence with Pioneer South Creek to approximately 1,860 feet upstream of confluence with Pioneer South Creek

SUMMARY OF REVISIONS

Flooding Source	Effective Flooding	Revised Flooding	Increases	Decreases
Pioneer South Creek Tributary	No BFEs*	BFEs	YES	NONE
	Zone A	Zone AE	YES	YES

* BFEs - Base (1-percent-annual-chance) Flood Elevations

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on our website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
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Federal Insurance and Mitigation Administration

Federal Emergency Management Agency
Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

COMMUNITY INFORMATION

APPLICABLE NFIP REGULATIONS/COMMUNITY OBLIGATION

We have made this determination pursuant to Section 206 of the Flood Disaster Protection Act of 1973 (P.L. 93-234) and in accordance with the National Flood Insurance Act of 1968, as amended (Title XIII of the Housing and Urban Development Act of 1968, P.L. 90-448), 42 U.S.C. 4001-4128, and 44 CFR Part 65. Pursuant to Section 1361 of the National Flood Insurance Act of 1968, as amended, communities participating in the NFIP are required to adopt and enforce floodplain management regulations that meet or exceed NFIP criteria. These criteria, including adoption of the FIS report and FIRM, and the modifications made by this LOMR, are the minimum requirements for continued NFIP participation and do not supersede more stringent State/Commonwealth or local requirements to which the regulations apply.

NFIP regulations Subparagraph 60.3(b)(7) requires communities to ensure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management ordinances; therefore, responsibility for maintenance of the altered or relocated watercourse, including any related appurtenances such as bridges, culverts, and other drainage structures, rests with your community. We may request that your community submit a description and schedule of maintenance activities necessary to ensure this requirement.

COMMUNITY REMINDERS

We based this determination on the 1-percent-annual-chance discharges computed in the submitted hydrologic model. Future development of projects upstream could cause increased discharges, which could cause increased flood hazards. A comprehensive restudy of your community's flood hazards would consider the cumulative effects of development on discharges and could, therefore, indicate that greater flood hazards exist in this area.

Your community must regulate all proposed floodplain development and ensure that permits required by Federal and/or State/Commonwealth law have been obtained. State/Commonwealth or community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction or may limit development in floodplain areas. If your State/Commonwealth or community has adopted more restrictive or comprehensive floodplain management criteria, those criteria take precedence over the minimum NFIP requirements.

We will not print and distribute this LOMR to primary users, such as local insurance agents or mortgage lenders; instead, the community will serve as a repository for the new data. We encourage you to disseminate the information in this LOMR by preparing a news release for publication in your community's newspaper that describes the revision and explains how your community will provide the data and help interpret the NFIP maps. In that way, interested persons, such as property owners, insurance agents, and mortgage lenders, can benefit from the information.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on our website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

We have designated a Consultation Coordination Officer (CCO) to assist your community. The CCO will be the primary liaison between your community and FEMA. For information regarding your CCO, please contact:

Ms. Kristen Meyers
Director, Mitigation Division
Federal Emergency Management Agency, Region X
Federal Regional Center
130 228th Street, Southwest
Bothell, WA 98021-8627
(425) 487-4543

STATUS OF THE COMMUNITY NFIP MAPS

We will not physically revise and republish the FIRM and FIS report for your community to reflect the modifications made by this LOMR at this time. When changes to the previously cited FIRM panel(s) and FIS report warrant physical revision and republication in the future, we will incorporate the modifications made by this LOMR at that time.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on our website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

Federal Emergency Management Agency

Washington, D.C. 20472

LETTER OF MAP REVISION
DETERMINATION DOCUMENT (CONTINUED)

PUBLIC NOTIFICATION OF REVISION

A notice of changes will be published in the *Federal Register*. This information also will be published in your local newspaper on or about the dates listed below, and through FEMA's Flood Hazard Mapping website at https://www.floodmaps.fema.gov/fhm/bfe_status/bfe_main.asp

LOCAL NEWSPAPER

Name: *The News Tribune*

Dates: May 4, 2022 and May 11, 2022

Within 90 days of the second publication in the local newspaper, any interested party may request that we reconsider this determination. Any request for reconsideration must be based on scientific or technical data. Therefore, this letter will be effective only after the 90-day appeal period has elapsed and we have resolved any appeals that we receive during this appeal period. Until this LOMR is effective, the revised flood hazard determination presented in this LOMR may be changed.

This determination is based on the flood data presently available. The enclosed documents provide additional information regarding this determination. If you have any questions about this document, please contact the FEMA Mapping and Insurance eXchange toll free at 1-877-336-2627 (1-877-FEMA MAP) or by letter addressed to the LOMC Clearinghouse, 3601 Eisenhower Avenue, Suite 500, Alexandria, VA 22304-6426. Additional Information about the NFIP is available on our website at https://www.fema.gov/flood-insurance.

Patrick "Rick" F. Sacbibit, P.E., Branch Chief
Engineering Services Branch
Federal Insurance and Mitigation Administration

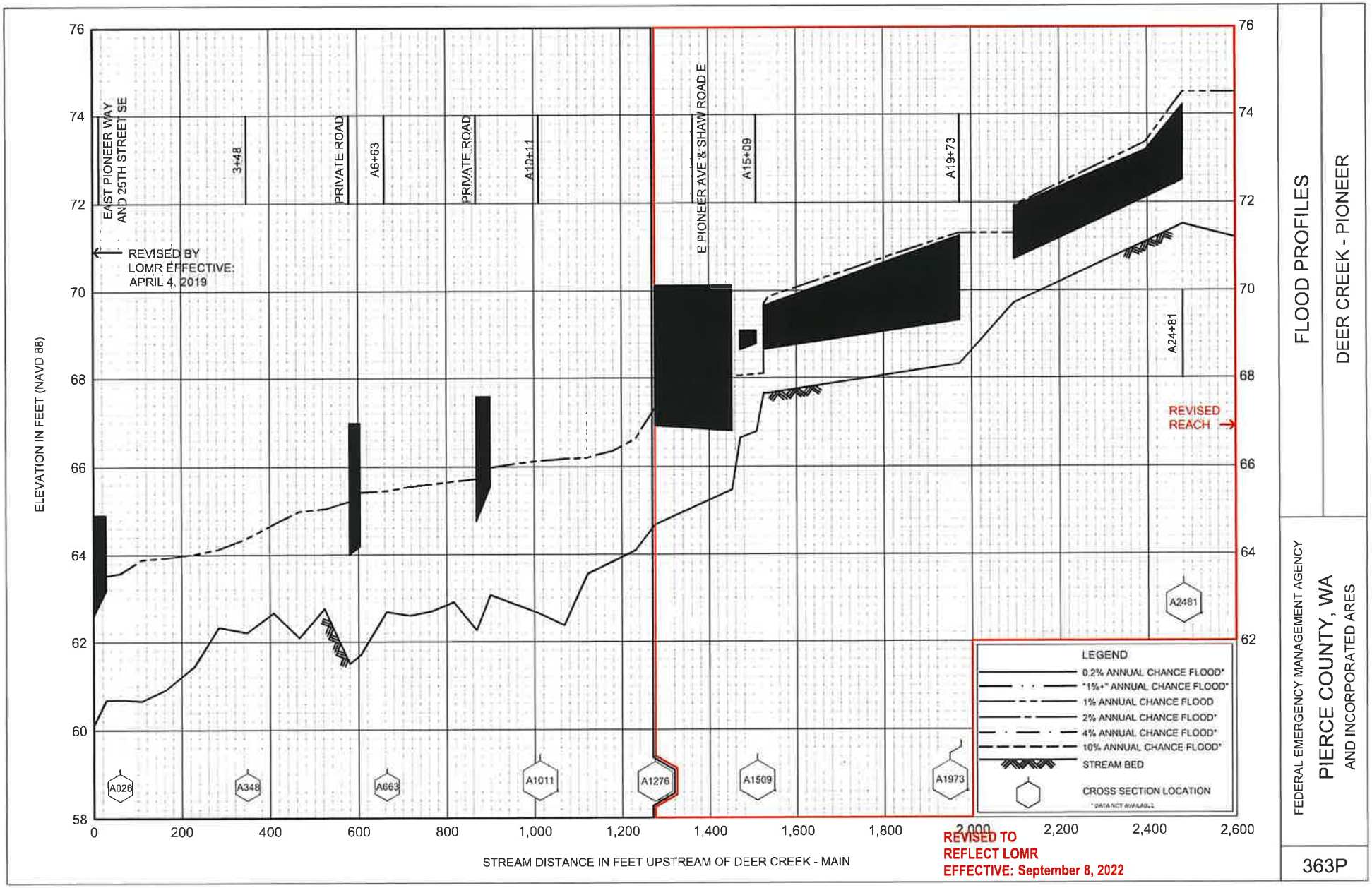
REVISED TO
REFLECT LOMR
EFFECTIVE: April 4,
2019

REVISED TO
REFLECT LOMR
EFFECTIVE: September 8, 2022

Table 2 – Summary of Discharges

Flooding Source and Location	Drainage Area (square miles)	Peak Discharges (cubic feet per second) 10-Percent-Annual-Chance	2-Percent-Annual-Chance	1-Percent-Annual-Chance	0.2-Percent-Annual-Chance
DEBRA JANE CREEK					
At Mouth	1.3	45	62	69	85
At Confluence with Bonney Lake Outflow	0.8	26	34	38	48
At Upstream End of Debra Jane Lake	0.1	9	12	14	17
DEER CREEK					
At the BNSF Railroad crossing near E. Pioneer Way and 23rd Street SE	2.4	N/A	N/A	220	N/A
DEER CREEK - PIONEER					
Upstream of Shaw Road E	0.8	N/A	N/A	11	N/A
PIONEER SOUTH CREEK					
Upstream of Shaw Road E	1.7	N/A	N/A	35	N/A
PIONEER SOUTH CREEK TRIBUTARY					
At confluence with Pioneer South Creek	0.2	N/A	N/A	3	N/A

Revised Data



FLOOD PROFILES

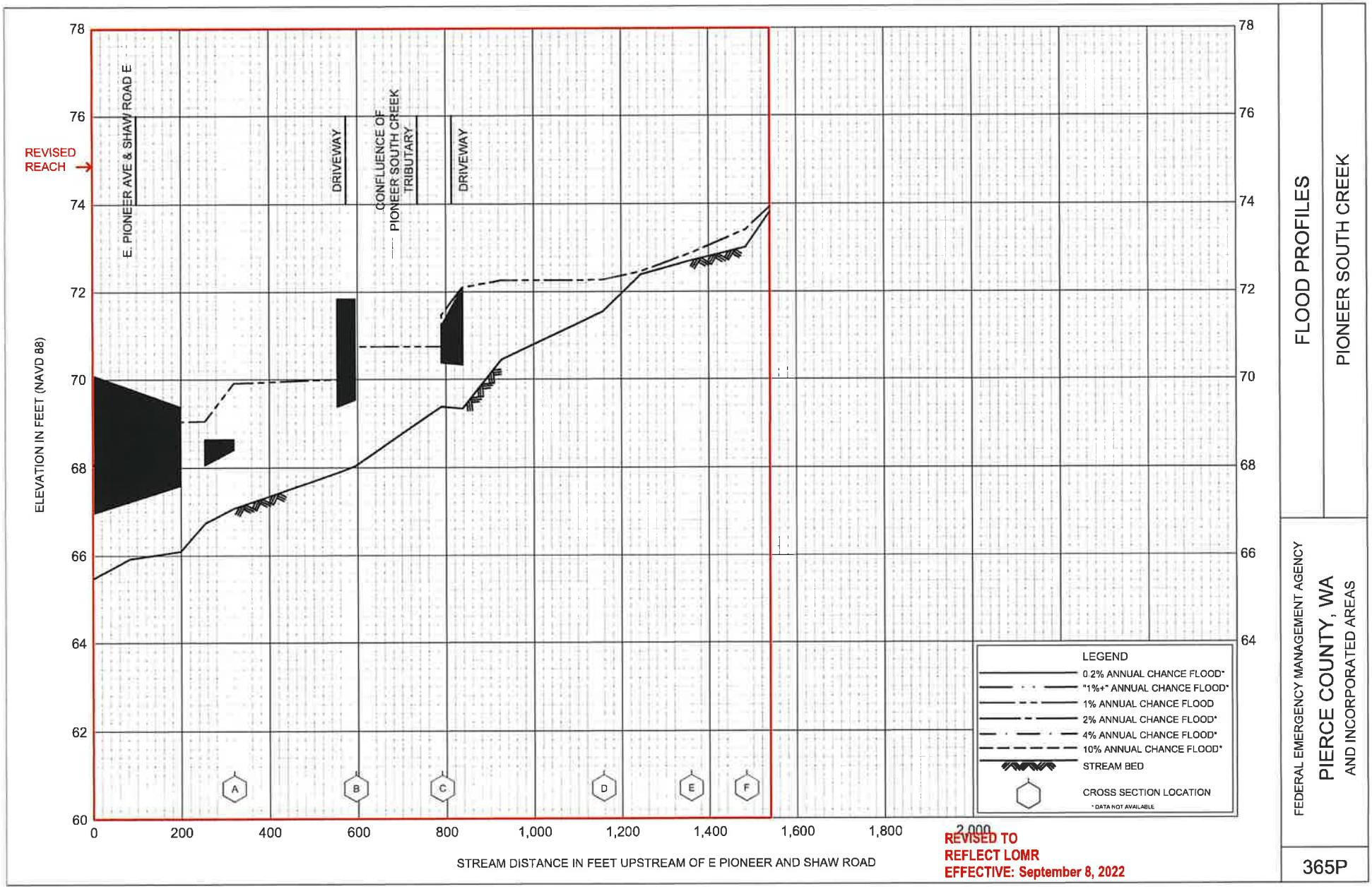
DEER CREEK - PIONEER

FEDERAL EMERGENCY MANAGEMENT AGENCY

PIERCE COUNTY, WA

AND INCORPORATED ARES

363P



REVISED TO REFLECT LOMR EFFECTIVE: September 8, 2022

FLOOD PROFILES

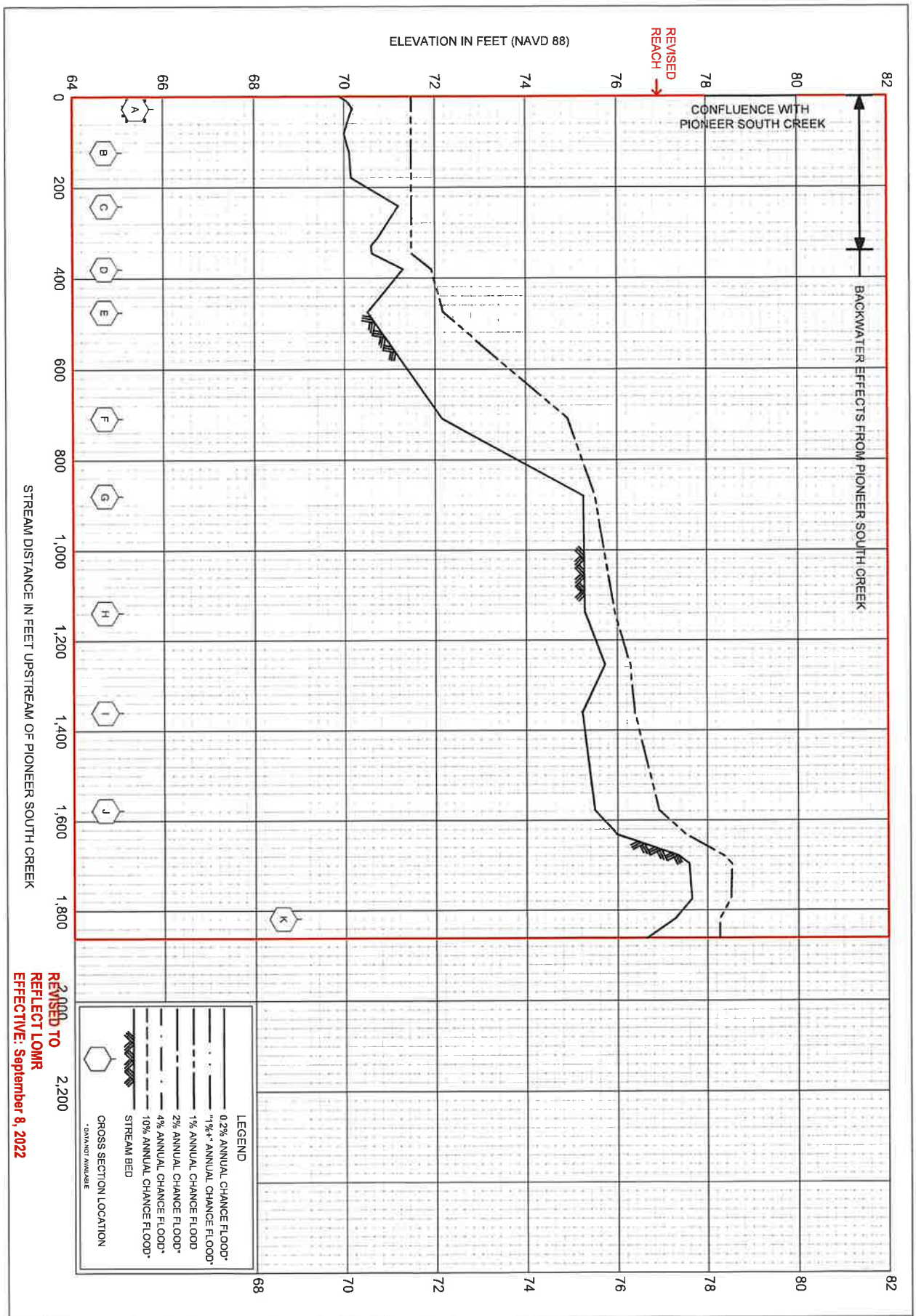
PIONEER SOUTH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

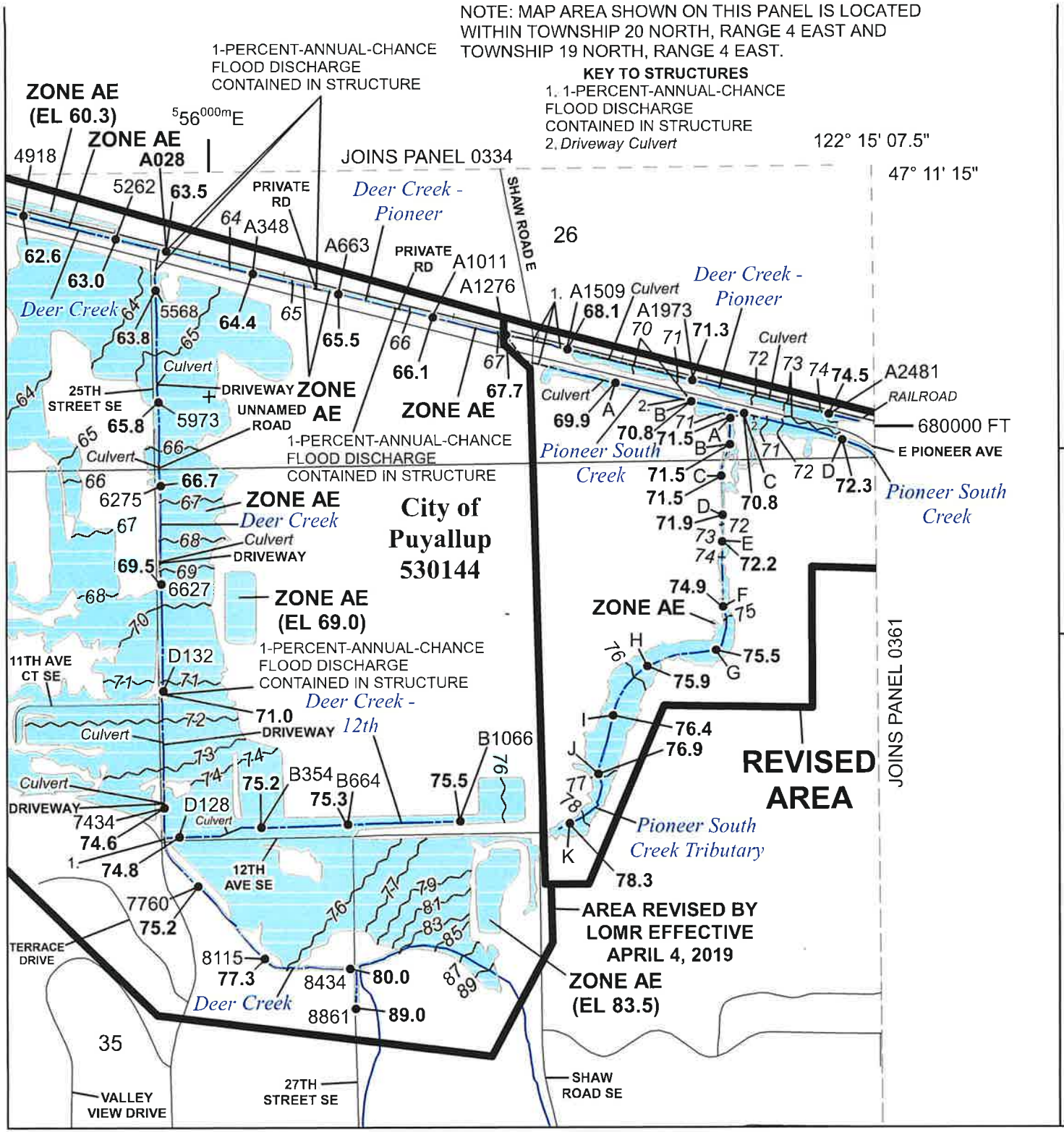
PIERCE COUNTY, WA

AND INCORPORATED AREAS

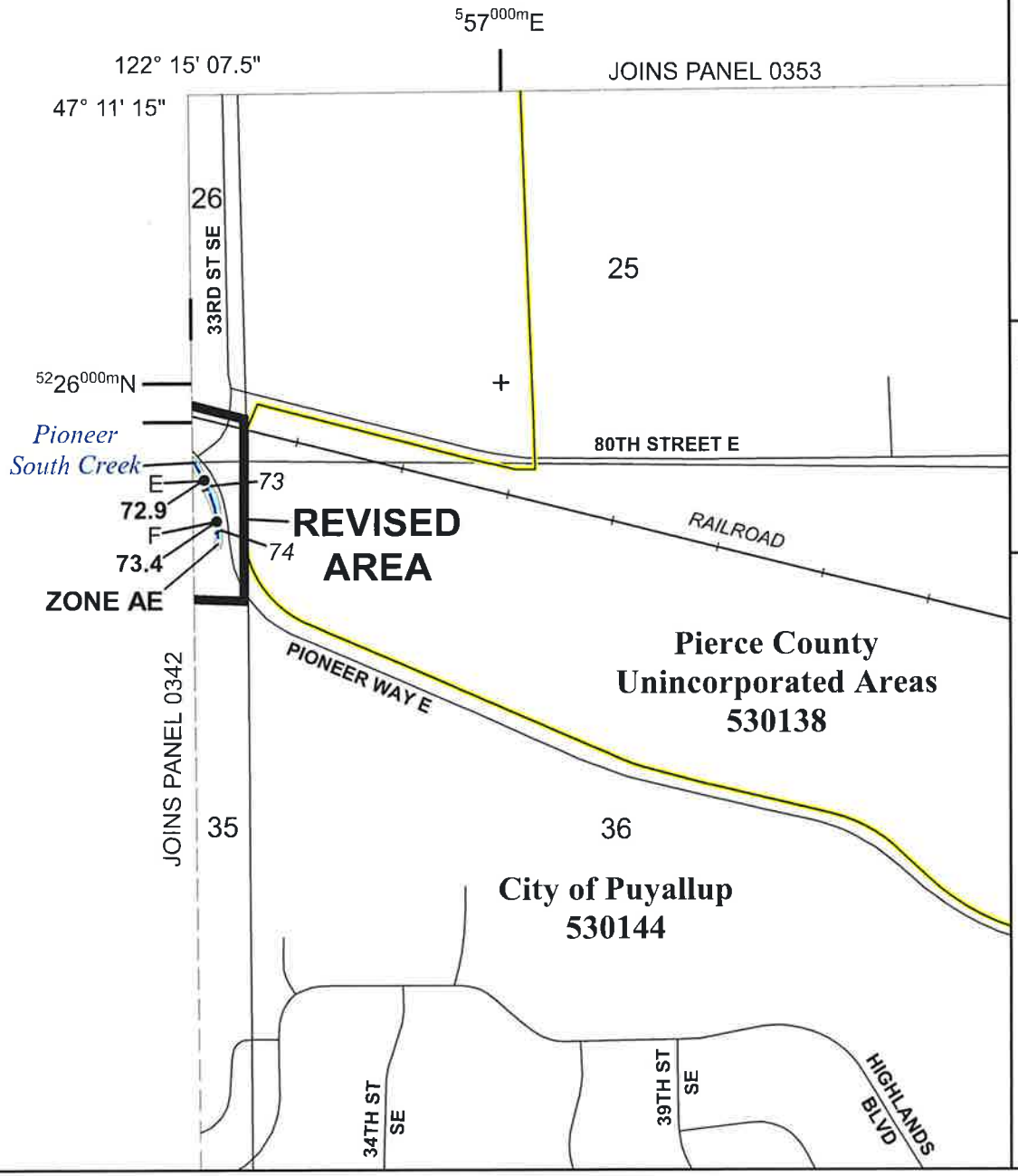
365P



366P	FEDERAL EMERGENCY MANAGEMENT AGENCY PIERCE COUNTY, WA UNINCORPORATED AREAS	FLOOD PROFILES PIONEER SOUTH CREEK TRIBUTARY


NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 20 NORTH, RANGE 4 EAST AND TOWNSHIP 19 NORTH, RANGE 4 EAST.
KEY TO STRUCTURES
1. 1-PERCENT-ANNUAL-CHANCE FLOOD DISCHARGE CONTAINED IN STRUCTURE
2. Driveway Culvert
1-PERCENT-ANNUAL-CHANCE FLOOD DISCHARGE CONTAINED IN STRUCTURE
ZONE AE (EL 60.3)
ZONE AE A028
5560000mE
122° 15' 07.5"
47° 11' 15"
JOINS PANEL 0334
PRIVATE RD
SHAW ROAD E
26
Deer Creek - Pioneer
Deer Creek
Pioneer South Creek
Pioneer South Creek Tributary
Deer Creek - 12th
25TH STREET SE
UNNAMED ROAD
DRIVEWAY
Culvert
RAILROAD
A2481
680000 FT
E PIONEER AVE
City of Puyallup 530144
ZONE AE
ZONE AE (EL 69.0)
ZONE AE (EL 83.5)
11TH AVE CT SE
12TH AVE SE
TERRACE DRIVE
VALLEY VIEW DRIVE
27TH STREET SE
SHAW ROAD SE
JOINS PANEL 0361
REVISED AREA
AREA REVISED BY LOMR EFFECTIVE APRIL 4, 2019
SPECIAL FLOOD HAZARD AREAS
Without Base Flood Elevation (BFE) Zone A, V, A99
With BFE or Depth Zone AE, AO, AH, VE, AR
Regulatory Floodway
OTHER AREAS OF FLOOD HAZARD
0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
Future Conditions 1% Annual Chance Flood Hazard Zone X
Area with Reduced Flood Risk due to Levee See Notes. Zone X
SCALE
Map Projection: NAD 1983 UTM Zone 10N; Western Hemisphere; Vertical Datum: NAVD 88
1 inch = 500 feet 1:6,000
0 250 500 1,000 Feet
0 75 150 300 Meters
NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP
PIERCE COUNTY, WASHINGTON and Incorporated Areas
PANEL 342 OF 1375
Panel Contains:
COMMUNITY NUMBER PANEL SUFFIX
PIERCE COUNTY 530138 0342 E
PUYALLUP, CITY OF 530144 0342 E
REVISED TO REFLECT LOMR EFFECTIVE: September 8, 2022
VERSION NUMBER 2.1.3.0
MAP NUMBER 53053C0342E
EFFECTIVE DATE MARCH 7, 2017
FEMA
National Flood Insurance Program

MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 19 NORTH, RANGE 4 EAST, TOWNSHIP 19 NORTH, RANGE 5 EAST, TOWNSHIP 20 NORTH, RANGE 4 EAST, AND TOWNSHIP 20 NORTH, RANGE 5 EAST.



SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) Zone A, V, 499
- With BFE or Depth Zone AE, AO, AH, VE, AR
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X
- Future Conditions 1% Annual Chance Flood Hazard Zone X
- Area with Reduced Flood Risk due to Levee See Notes. Zone X

SCALE

N

Map Projection:
NAD 1983 UTM Zone 10N;
Western Hemisphere; Vertical Datum: NAVD 88

1 inch = 500 feet 1:6,000

0 250 500 1,000 Feet

0 75 150 300 Meters

FEMA

National Flood Insurance Program

NATIONAL FLOOD INSURANCE PROGRAM
FLOOD INSURANCE RATE MAP

PIERCE COUNTY, WASHINGTON
and Incorporated Areas

PANEL 361 OF 1375

Panel Contains:

COMMUNITY	NUMBER	PANEL	SUFFIX
PIERCE COUNTY	530138	0361	E
PUYALLUP, CITY OF	530144	0361	E
SUMNER, CITY OF	530147	0361	E

REVISED TO REFLECT LOMR EFFECTIVE: September 8, 2022

VERSION NUMBER
2.1.3.0

MAP NUMBER
53053C0361E

EFFECTIVE DATE
MARCH 7, 2017

Appendix F: Water Quality Information

WASHINGTON STATE DEPARTMENT OF ECOLOGY

August 2021

GENERAL USE LEVEL DESIGNATION FOR BASIC (TSS) ENHANCED AND PHOSPHORUS TREATMENT

For

MWS-Linear Modular Wetland

Ecology's Decision

Based on Modular Wetland Systems, Inc, application submissions, including the Technical Evaluation Report, dated April 1, 2014, Ecology hereby issues the following use level designation:

1. General Use Level Designation (GULD) for the MWS-Linear Modular Wetland Stormwater Treatment System for Basic, Phosphorus, and Enhanced treatment
    - Sized at a hydraulic loading rate of:
        - 1 gallon per minute (gpm) per square foot (sq ft) of Wetland Cell Surface Area
        - Prefilter box (approved at either 22 inches or 33 inches tall)
            - 3.0 gpm/sq ft of prefilter box surface area for moderate pollutant loading rates (low to medium density residential basins).
            - 2.1 gpm/sq ft of prefilter box surface area for high pollutant loading rates (commercial and industrial basins).
2. Ecology approves the MWS – Linear Modular Wetland Stormwater Treatment System units for Basic, Phosphorus, and Enhanced treatment at the hydraulic loading rate listed above. 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 water quality treatment design 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 water quality treatment design 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 treatment design flow rate is the full 2-year release rate of the detention facility.

3. These use level designations have no expiration date but may be amended or revoked by Ecology, and are subject to the conditions specified below.

Ecology's Conditions of Use

Applicants shall comply with the following conditions:

1) Design, assemble, install, operate, and maintain the MWS – Linear Modular Wetland Stormwater Treatment System units, in accordance with Modular Wetland Systems, Inc. applicable manuals and documents and the Ecology Decision.
2) Each site plan must undergo Modular Wetland Systems, Inc. review and approval before site installation. This ensures that site grading and slope are appropriate for use of a MWS – Linear Modular Wetland Stormwater Treatment System unit.
3) MSW – Linear Modular Wetland Stormwater Treatment System media shall conform to the specifications submitted to and approved by Ecology.
4) The applicant tested the MWS – Linear Modular Wetland Stormwater Treatment System with an external bypass weir. This weir limited the depth of water flowing through the media, and therefore the active treatment area, to below the root zone of the plants. This GULD applies to MWS – Linear Modular Wetland Stormwater Treatment Systems whether plants are included in the final product or not.
5) Maintenance: The required maintenance interval for stormwater treatment devices is often dependent upon 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 stormwater treatment technology.
    - Typically, Modular Wetland Systems, Inc. designs MWS – Linear Modular Wetland systems for a target prefilter media life of 6 to 12 months.
    - Indications of the need for maintenance include effluent flow decreasing to below the design flow rate or decrease in treatment below required levels.
    - Owners/operators must inspect MWS – Linear Modular Wetland systems for a minimum of twelve months from the start of post-construction operation to determine site-specific maintenance schedules and requirements. You 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 the 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.

- Conduct inspections by qualified personnel, follow manufacturer's guidelines, and use methods capable fo determining either a decrease in treated effluent flowrate and/or a decrease in pollutant removal ability.
- When inspections are performed, the following findings typically serve as maintenance triggers:
    - Standing water remains in the vault between rain events, or
    - Bypass occurs during storms smaller than the design storm.
    - If excessive floatables (trash and debris) are present (but no standing water or excessive sedimentation), perform a minor maintenance consisting of gross solids removal, not prefilter media replacement.
    - Additional data collection will be used to create a correlation between pretreatment chamber sediment depth and pre-filter clogging (see *Issues to be Addressed by the Company* section below)

6) Discharges from the MWS – Linear Modular Wetland Stormwater Treatment System units shall not cause or contribute to water quality standards violations in receiving waters.

Applicant:	Modular Wetland Systems, Inc.
Applicant's Address:	5796 Armada Drive, Suite 250 Carlsbad, CA 92008

Application Documents:

Original Application for Conditional Use Level Designation, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., January 2011

Quality Assurance Project Plan: Modular Wetland System – Linear Treatment System Performance Monitoring Project, draft, January 2011

Revised Application for Conditional Use Level Designation, Modular Wetland System, Linear Stormwater Filtration System Modular Wetland Systems, Inc., May 2011

Memorandum: Modular Wetland System-Linear GULD Application Supplementary Data, April 2014

Technical Evaluation Report: Modular Wetland System Stormwater Treatment System Performance Monitoring, April 2014

Applicant's Use Level Request:

- General Use Level Designation as a Basic, Enhanced, and Phosphorus treatment device in accordance with Ecology's Guidance for Evaluating Emerging Stormwater Treatment Technologies Technology Assessment Protocol – Ecology (TAPE) January 2011 Revision.

Applicant's Performance Claims:

- The MWS – Linear Modular wetland is capable of removing a minimum of 80-percent of TSS from stormwater with influent concentrations between 100 and 200 mg/L.
- The MWS – Linear Modular wetland is capable of removing a minimum of 50-percent of total phosphorus from stormwater with influent concentrations between 0.1 and 0.5 mg/L.
- The MWS – Linear Modular wetland is capable of removing a minimum 30-percent of dissolved copper from stormwater with influent concentrations between 0.005 and 0.020 mg/L.
- The MWS – Linear Modular wetland is capable of removing a minimum 60-percent of dissolved zinc from stormwater with influent concentrations between 0.02 and 0.30 mg/L.

Ecology's Recommendations:

- Modular Wetland System, Inc. has shown Ecology, through laboratory and field-testing, that the MWS – Linear Modular Wetland Stormwater Treatment System filter system is capable of attaining Ecology's Basic, Phosphorus, and Enhanced treatment goals.

Findings of Fact:

<u>Laboratory Testing</u>

The MWS-Linear Modular wetland has the:

- Capability to remove 99 percent of total suspended solids (using Sil-Co-Sil 106) in a quarter-scale model with influent concentrations of 270 mg/L.
- Capability to remove 91 percent of total suspended solids (using Sil-Co-Sil 106) in laboratory conditions with influent concentrations of 84.6 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 93 percent of dissolved Copper in a quarter-scale model with influent concentrations of 0.757 mg/L.
- Capability to remove 79 percent of dissolved Copper in laboratory conditions with influent concentrations of 0.567 mg/L at a flow rate of 3.0 gpm per square foot of media.

- Capability to remove 80.5-percent of dissolved Zinc in a quarter-scale model with influent concentrations of 0.95 mg/L at a flow rate of 3.0 gpm per square foot of media.
- Capability to remove 78-percent of dissolved Zinc in laboratory conditions with influent concentrations of 0.75 mg/L at a flow rate of 3.0 gpm per square foot of media.

Field Testing

- Modular Wetland Systems, Inc. conducted monitoring of an MWS-Linear (Model # MWS-L-4-13) from April 2012 through May 2013, at a transportation maintenance facility in Portland, Oregon. The manufacturer collected flow-weighted composite samples of the system's influent and effluent during 28 separate storm events. The system treated approximately 75 percent of the runoff from 53.5 inches of rainfall during the monitoring period. The applicant sized the system at 1 gpm/sq ft. (wetland media) and 3gpm/sq ft. (prefilter).
- Influent TSS concentrations for qualifying sampled storm events ranged from 20 to 339 mg/L. Average TSS removal for influent concentrations greater than 100 mg/L (n=7) averaged 85 percent. For influent concentrations in the range of 20-100 mg/L (n=18), the upper 95 percent confidence interval about the mean effluent concentration was 12.8 mg/L.
- Total phosphorus removal for 17 events with influent TP concentrations in the range of 0.1 to 0.5 mg/L averaged 65 percent. A bootstrap estimate of the lower 95 percent confidence limit (LCL95) of the mean total phosphorus reduction was 58 percent.
- The lower 95 percent confidence limit of the mean percent removal was 60.5 percent for dissolved zinc for influent concentrations in the range of 0.02 to 0.3 mg/L (n=11). The lower 95 percent confidence limit of the mean percent removal was 32.5 percent for dissolved copper for influent concentrations in the range of 0.005 to 0.02 mg/L (n=14) at flow rates up to 28 gpm (design flow rate 41 gpm). Laboratory test data augmented the data set, showing dissolved copper removal at the design flow rate of 41 gpm (93 percent reduction in influent dissolved copper of 0.757 mg/L).

Issues to be addressed by the Company:

1. Modular Wetland Systems, Inc. should collect maintenance and inspection data for the first year on all installations in the Northwest in order to assess standard maintenance requirements for various land uses in the region. Modular Wetland Systems, Inc. should use these data to establish required maintenance cycles.
2. Modular Wetland Systems, Inc. should collect pre-treatment chamber sediment depth data for the first year of operation for all installations in the Northwest. Modular Wetland Systems, Inc. will use these data to create a correlation between sediment depth and pre-filter clogging.

Technology Description:
Download at http://www.modularwetlands.com/

Contact Information:

Applicant: Zach Kent
BioClean A Forterra Company
5796 Armada Drive, Suite 250
Carlsbad, CA 92008
zach.kent@forterrabp.com

Applicant website: http://www.modularwetlands.com/

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

Ecology: Douglas C. Howie, P.E. Department of Ecology Water Quality Program
(360) 870-0983
douglas.howie@ecy.wa.gov

Revision History

Date	Revision
June 2011	Original use-level-designation document
September 2012	Revised dates for TER and expiration
January 2013	Modified Design Storm Description, added Revision Table, added maintenance discussion, modified format in accordance with Ecology standard
December 2013	Updated name of Applicant
April 2014	Approved GULD designation for Basic, Phosphorus, and Enhanced treatment
December 2015	Updated GULD to document the acceptance of MWS – Linear Modular Wetland installations with or without the inclusion of plants
July 2017	Revised Manufacturer Contact Information (name, address, and email)
December 2019	Revised Manufacturer Contact Address
July 2021	Added additional prefilter sized at 33 inches
August 2021	Changed “Prefilter” to “Prefilter box”