REVISED STORMWATER DESIGN RECEIVED NOV 2022. (1st Review)

The applicant has proposed 100% stormwater detention to serve the project which is a conservative assumption in terms of the viability of the overall project for the Landuse Application. However, it will be necessary to show MR5 compliance (LID Performance Standard or List 2 Feasibility) at time of civil application. [Storm Rpt; Pg 1 of 148]

See review comments ("markups") on this storm report, some of which must be addressed prior to Landuse Approval (see DRT Letter Action Items) and some that can be addressed at civil application. [Storm Rpt; Pg 1 of 148]

[Storm Rpt; Pg 1 of 148]

PRELIMINARY
Drainage Report and Stormwater Pollution Prevention Plan

East Town Crossing

Parcel ...054. [Storm Rpt; Pg 1 of 148]

City of Puyallup, Washington

Parcel No. 0420264021, 0420264053, 0420264053, 0420351066, 0420351030, 0420351029, 0420351026

11/22/2022

Project Address: 1001 Shaw Road
Puyallup, WA 98372

Property Owner:
East Town Crossing LLC
Contact: Greg Helle

Engineer: McInnis Engineering, LLC
535 Dock Street, Suite 111
Tacoma, WA 98402
Contact: Kallie Maas

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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."

Table of Contents

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Parcel ...054.
[Storm Rpt; Pg 5 of 148]

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 consists of a mixed-use project that will include 8.5 acres of multifamily housing, and 1.8 acres of commercial lots. Also included is the associated parking, access roads, utilities, and stormwater design. The project includes 179 residential multifamily units, 9,583 sq ft of commercial buildings, and the associated vehicular and pedestrian routes. It also includes several plaza areas to accommodate outdoor activities and recreation.

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

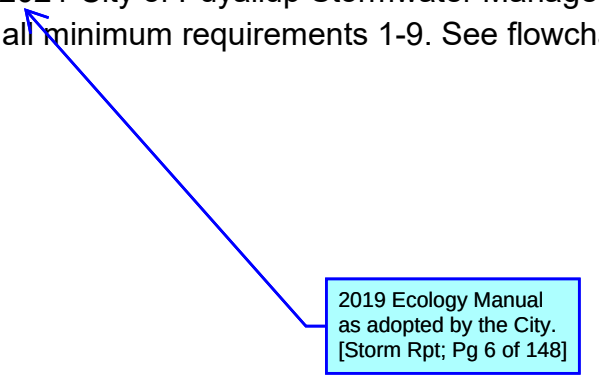
Project Land Use	Existing Area (Acres)	Proposed Area (Acres)	Area Change (Acres)	Frontage Improvement Area (Acres)
Roof	0	2.18	2.18	-
Driveway/Parking /Walkway	0	4.91	4.91	-
Undisturbed	10.36	3.27	-7.09	-
Total Impervious	0	7.09	7.09	0.74
Total Pervious	10.36	3.27	-7.09	0.18 (includes porous hard surfaces from Shaw Road Frontage)
Project Area	10.36	10.36	0	0.92

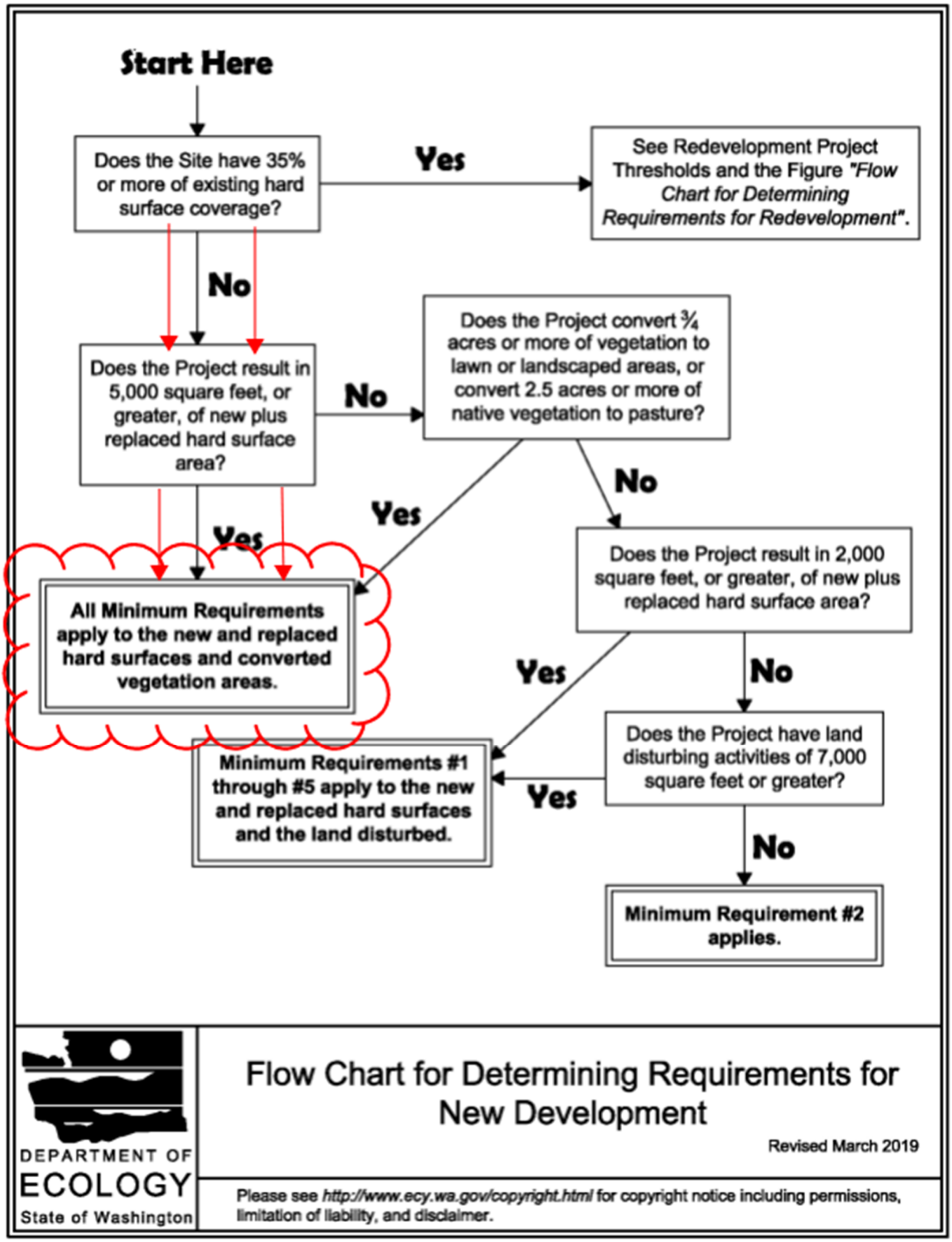
Section 2: Existing Conditions Description

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 7.09 acres of new hard surfaces and will result in coverage of 68% of the project area being covered by impervious surfaces. Per the 2021 City of Puyallup Stormwater Management Manual, 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?
Yes
No
Yes
All Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas.
Does the Project result in 2,000 square feet, or greater, of new plus replaced hard surface area?
Yes
No
Minimum Requirements #1 through #5 apply to the new and replaced hard surfaces and the land disturbed.
Yes
Does the Project have land disturbing activities of 7,000 square feet or greater?
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. Additionally, see Figure 3: Temporary Erosion and Sediment Control Plan and 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 area 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 per City of Puyallup standards. We suspect two construction entrances may be necessary, one for each entrance to the site.

Element # 3: Control Flow Rates

- The proposed 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 silt fence meets flow control requirements based on slopes and proposed flow path. Additionally, exposed soils not worked for a period of 7 days between May 1st- September 30th and for a period of 2 days between October 1st and April 30th will be hydroseeded and stabilized. Contractor shall adjust silt fencing as necessary to keep sediment laden runoff onsite.

Element # 4: Install Sediment Control

o 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.

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 longer than 7 days.

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 driveway and dwelling will be hydroseeded, and there will be no slopes greater than 2:1.

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 are no proposed channels or outlets proposed as part of the SWPPP. 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

- 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

- 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

- 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

- 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 plans 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.

Per the WWHM LID Report on Pg 126 of 148, it does not appear that flow durations for Vault 2/3 were included in the LID analysis. See comment on Pg 126. [Storm Rpt; Pg 11 of 148]

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 vaults 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 vaults. The design involves the collection of stormwater 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 vault systems.

The Commercial site in the northwest corner includes a single, large concrete detention vault. The runoff from the commercial site will be collected in the conveyance system to the vault 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 vault.

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 2 concrete vaults 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.

NOTE: At this phase (landuse application) of the project it is not necessary to show MR5 compliance if 100% detention is proposed and the preliminary design meets the stream duration standard. However, it will be necessary to show MR5 compliance at time of civil application. [Storm Rpt; Pg 11 of 148]

Per prior reviews, the proposed replacement "vault" did not provide equal or better FC and WQ mitigation of the original stormwater pond. Please submit the proposed facility so the City can can confirm preliminary sizing in relation to site constaints. In addition, please review BMP T10.40 and BMP D.3, vault design criteria described in the Ecology Manual as applicable. [Storm Rpt; Pg 12 of 148]

The project required additional Pollution Generating Hard Surface in E Pioneer Way and Shaw Road, as well. The runoff volume and rate from East Pioneer way is being accounted for by over-detaining in the large on-site detention system. Water quality will be provided by smaller Contech Modular Wetlands in the new curb line of East Pioneer. The stormwater on Shaw Road is being accounted for with pervious pavement and pervious concrete.

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

To deal with offsite stormwater produced by the neighboring property a vault was previously designed by Abbey Road Group to meet the same conditions of the original pond design.

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 vaults 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. As this water quality system is downstream of the detention system, a smaller system can be used. In addition, due to elevation constraints on the site, a system with 1.8' of elevation head loss across the unit was chosen for this project.

In East Pioneer Way, the receiving stormwater inlets will consist of Contech Stormfilter systems for treatment of the stormwater before direct release to the ditch system in the south shoulder of East Pioneer Way. Flow control is not provided within East Pioneer Way as the increased volume and flow rate are being accounted for in the on-site detention vault.

WQ facilities downstream of detention must be sized for the 2yr release rate. [Storm Rpt; Pg 12 of 148]

Minimum Requirement # 7: Flow Control

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

The vault serving the commercial site in the northwest portion of the site is designed to include an active detention area that is 218' Long x 60' wide x 3.5' deep. There will be an additional 0.5' of sediment storage on the bottom of the vault that is not included in

Min. Vault Height is 7' per Ecology Manual. Due to the size of this vault, the City is unwilling to support an AMR to reduce the height of the vault below 5.5 feet due to maintenance and safety concerns. Would a StormChamber or similar system be an option? [Storm Rpt; Pg 12 of 148]

If the vaults are located within the designated fire lane, the vaults shall be designed to support the full weight of the fire truck apparatus, including outrigger point loading(s). A "designated outrigger area" is not acceptable.
[Storm Rpt; Pg 13 of 148]

the volume calculations. The 60’ width of the vault is chosen to accommodate the ConcreteTech pre-cast, hollow-core, HS-20 rated lid system.

The vault system serving the remainder of the site is 136,400 Cubic Feet and is comprised of 2 vaults joined by a 36” diameter detention pipe. The pipe adds to the detention volume, but the pipe volume was not used to calculate the detention volume. The vault on the west side of the site is 200’ long x 70’ wide x 5.5’ deep, and the last vault is 180’ x 60’ x 5.5’ deep. There will be an additional 0.5’ of sediment storage on the bottom of both vaults that is not included in the volume calculations. Again, the width of the vault was chosen to work with the ConcreteTech pre-cast, hollow-core, HS-20 rated lid system.

Min. Vault Height is 7' per Ecology Manual. The City is willing to allow a 5.5' deep vault provided an AMR is submitted to document the revision.
[Storm Rpt; Pg 13 of 148]

While the specific structural details for the vaults will be provided in the final design, the structural engineer was consulted for the layout of the vaults, 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 vaults 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 vaults. The vaults will provide detention for the stormwater system. Downstream of the vaults 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

Portions of the site remain in the regulated floodplain. Any proposed work within the regulated floodplain shall adhere to the criteria of PMC 21.07 (comp. storage; structure protection; habitat assessment; etc.). [Storm Rpt; Pg 14 of 148]

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.

At time of civil application, a downstream analysis will be required to ensure there is adequate conveyance capacity between the project site and the Pioneer north ditch. This would include a backwater analysis from the OHWM and include runoff from onsite and offsite basins tributary to the discharge location. [Storm Rpt; Pg 15 of 148]

Section 9: Facility Sizing and Downstream Analysis

Facility Sizing

The proposed stormwater facilities were designed and sized per the 2021 City of Puyallup Stormwater Management Manual. We are proposing an LID method of Contech Modular Wetlands water quality and a storage vault for flow control.

2019 Ecology Manual as adopted by the City. [Storm Rpt; Pg 15 of 148]

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.

At time of civil application, need to discuss Pioneer WQ. [Storm Rpt; Pg 15 of 148]

Flow Control

Three vaults will provide detention onsite. The first vault will provide 45,780 cubic feet of detention to the commercial basin and has been oversized to allow the commercial entrance to bypass the treatment. The other two vaults will work together to provide detention to the rest of the site. The second vault will provide 77,000 cubic feet of detention and the third vault will provide 59,400 cubic feet of detention; in total the two vaults 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 vaults that provide flow control treatment for the multifamily housing area of the site are connected by a 36” pipe at 0% slope. The vaults have also been oversized to allow for the stormwater on the half street of Pioneer frontage to bypass the site. The vaults have been sized in WWHM and the report is provided in Appendix D.

Confusing...can't bypass WQ. Clarify at time of civil application. [Storm Rpt; Pg 15 of 148]

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 vaults. From the vaults 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 ditch in Pioneer Way E.

a regulated stream [Storm Rpt; Pg 15 of 148]

At time of civil application, provide a backwater analysis of the Pioneer Avenue conveyance system as outlined in City Standards Section 204.3 considering the tailwater elevation (OHWM) of the Pioneer Avenue north ditch. The analysis shall include runoff from onsite and offsite basins tributary to the discharge location. [Storm Rpt; Pg 15 of 148]

a regulated stream
[Storm Rpt; Pg 16 of 148]

The system will ultimately flow to the ditch 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.

The applicant will be required to post a financial guarantee in accordance with PMC 21.10.160.
[Storm Rpt; Pg 16 of 148]

Appendix A – Supporting Figures

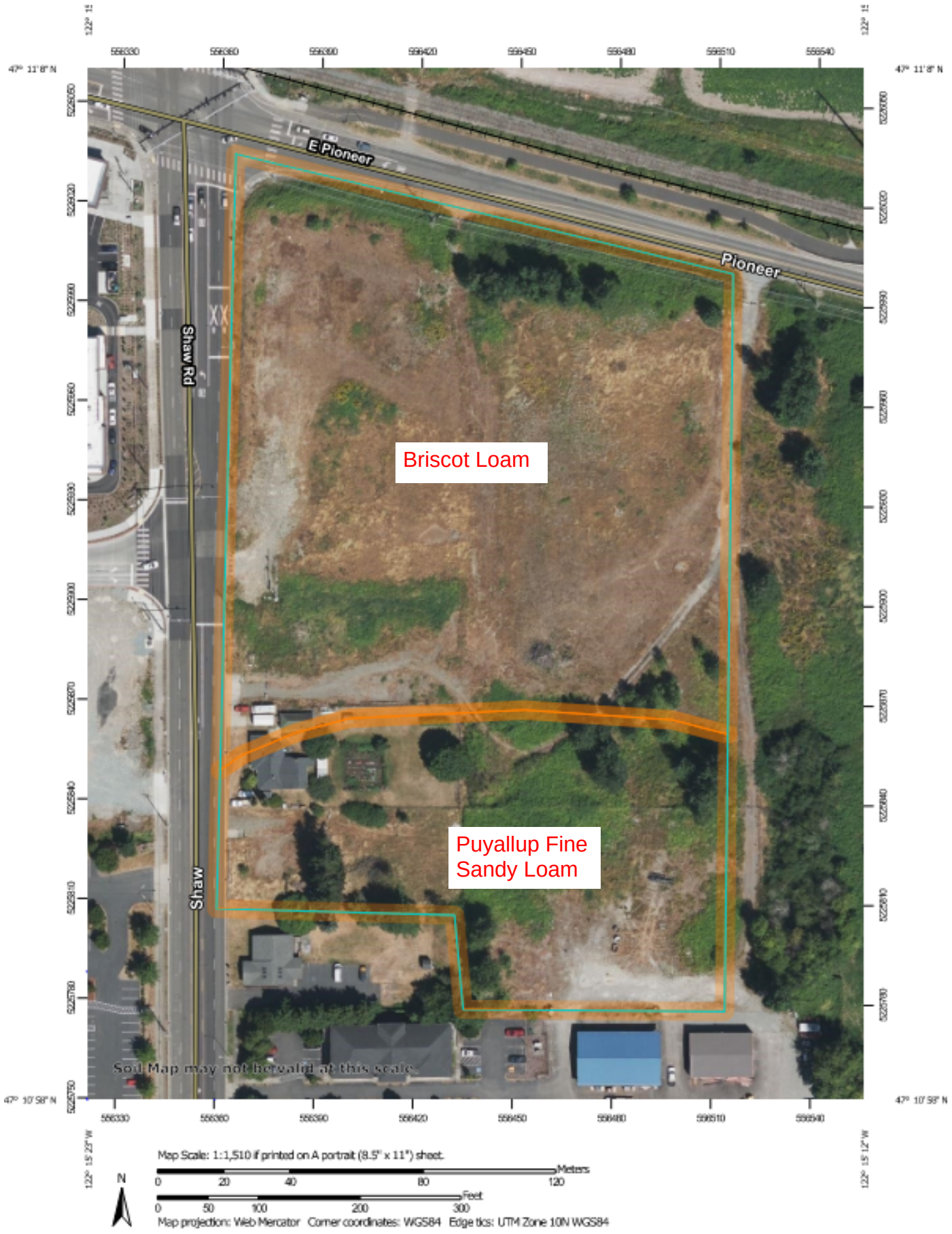
Figure 1: Vicinity Map

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

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

TESC PLAN

APPROVED

BY _____
CITY OF PUYALLUP
DEVELOPMENT ENGINEERING

DATE _____

NOTE: THIS APPROVAL IS VOID AFTER 180 DAYS FROM APPROVAL DATE.
THE CITY WILL NOT BE RESPONSIBLE FOR ERRORS AND/OR OMISSIONS ON THESE PLANS.
FIELD CONDITIONS MAY DICTATE CHANGES TO THESE PLANS AS DETERMINED BY THE DEVELOPMENT ENGINEERING MANAGER.

0 20 40 80
SCALE: 1" = 40
FOR 24" X 36" SHEET

LINE IS 1" AT
FULL SCALE

0420351074
RS-10

0420351003
RS-10

6026470050
CBD

6026470040
CBD

6026470030
CBD

SHAW ROAD E

EXISTING ROW

PROPOSED ROW

0420351025
CG

PROVIDE 167' LONG x 120' WIDE
(MIN. 3600 SF TOP SURFACE AREA) TEMPORARY
SEDIMENT TRAP WITH OVERFLOW SPILLWAY
(SEE SEDIMENT TRAP DETAIL).
TRANSITION TO BARRIER WITH
GRAVEL OUTLET OR AS DIRECTED BY CESCL.
TOP OF POND EL. = 71.0
OVERFLOW SPILLWAY EL. = 70.0
BOTTOM OF POND EL. = 68.5

TESC POND WHERE
GAS AREA IS LOCATED

7256 CF
(MIN. DEPTH OF 1')

167'

120'

EMERGENCY
OVERFLOW

LOT 2
50,886 SF

7256 CF
(MIN. DEPTH OF 1')

BMP C241
TEMPCRARY SEDIMENT POND

OVERFLOW
TO EXISTING
CB

CONTROL
STRUCTURE
TOP OF RISER EL. = 70.0
IE = 67.0 12" PVC (N)

LOT 1
28,824 SF

3 FT BERM

0420264005
CMX

W(REC)

0420355026
ML
RS-35

CONTRACTOR MAY ALSO USE
LARGE VEGETATIVE FIELD TO
IMPLEMENT MECHANICAL LEVEL
SPREADERS BMP C206, BMP C236

BMP C241
TEMPORARY SEDIMENT POND

EXISTING STORM POND
WILL BE USED AS
PART OF TESC SYSTEM

LOT 3
361,499 SF

CONSTRUCT TEMPORARY
CONSTRUCTION
ENTRANCE. ENSURE
STREET REMAINS FREE
OF SEDIMENT & DEBRIS.
IF SEDIMENT IS
ANTICIPATED OR
OBSERVED STREET
SWEEPING SHALL BE
EMPLOYED.

PIONEER WAY E

0420264006
CMX

0420351000
NIX HERMAN
GOTFRIED
CONRAD

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

811
CALL BEFORE YOU DIG (811)
WWW.WASHINGTON811.COM

TITLE: East Town Crossing
TESC Plan
Puyallup, WA

FOR: East Town Crossing, LLC.
1001 Shaw Road
Puyallup, WA 98372

Abbey Road Group
Land Development
Services Company, LLC
2102 E MAIN AVE, SUITE 109
PUYALLUP, WA 98372
P.O. Box 1224, Puyallup, WA 98371
(253) 435-3699, Fax (253) 446-3159

Abbey Road GROUP

REVISIONS:	CHK:	APR:	DATE:	PER:
BY:				

JOB #: 06-171-1
DESIGNED BY: JMB
DEVELOPMENT REVIEW: PRB
APPROVED BY: GH
DRAFTED BY: HPJ
DATE: 05/17/2022
SHEET:

File: T:\PROJECTS FILES (ACTIVE)\06-171-01\1. East Town Crossing\DESIGN\Engineering\06-171 TESC.dwg
Plotted: 5/18/2022 10:19 AM
Plotted By: Harrison Jastrzembski

Figure 4: Grading and Drainage Plan

EAST TOWN CROSSING

PRELIMINARY STORM & GRADING PLAN

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

DRAINAGE NOTE
ALL PROPOSED BUILDING WILL HAVE SEPERATE ROOF AND FOOTING DRAIN LINES THAT WILL BE SHOWN IN FINAL DESIGN

Use conventional paving thru the approach.
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

Use conventional paving thru the approach.
[Storm Rpt; Pg 25 of 148]

POROUS ASPHALT

POTENTIAL PHASE LINE

BYPASS AREA ACCOUNTED FOR IN VAULT 1

Min. Vault Height is 7' per Ecology Manual. Due to the size of this vault, the City is unwilling to support an AMR to reduce the height of the vault below 5.5 feet due to maintenance and safety concerns. Would a StormChamber or similar system be an option? Revise accordingly.
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

PERVIOUS CONCRETE SIDEWALK

ENCLOSED CONCRETE SURFACE DRAINS

Min. Vault Height is 7' per Ecology Manual. The City is willing to allow a 5.5' deep vault provided an AMR is submitted to document the revision.
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

VAULT 2
70'X200'
5.5' DEPTH

VAULT 1
218'X60'
3.5' DEPTH

VAULT 3
60'X180'
5.5' DEPTH

EXISTING GRAVEL/GLASS BED @0.4 POROSITY (DESIGNED BY ARG)

BLD'G H (TYPE 3a) 3-STORY 24-UNIT 1 BEDRMS

BLD'G G (TYPE 3) 3-STORY 24-UNIT 1 BEDRMS

BLD'G D (TYPE 1c) 3-STORY / 24 UNIT 24 - (2) BEDRMS

BLD'G C (TYPE 1b) 3-STORY / 24 UNIT 24 - (2) BEDRMS

BLD'G B (TYPE 1) 3-STORY / 24 UNIT 24 - (2) BEDRMS

BLD'G E (TYPE 1a) 3-STORY / 24 UNIT 24 - (2) BEDRMS

BLD'G F (TYPE 2) 3-STORY / 24-UNIT (12) - 2 BEDRMS (12) - 1 BEDRMS

BLD'G A (TYPE 3b) 3-STORY 24-UNIT 1 BEDRMS

CLUB HOUSE 7 sq ft
I.I: AMENITYS & LI

PLAZA

At time of civil application, a downstream analysis will be required to ensure there is adequate conveyance capacity between the project site and the Pioneer north ditch. This would include a backwater analysis from the OHWM and include runoff from onsite and offsite basins tributary to the discharge location.
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

Downstream of detention, treat for the 2yr release rate.
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

SDMH W/ SOLID LID
RIM = 69.7±
IE = 66.1 (18" PVC WEST)
IE = 66.1 (12" CPEP SOUTH)
IE = 66.1 (12" DIP EAST)

CONTECH STORMFILTER SYSTEM

CONTECH MODULAR WETLAND W/ ENHANCED TREATMENT
SEE DETAIL 1/C5

Verify Flow Control location? The FC structure structure location conflicts with the Vault 2/3 release (unless its a flow splitter).
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

CONTROL MANHOLE
SEE DETAIL 1/C4

CONTROL MANHOLE
SEE DETAIL 2/C4

At time of civil application, will need to clarify how this surface area is being captured and detained.
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

CONTECH STORMFILTER SYSTEM

BYPASS AREA ACCOUNTED FOR IN COMBINATION VAULT 2/3

Shouldn't portions of this area be included in the Bypass (excluding stream)?
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

HP?
[Storm Rpt; Pg 25 of 148]
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

If this is intended to be a combined water quality and flow control facility, the design must adhere to Ecology criteria outlined in Ecology Manual Vol V for combined facilities, i.e., 2 cell design for WQ, etc. Similarly, the design must meet the WQ treatment and detention volumes of the original, approved, CES design. See prior comments in the Storm Report dated December 15, 2021 as well as review comments on the previously submitted "Storm Detention Plan". Show that the facility is appropriately sized and will fit on the site plan without negatively affecting the proposed development features and structures.
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

To be revised per McInnis letter dated Nov 22, 2022. Facility shall be preliminarily designed, per prior review comments, to ensure the replacement facility is appropriately sized and will not negatively affect the proposed site plan features and structures.
[Storm Report; Storm Plans Sht 1 of 5; Pg 25 of 148]

To be revised per McInnis letter dated Nov 22, 2022. Facility shall be preliminarily designed, per prior review comments, to ensure the replacement facility is appropriately sized and will not negatively affect the proposed site plan features and structures.
[Prelim. Civil Dwgs Part 1; Storm P

0 40 80 Feet

CALL BEFORE YOU DIG
1-800-424-5555 OR 811

McInnis ENGINEERING
535 Dock Street, Suite 111, Tacoma, WA 98402
253.414.1992
mcinnisengineering.com

EAST TOWN CROSSING
1001 SHAW ROAD
PUYALLUP, WA 98372

JEFFREY W. MCINNIS — STATE OF WASHINGTON — 37399 — REGISTERED PROFESSIONAL ENGINEER
11/22

NUM	DATE	DESCRIPTION

DESIGNED	SCALE
J. MCINNIS	1:40
DRAWN	CHECKED
W. MCINNIS	CHCK
DATE	APPROVED
11/22/22	APRD

C1

SHEET 1 OF 5

Figure 5: Subbasins

EAST TOWN CROSSING
BASIN MAP

At time of civil application, add the conventional paving thru the approach into the WWHM analysis. [Storm Rpt; Pg 27 of 148]

COMMERCIAL BYPASS BASIN

COMMERCIAL BASIN

MULTIFAMILY HOUSING BASIN

PIONEER WAY E FRONTAGE BYPASS BASIN

EXISTING GRAVEL/GLASS BED @0.4 POROSITY (DESIGNED BY ARG)

ARG replacement facility to be sized correctly per prior review comments and prior to Landuse approval. [Storm Rpt; Pg 27 of 148]

At time of civil application, please indicate the basin landuse types and areas on this exhibit (lawn, roofs, sidewalks (permeable vs conventional, roads, etc.) for each subbasin. [Storm Rpt; Pg 27 of 148]

0 40 80 Feet

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JEFFREY W. MCINNIS
STATE OF WASHINGTON
37399
REGISTERED PROFESSIONAL ENGINEER
11/22/2022

NUM	DATE	DESCRIPTION

DESIGNED	SCALE
J. MCINNIS	
DRAWN	CHECKED
W. MCINNIS	CHCK
DATE	APPROVED
11/17/22	APRD

SHEET 1 OF 1

At time of civil application, provide results of the groundwater monitoring at Monitoring Wells #1 and #2 (Figure A8 in the previously submitted storm report). [Storm Rpt; Pg 28 of 148]

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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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.

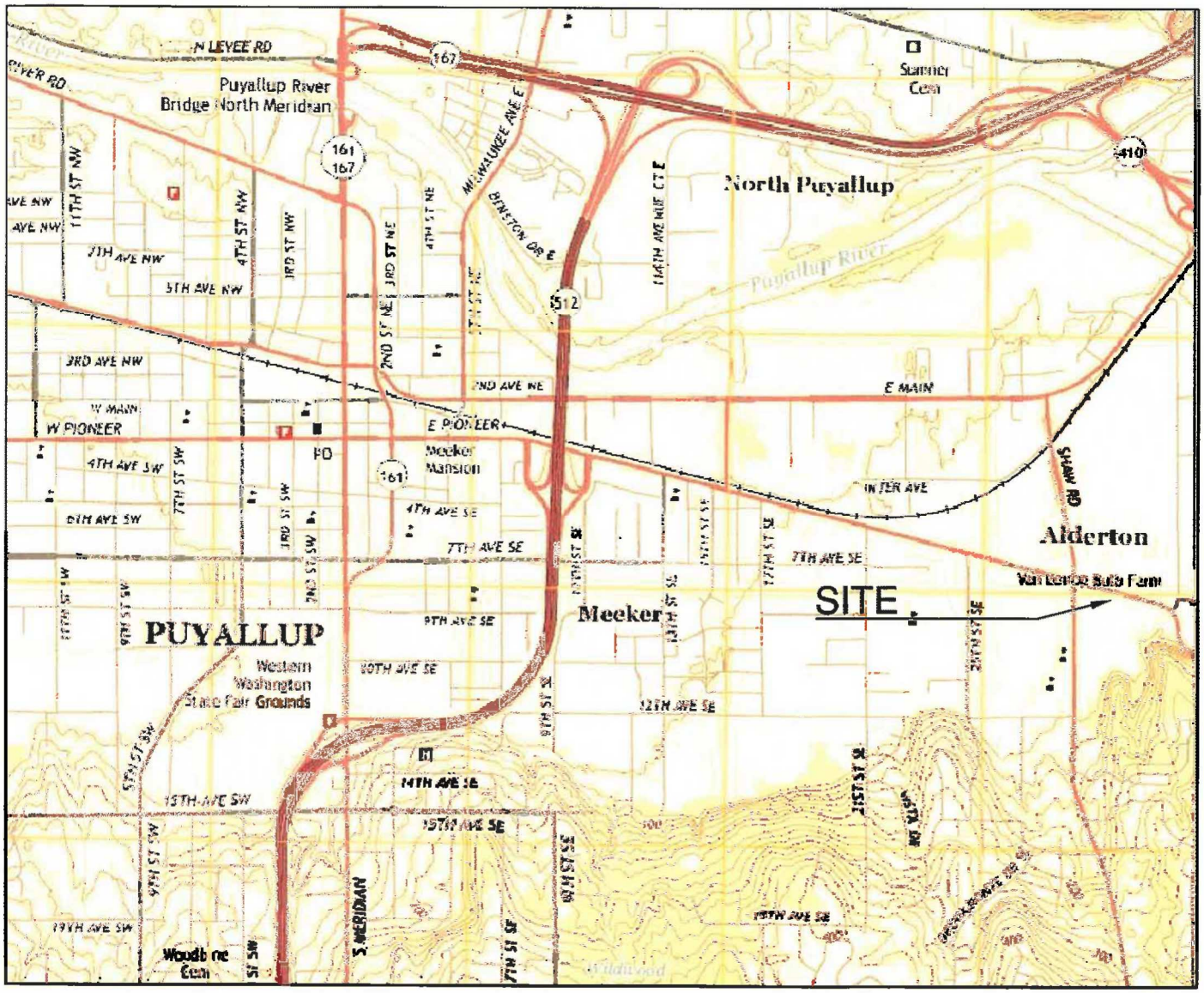
04/11/19

Theresa R. Nunan

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

Theresa R. Nunan
Project Engineer

TRN:MDR

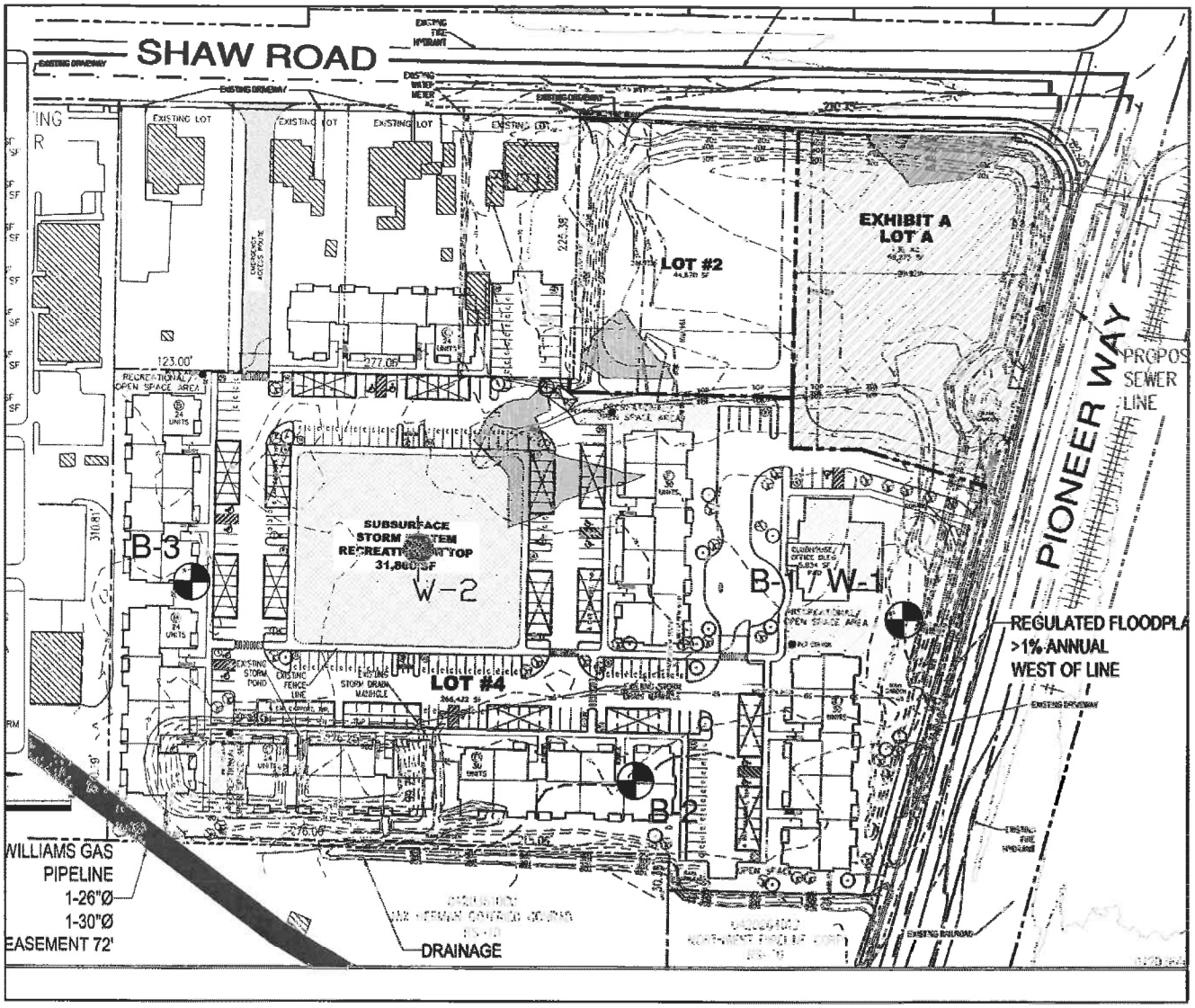


Reference: USGS topographic map website, Puyallup, WA, dated 2017.

N

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.

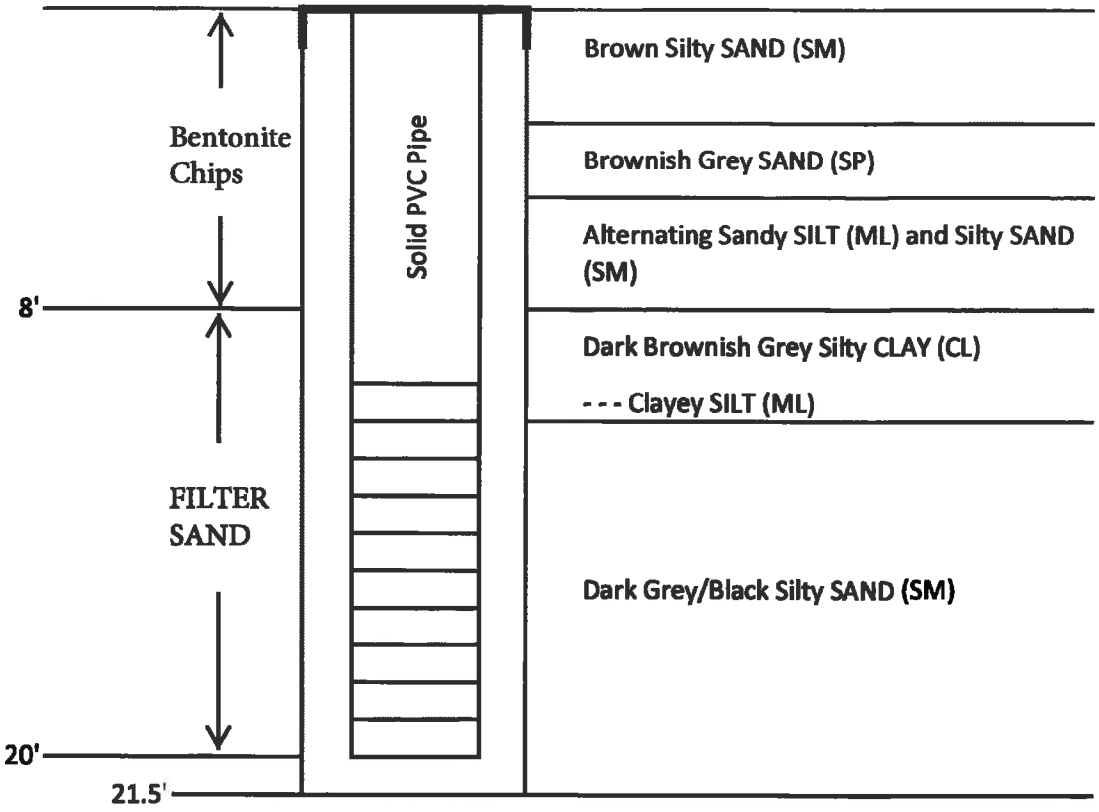
Elev. (feet)	Depth (feet)	Sample Type	Sample ID	Blow Counts	N-Value (blows/ft)	Graphic Log	Classification	Lab Results
	25	SPT	2-7	10 9 14	23		Dark Grey SAND (SP-SM) with Silt, trace gravel, fine to coarse grained, with occassional 3 to 4-inch thick seams gravel (GP-GM) with silt, medium dense, wet	
	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.

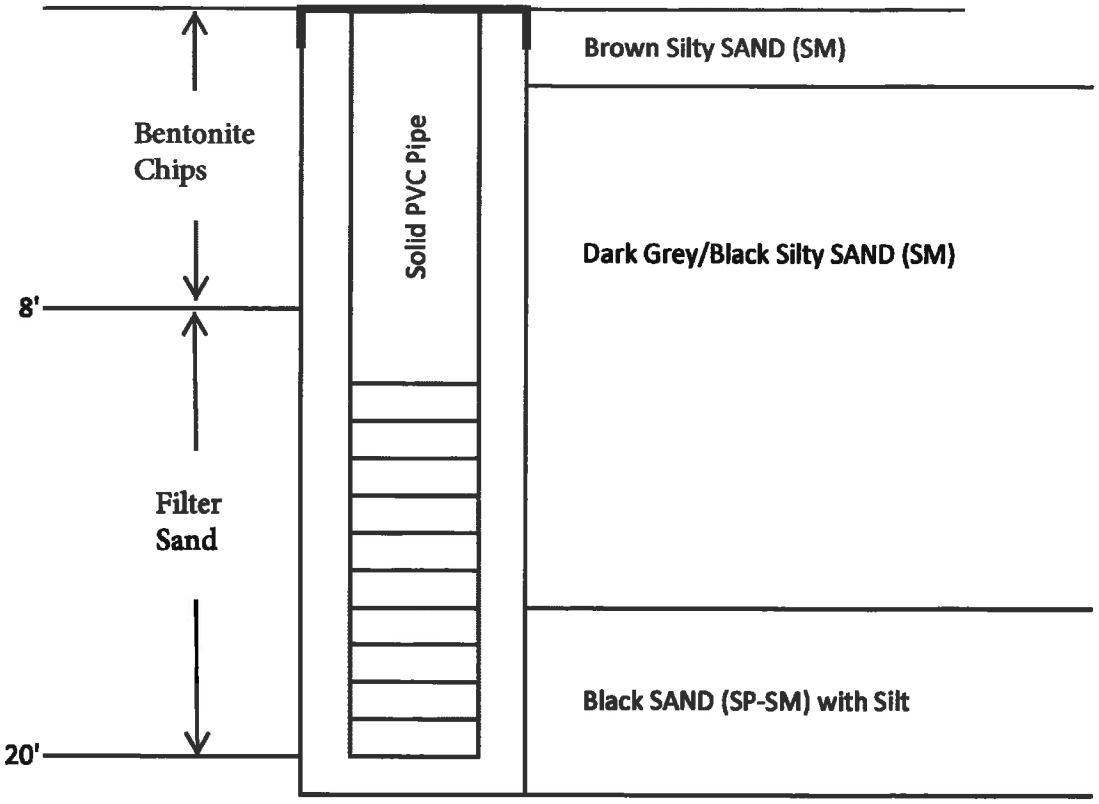
Project: East Town Crossing	**Project Number:** 062-19007	**Client:** Abbey Road Group	**Boring No.**	**B-3**
Address, City, State: SE Corner Shaw Road & E. Pioneer Way, Puyallup, WA			**Drilling Company:** Geologic Drill Partners	
Project Manager: Theresa Nunan	**Date** **Started:** 3.11.2019		**Equipment:** 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							

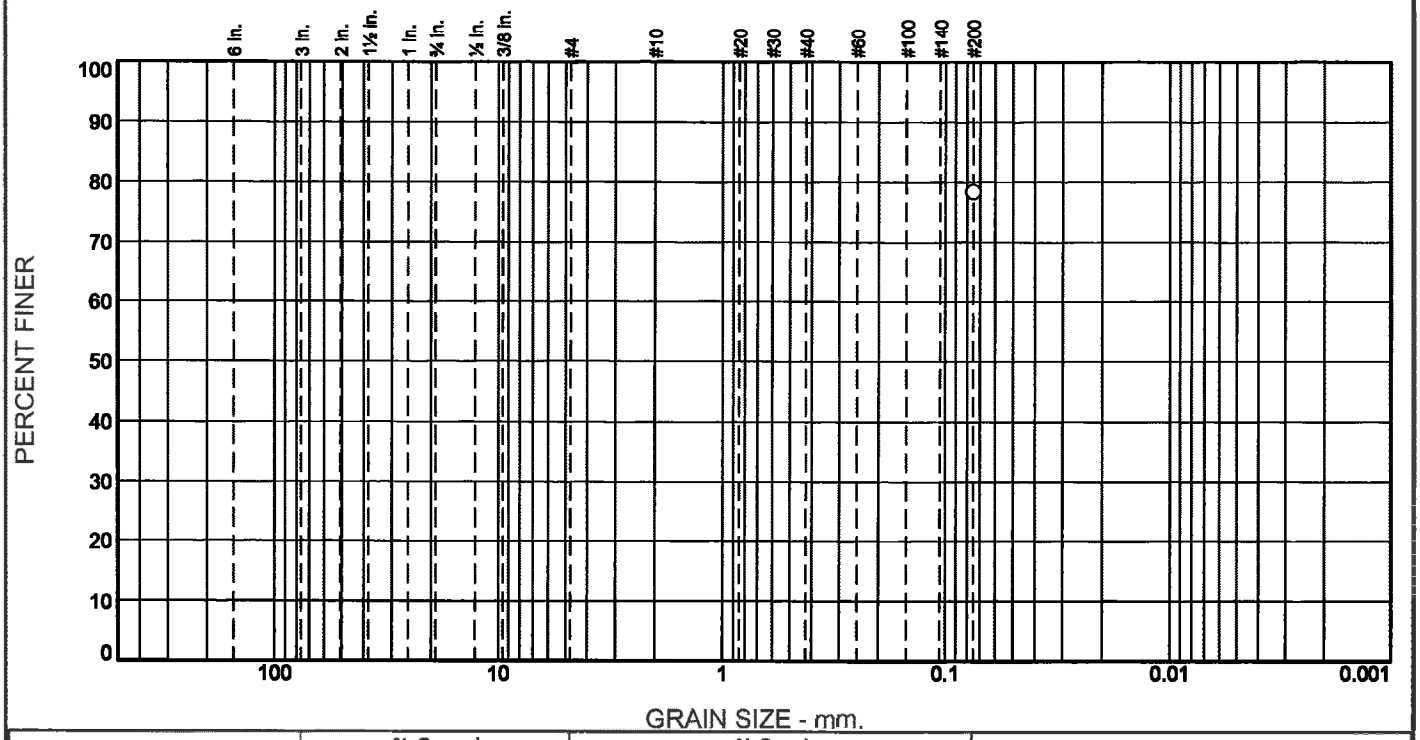
Monitoring Well
MW-1



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'

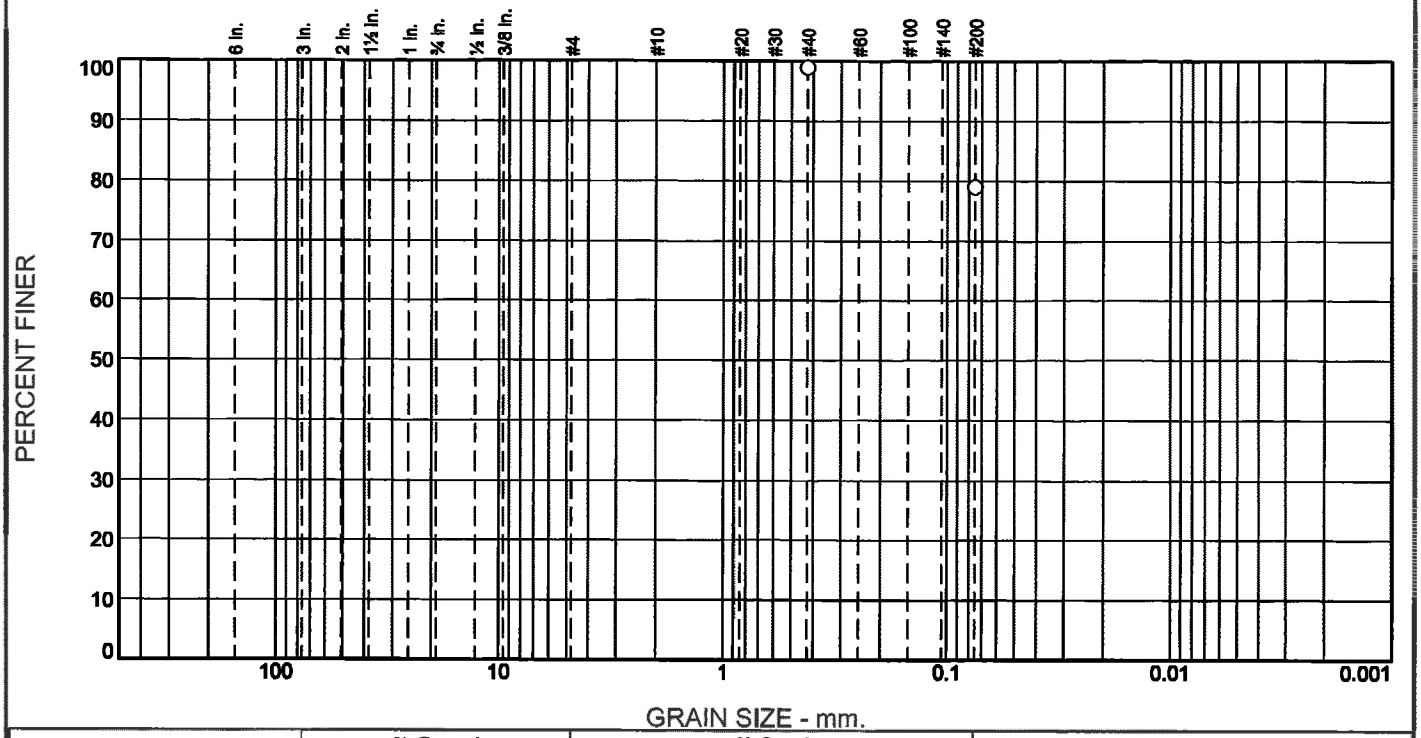
Date Sampled: 3-11-19

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'

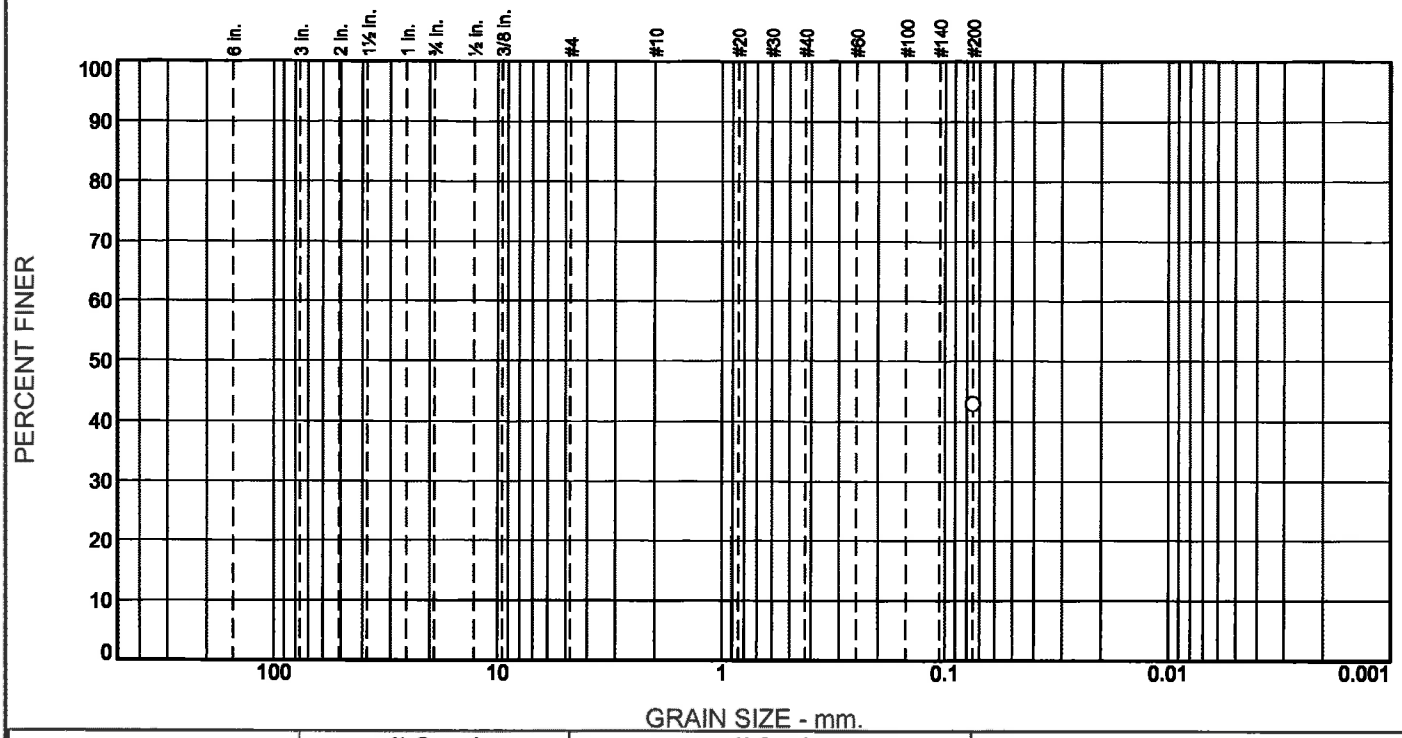
Date Sampled: 3-11-19

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	
						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'

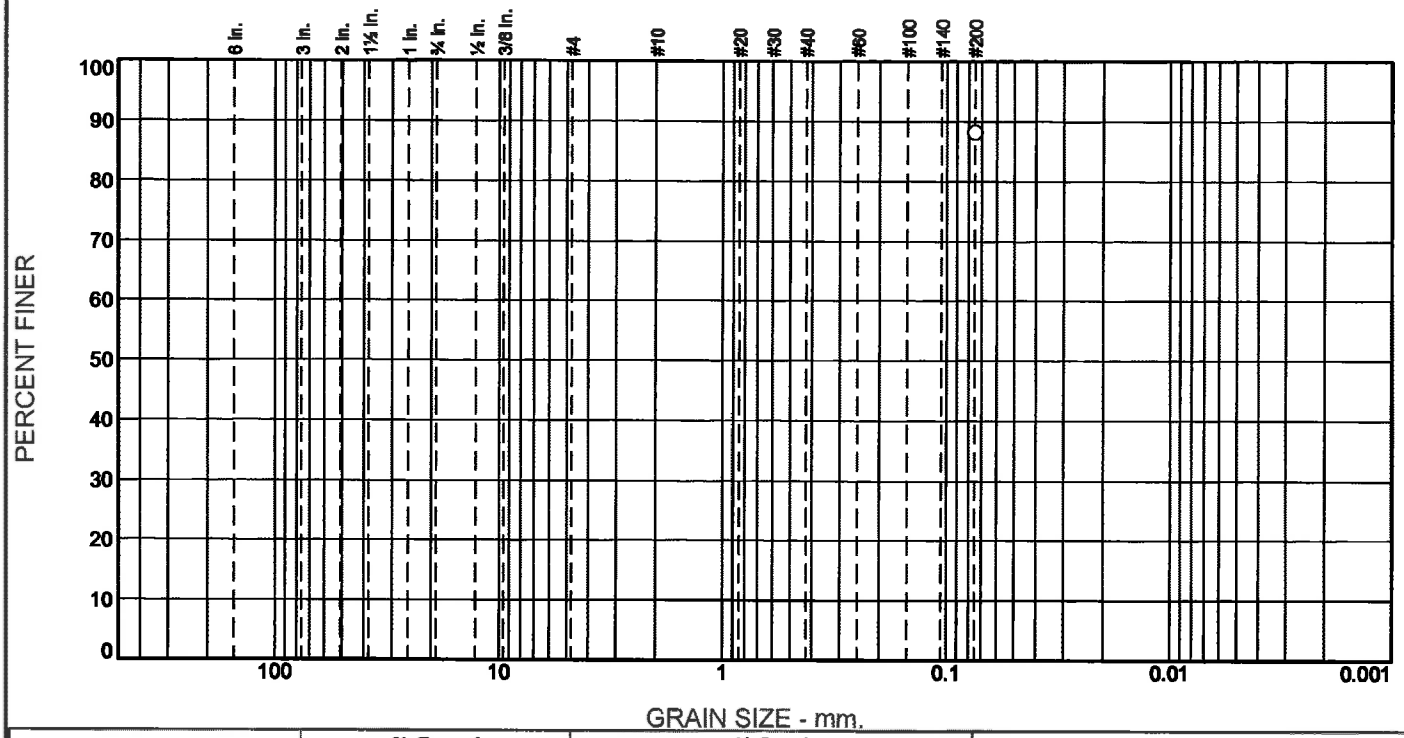
Date Sampled: 3-11-19

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'

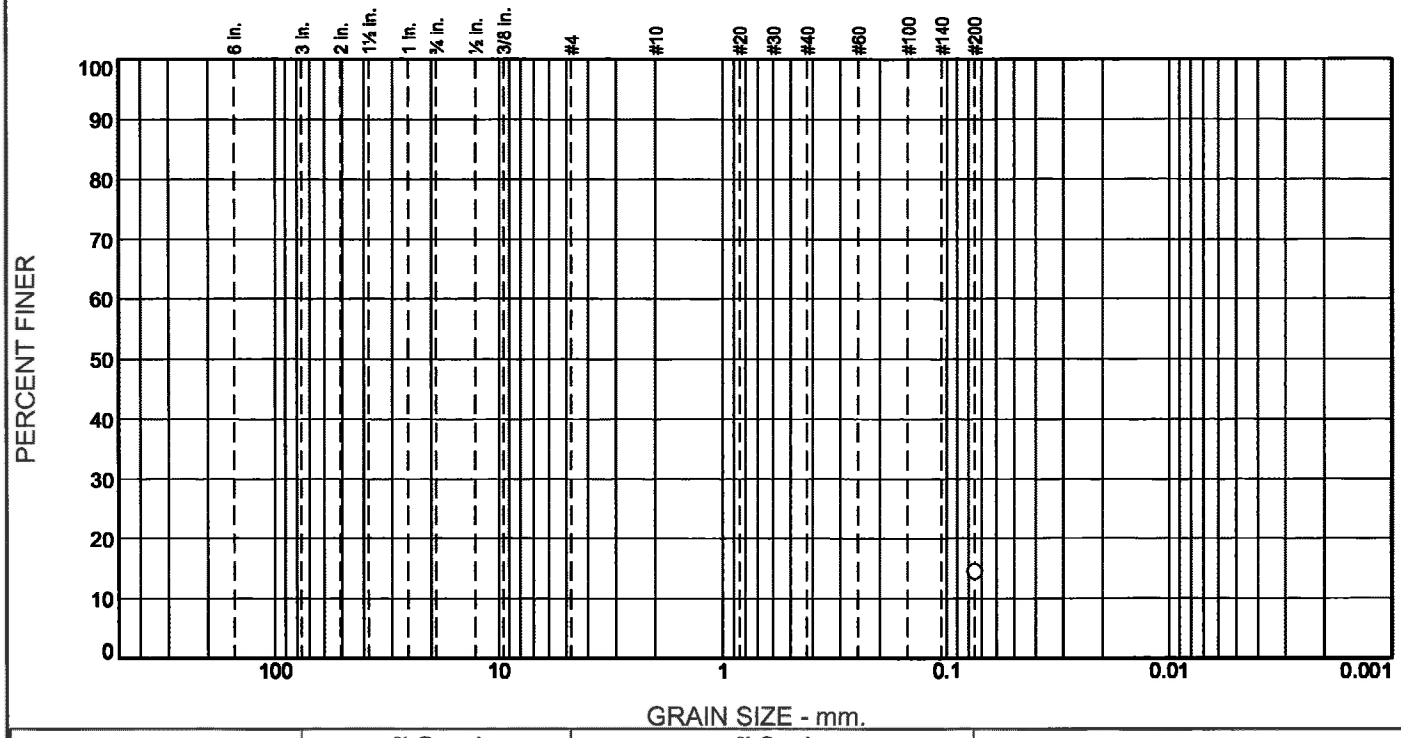
Date Sampled: 3-11-19

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	
						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'

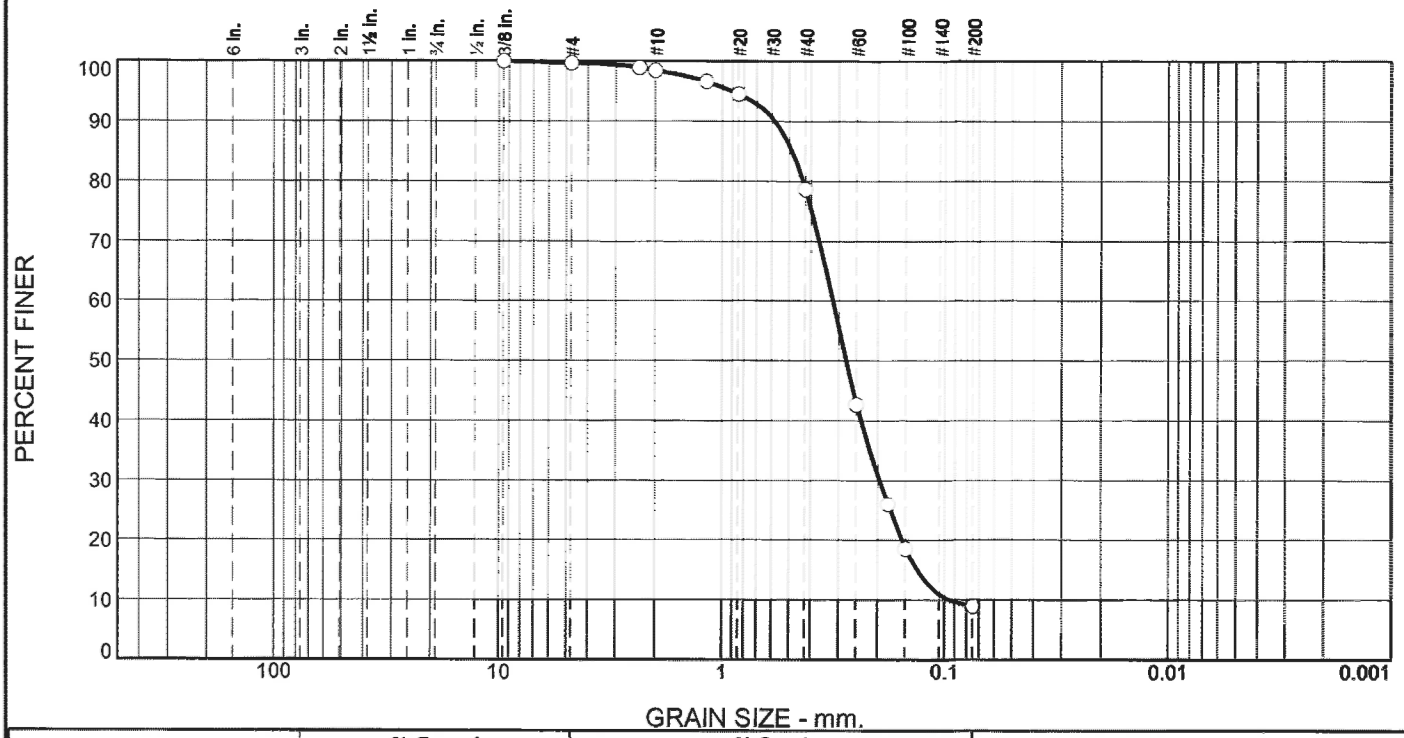
Date Sampled: 3-11-19

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	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'

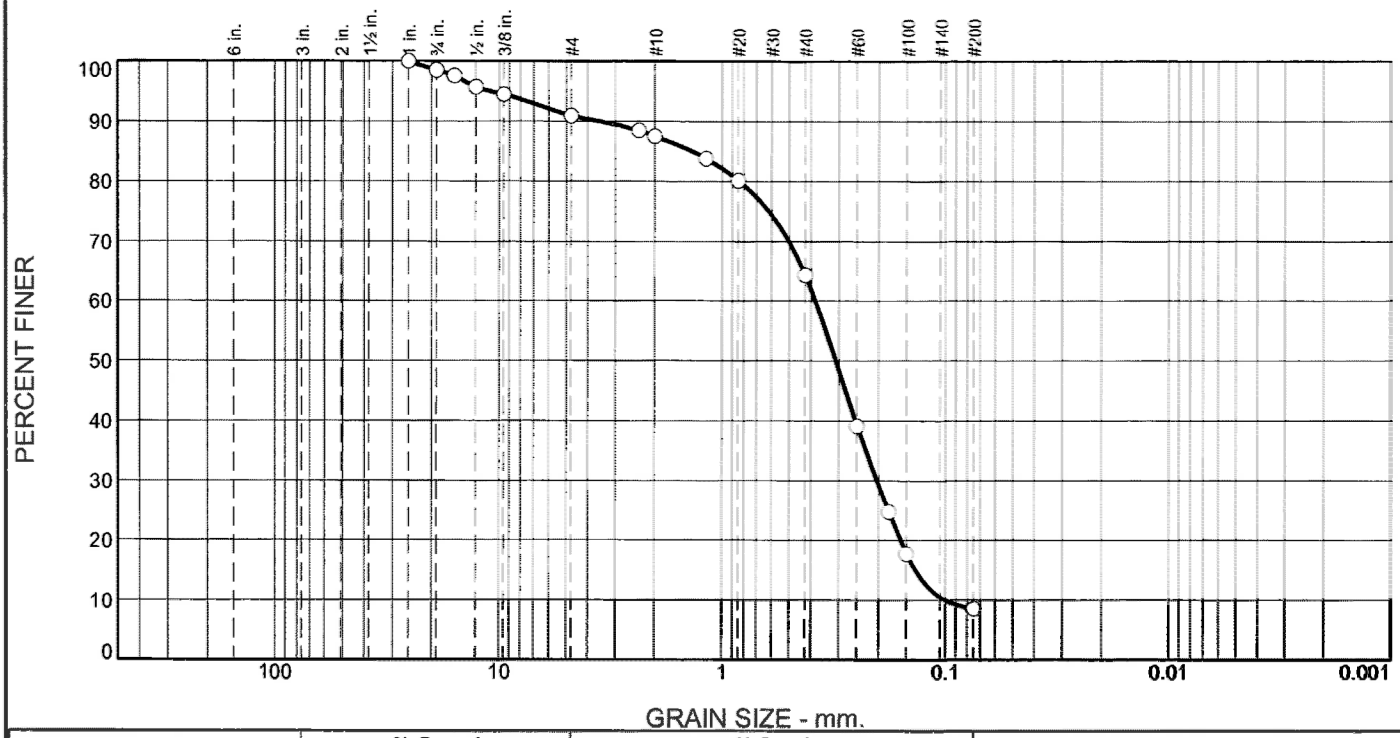
Date Sampled: 3-11-19

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'

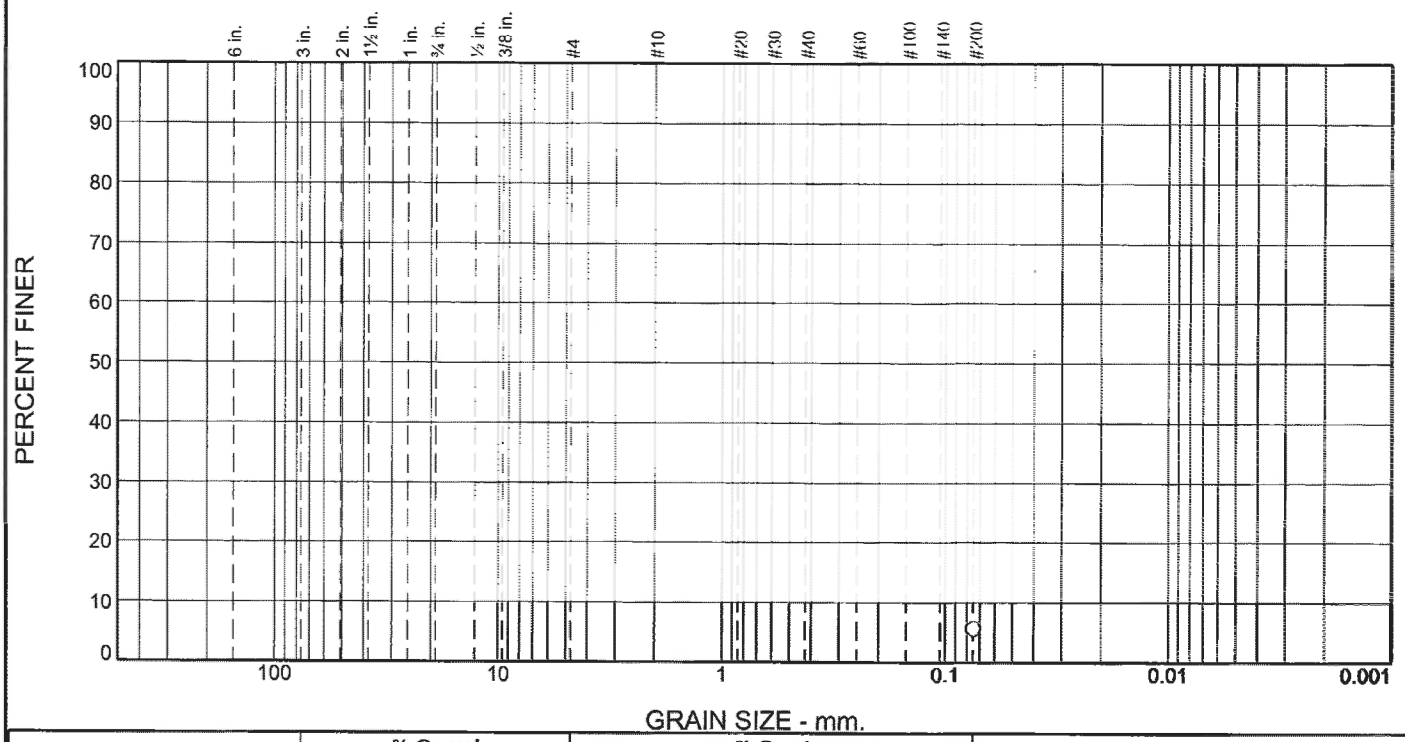
Date Sampled: 3-11-19

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'

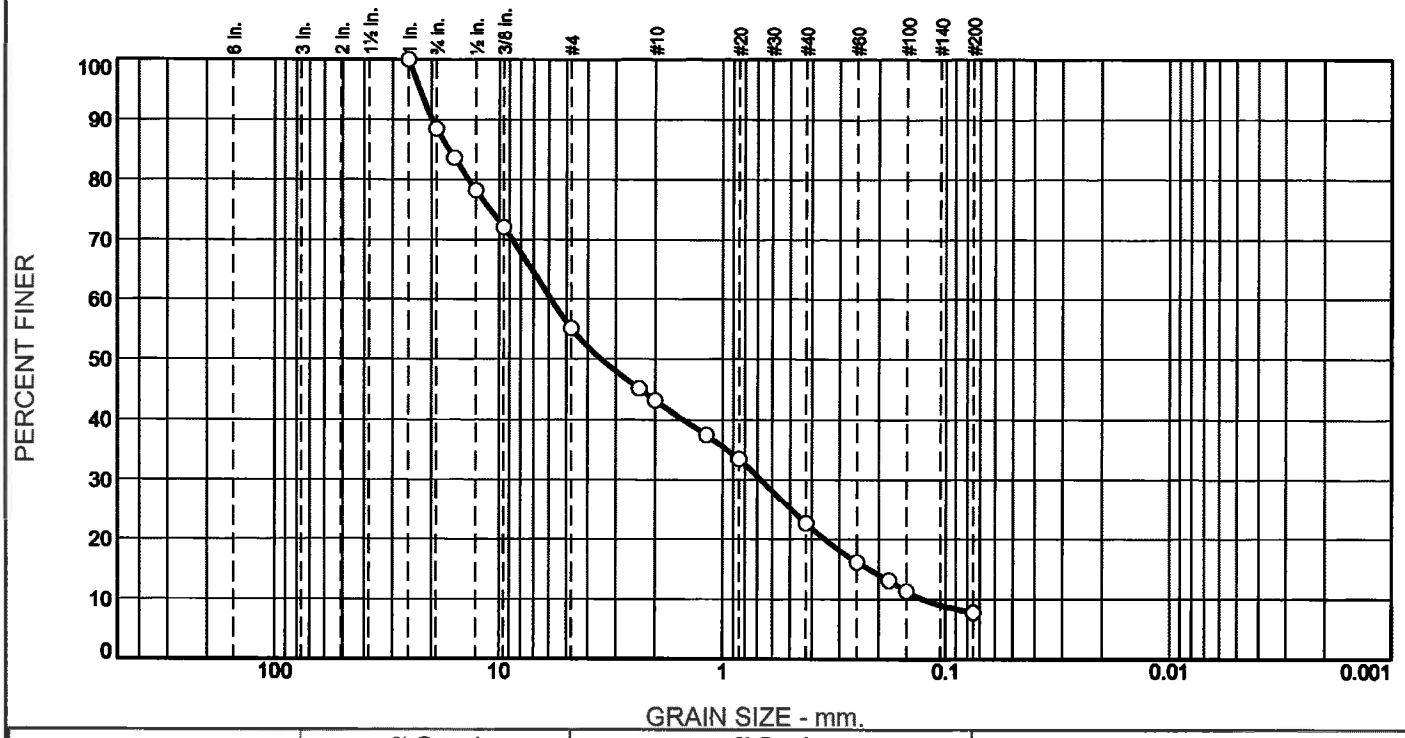
Date Sampled: 3-11-19

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.

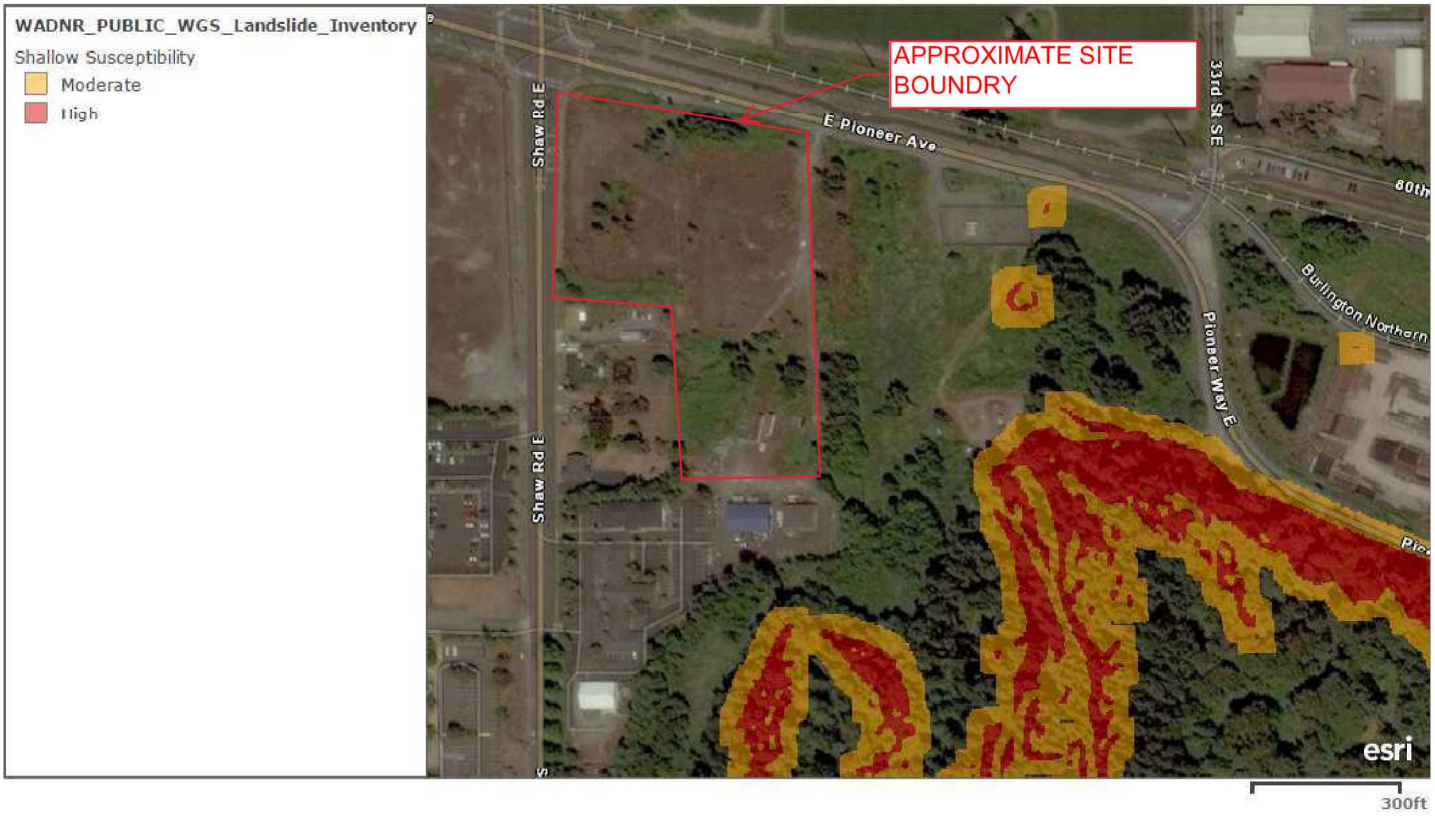
07/31/20

Vijay Chaudhary, P.E.
Project Engineer

Theresa Nunan

Theresa R. Nunan
Project Manager

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



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N

Krazan

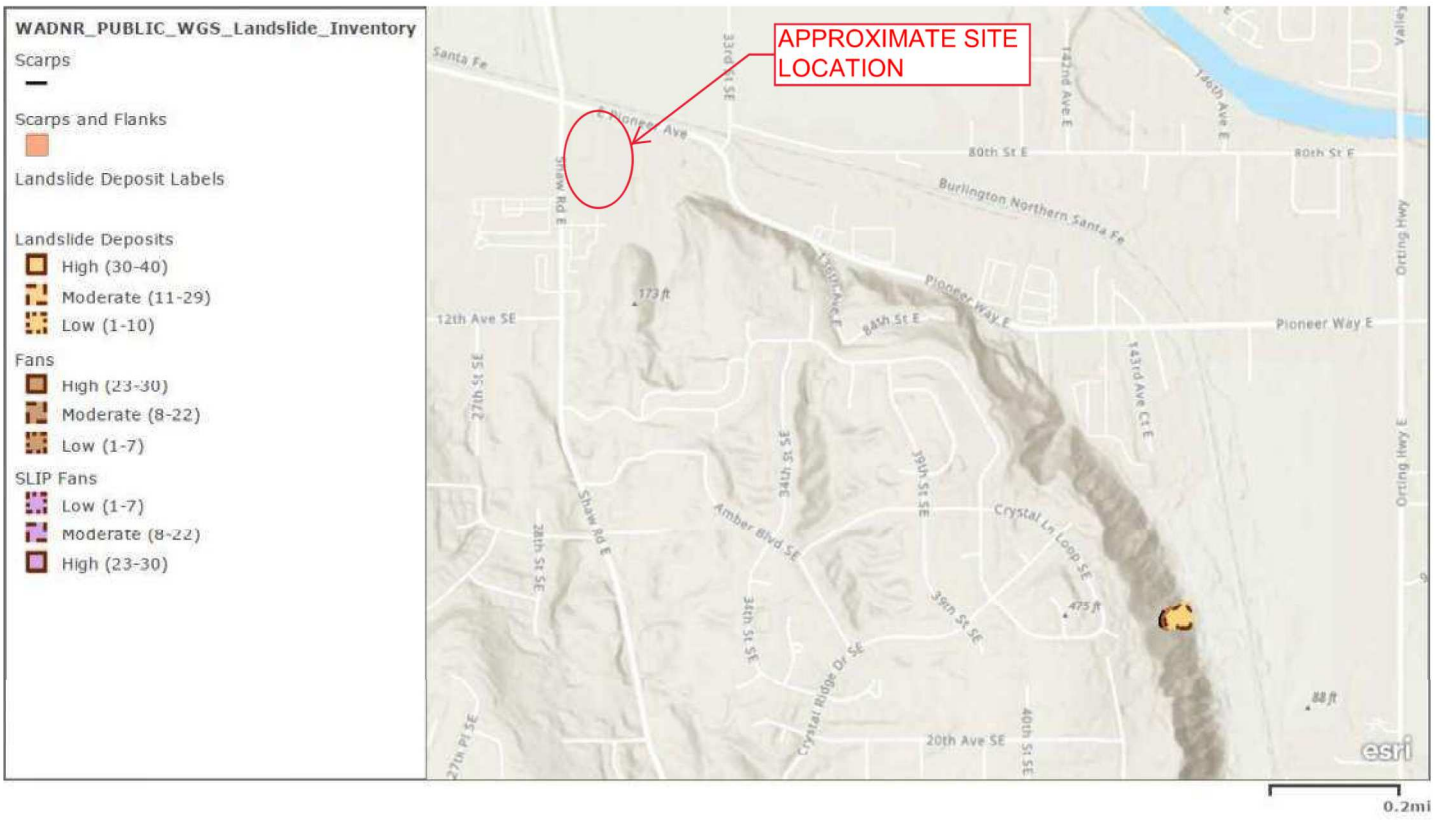
East Town Crossing		
Date: July 2020	Project Number: 062-19007	
Drawn By: VC	Figure: A	Not to scale

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
Page 1 of 3

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,

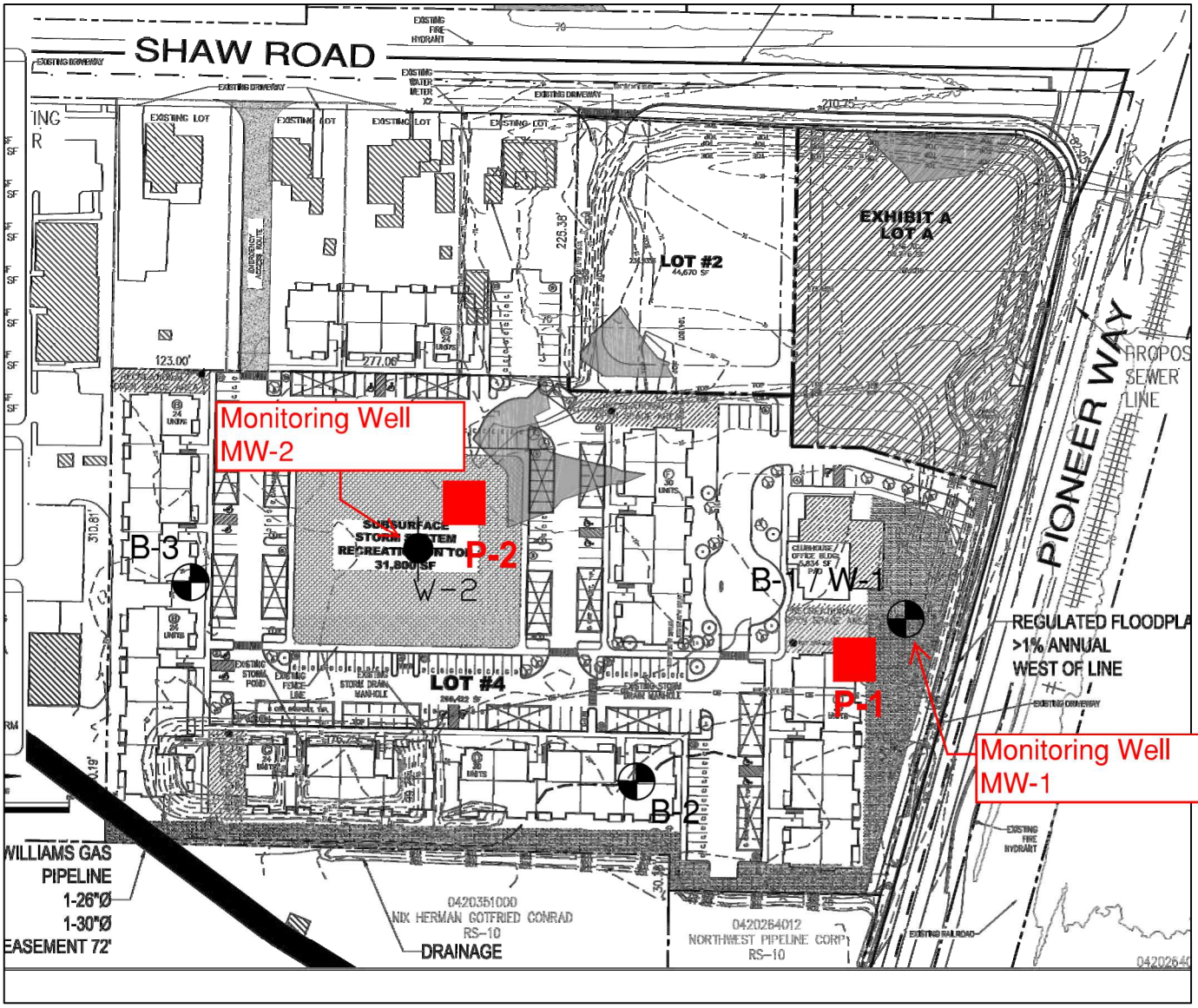
KRAZAN & ASSOCIATES, INC.

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.

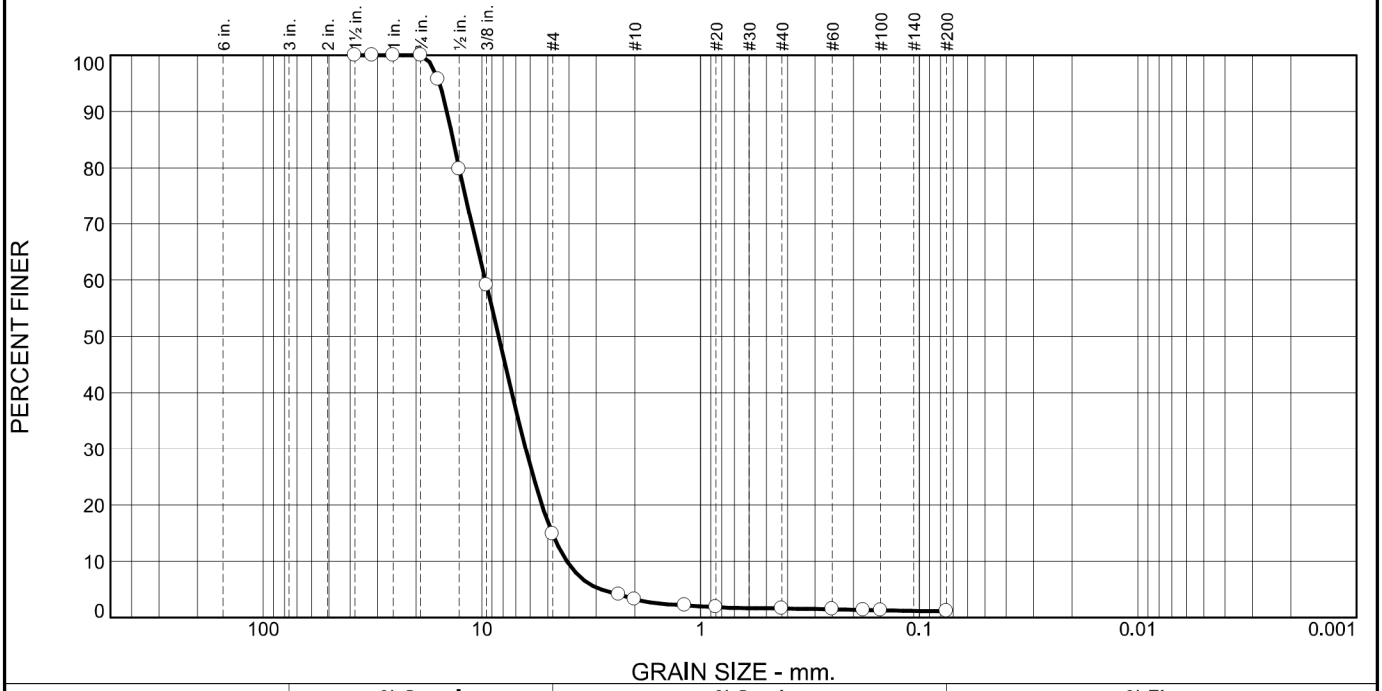
Respectfully submitted,

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

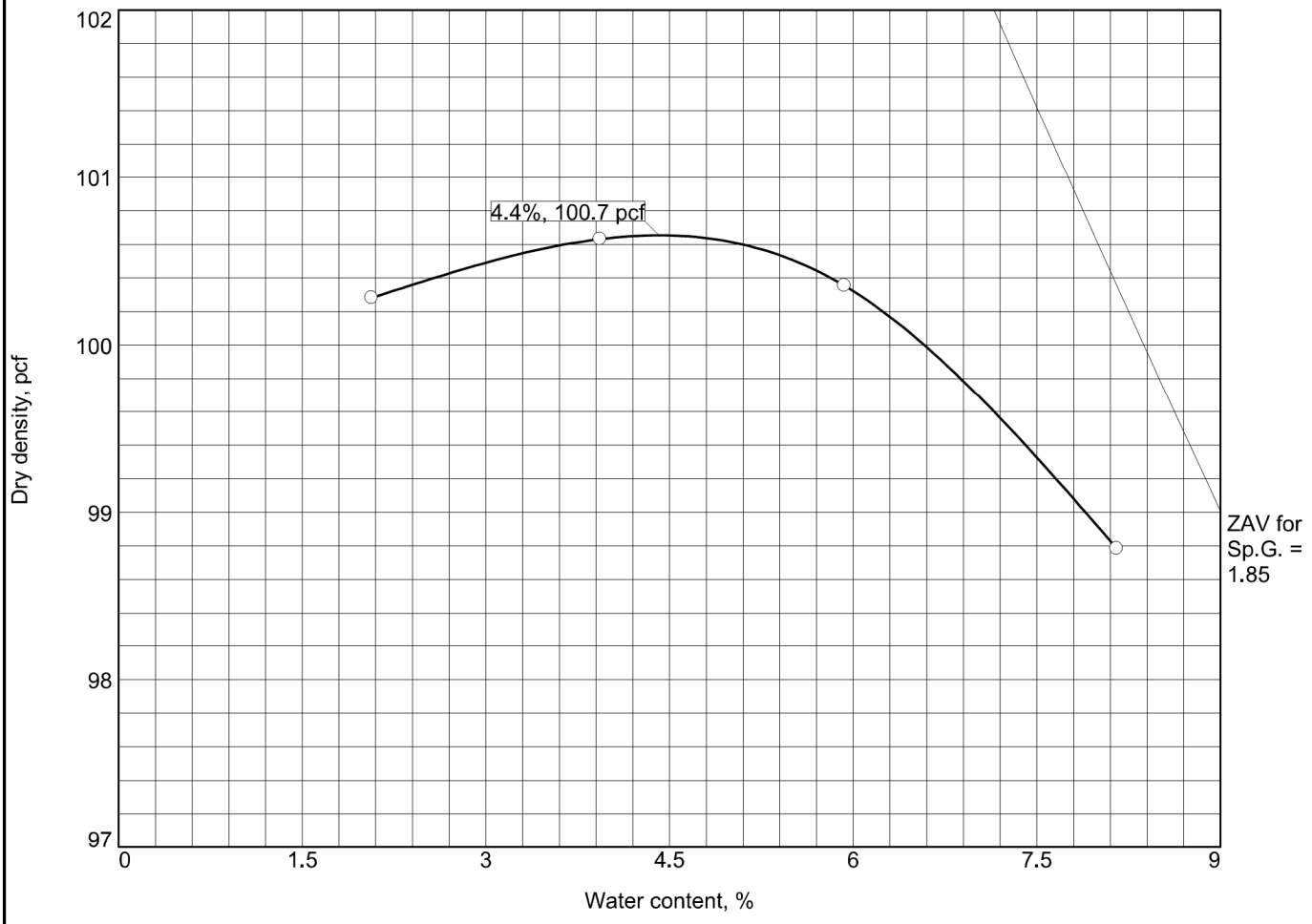
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L892

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:

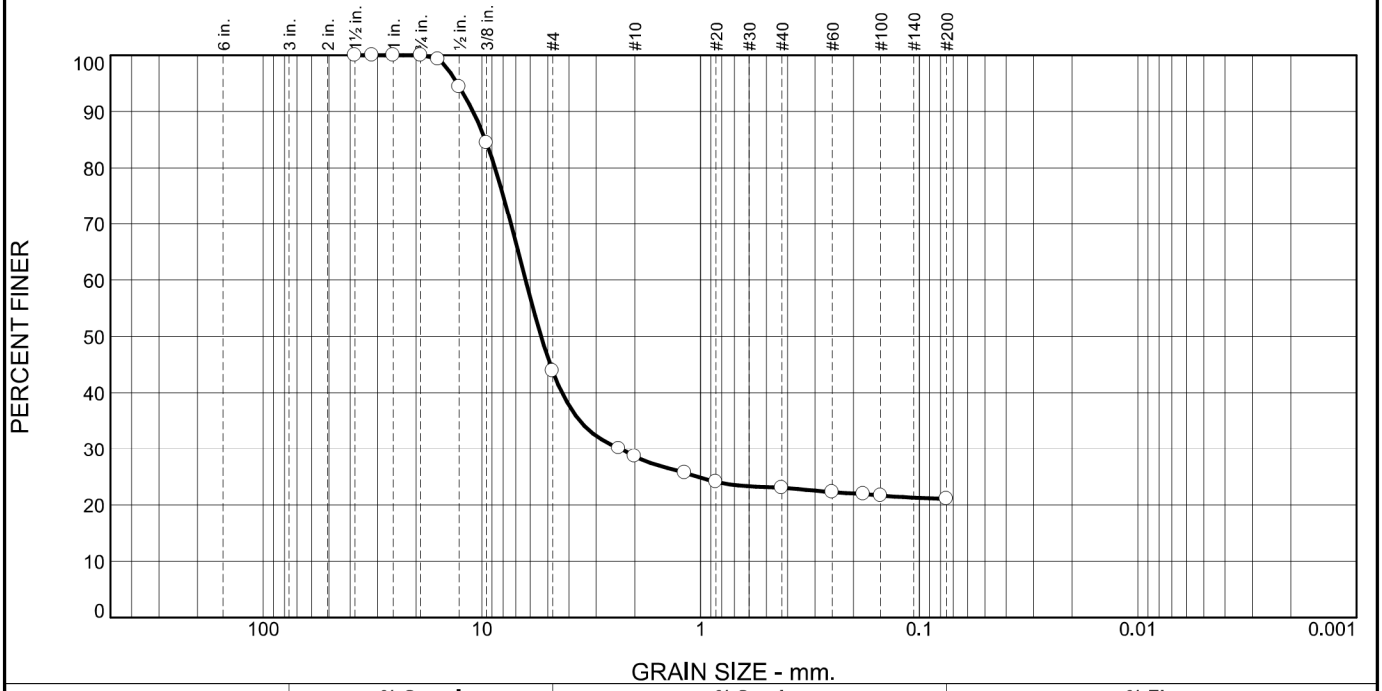
Sample ID:21L892
Sample Date:11-29-21
Void Ratio:0.14
Porosity:12%

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

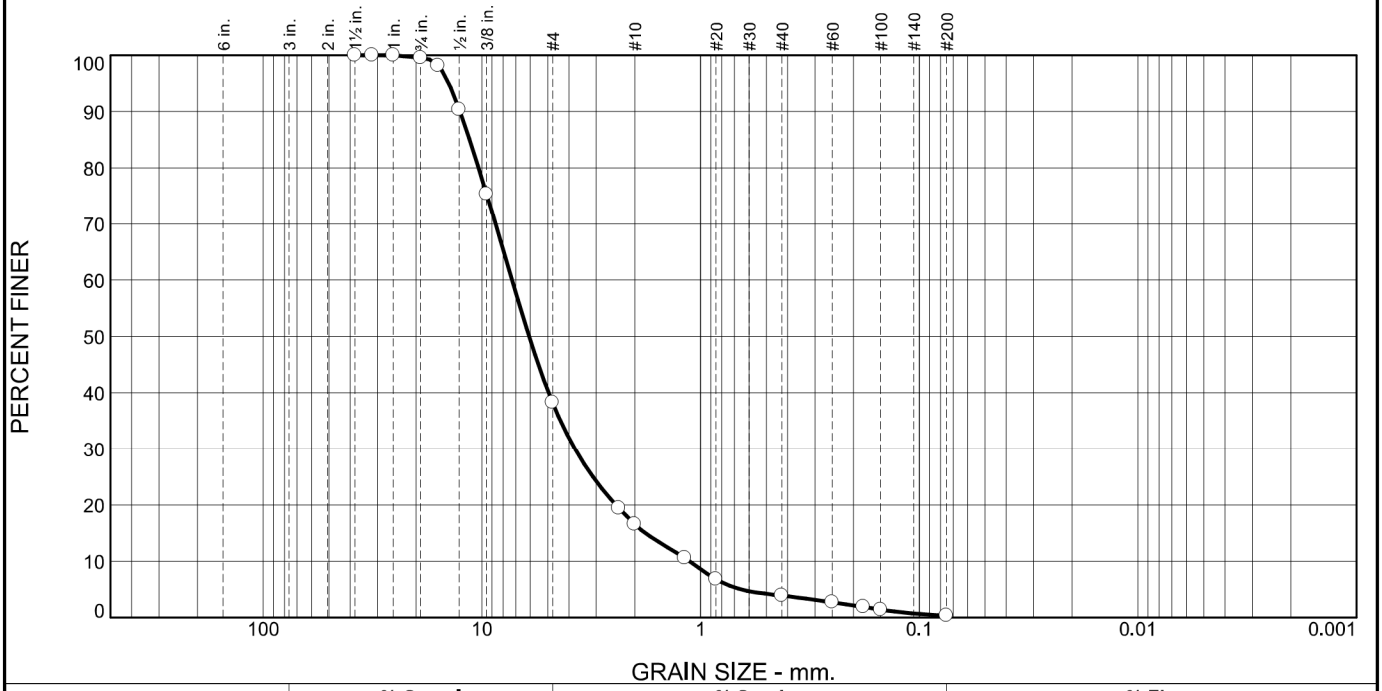
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L892

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

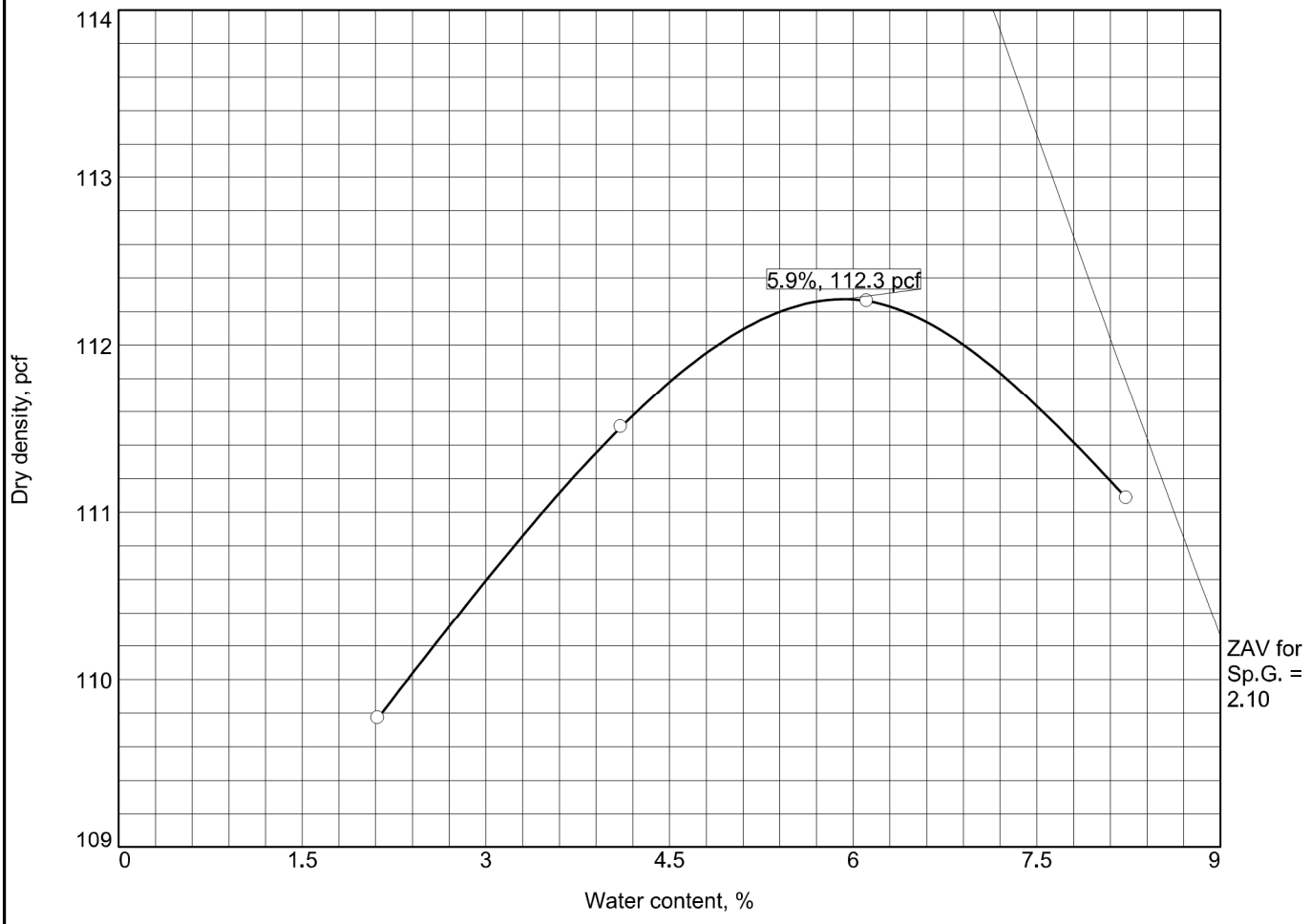
Source of Sample: Dan Lloyd Construction **Date Sampled:** 11-29-21
Sample Number: 21L893

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:

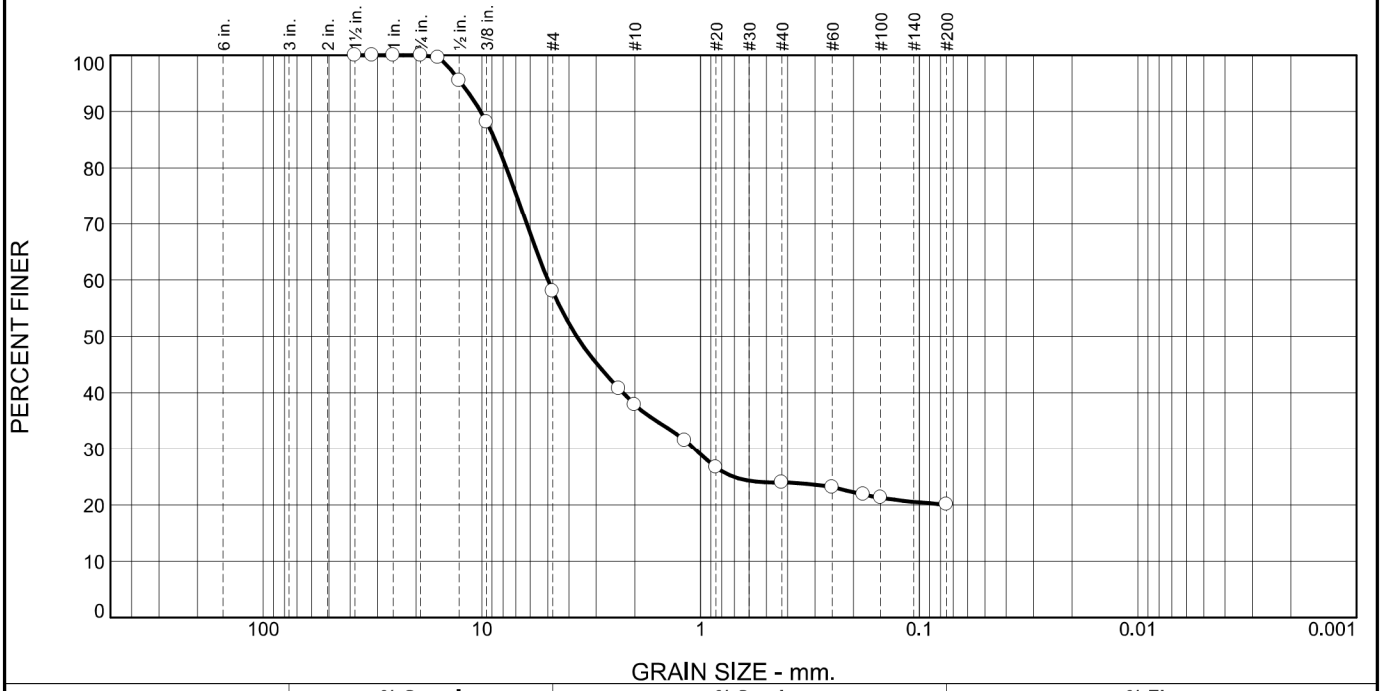
Sample ID:21L893
Sample Date:11-29-21
Void Ratio:0.16
Porosity:14%

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.

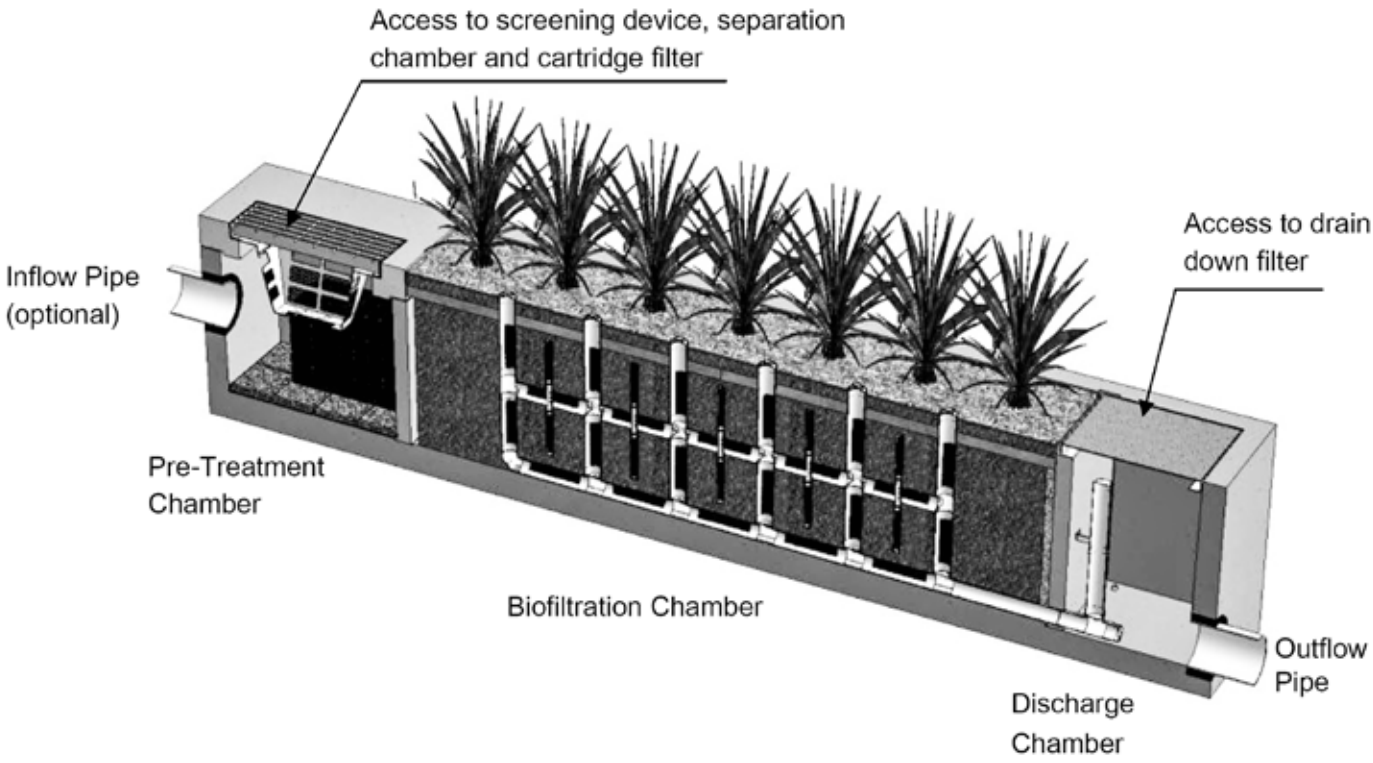
CONTECH®
ENGINEERED SOLUTIONS

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.

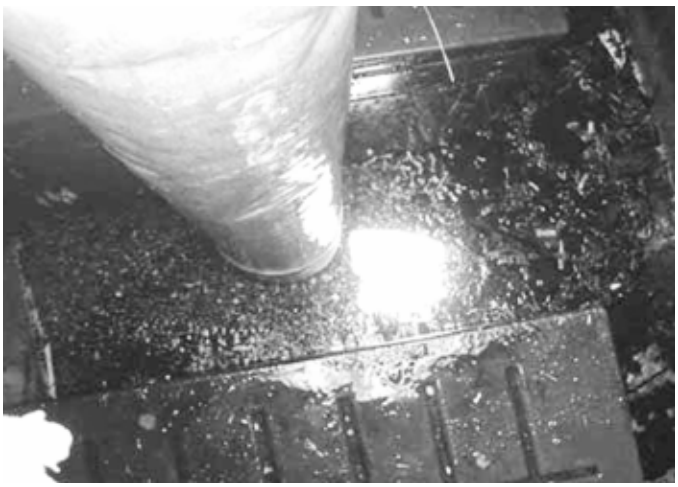
Maintenance Procedure Illustration

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.

CONTECH® ENGINEERED SOLUTIONS

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

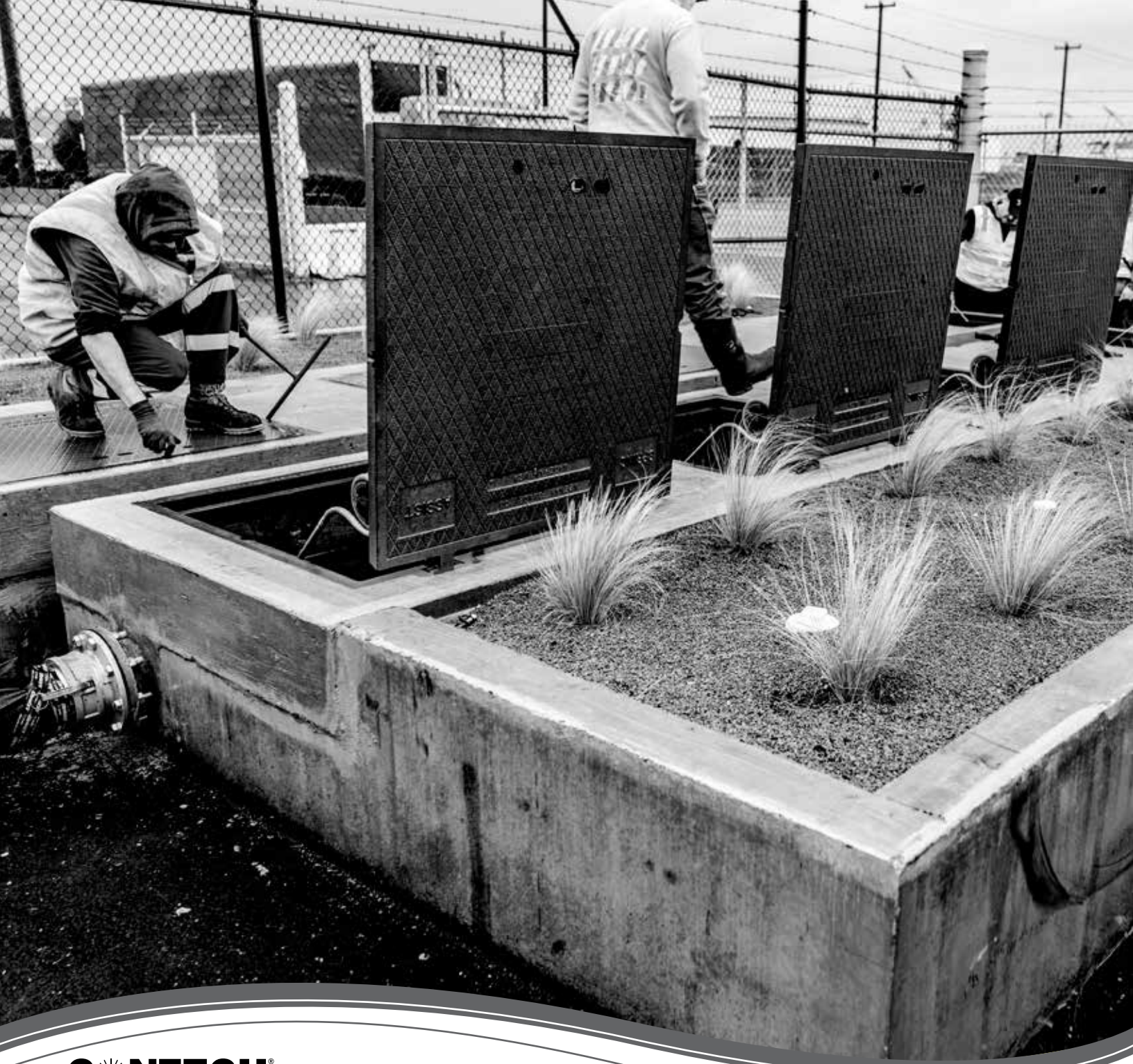
For Office Use Only
(Reviewed By)
(Date)
Office personnel to complete section to the left.

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

Combined East Town Crossing (Commercial + Rest of Site)

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	ETC
Site Name:	
Site Address:	
City:	
Report Date:	11/16/2022
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

Predeveloped Basin
- Area on Site
- Area from Pioneer Way E

Basin

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Mod	10.978
Pervious Total	10.978

Impervious Land Use	acre
Impervious Total	0
Basin Total	10.978

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Commercial Basin

Area from Commercial Lots on Site

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.44
Pervious Total	0.44

Impervious Land Use	acre
ROADS FLAT	0.81
ROOF TOPS FLAT	0.22
SIDEWALKS FLAT	0.23
Impervious Total	1.26
Basin Total	1.7

Element Flows To:

Surface	Interflow	Groundwater
Vault 1	Vault 1	

Bypass Basin Commercial Entrance

Entrance to Commercial Area bypassing treatment but upsizing detention

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
ROADS MOD	0.11
SIDEWALKS FLAT	0.0062
Impervious Total	0.1162
Basin Total	0.1162

Element Flows To:

Surface	Interflow	Groundwater

Pioneer Frontage

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.0188
Pervious Total	0.0188

Impervious Land Use	acre
ROADS FLAT	0.52
SIDEWALKS FLAT	0.083
Impervious Total	0.603
Basin Total	0.6218

Area from Pioneer Way E bypassing treatment Upsizing detention

Element Flows To:

Surface	Interflow	Groundwater

Rest of ETC Campus

Multifamily Area on Project Site

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	2.83
Pervious Total	2.83

Impervious Land Use	acre
ROADS FLAT	3.12
ROOF TOPS FLAT	1.96
SIDEWALKS FLAT	0.638
Impervious Total	5.718
Basin Total	8.548

Element Flows To:

Surface	Interflow	Groundwater
Vault 2	Vault 2	

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1 treats commercial area basin and has been up sized to provide detention for bypass of commercial entrance

Vault 1

Width:	114.3803 ft.
Length:	114.3803 ft.
Depth:	3.5 ft.
Discharge Structure	
Riser Height:	2.5 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	0.135 ft.
Notch Height:	0.500 ft.
Orifice 1 Diameter:	0.675 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

Min. Vault Height is 7' per Ecology Manual. Due to the size of this vault, the City is unwilling to support an AMR to reduce the height of the vault below 5.5 feet due to maintenance and safety concerns. Would a StormChamber or similar system be an option? [Storm Rpt; Pg 112 of 148]

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.300	0.000	0.000	0.000
0.0389	0.300	0.011	0.002	0.000
0.0778	0.300	0.023	0.003	0.000
0.1167	0.300	0.035	0.004	0.000
0.1556	0.300	0.046	0.004	0.000
0.1944	0.300	0.058	0.005	0.000
0.2333	0.300	0.070	0.006	0.000
0.2722	0.300	0.081	0.006	0.000
0.3111	0.300	0.093	0.006	0.000
0.3500	0.300	0.105	0.007	0.000
0.3889	0.300	0.116	0.007	0.000
0.4278	0.300	0.128	0.008	0.000
0.4667	0.300	0.140	0.008	0.000
0.5056	0.300	0.151	0.008	0.000
0.5444	0.300	0.163	0.009	0.000
0.5833	0.300	0.175	0.009	0.000
0.6222	0.300	0.186	0.009	0.000
0.6611	0.300	0.198	0.010	0.000
0.7000	0.300	0.210	0.010	0.000
0.7389	0.300	0.221	0.010	0.000
0.7778	0.300	0.233	0.010	0.000
0.8167	0.300	0.245	0.011	0.000
0.8556	0.300	0.257	0.011	0.000
0.8944	0.300	0.268	0.011	0.000
0.9333	0.300	0.280	0.011	0.000
0.9722	0.300	0.292	0.012	0.000
1.0111	0.300	0.303	0.012	0.000
1.0500	0.300	0.315	0.012	0.000
1.0889	0.300	0.327	0.012	0.000
1.1278	0.300	0.338	0.013	0.000
1.1667	0.300	0.350	0.013	0.000
1.2056	0.300	0.362	0.013	0.000
1.2444	0.300	0.373	0.013	0.000
1.2833	0.300	0.385	0.014	0.000
1.3222	0.300	0.397	0.014	0.000
1.3611	0.300	0.408	0.014	0.000
1.4000	0.300	0.420	0.014	0.000

1.4389	0.300	0.432	0.014	0.000
1.4778	0.300	0.443	0.015	0.000
1.5167	0.300	0.455	0.015	0.000
1.5556	0.300	0.467	0.015	0.000
1.5944	0.300	0.478	0.015	0.000
1.6333	0.300	0.490	0.015	0.000
1.6722	0.300	0.502	0.016	0.000
1.7111	0.300	0.513	0.016	0.000
1.7500	0.300	0.525	0.016	0.000
1.7889	0.300	0.537	0.016	0.000
1.8278	0.300	0.549	0.016	0.000
1.8667	0.300	0.560	0.016	0.000
1.9056	0.300	0.572	0.017	0.000
1.9444	0.300	0.584	0.017	0.000
1.9833	0.300	0.595	0.017	0.000
2.0222	0.300	0.607	0.019	0.000
2.0611	0.300	0.619	0.024	0.000
2.1000	0.300	0.630	0.031	0.000
2.1389	0.300	0.642	0.040	0.000
2.1778	0.300	0.654	0.050	0.000
2.2167	0.300	0.665	0.061	0.000
2.2556	0.300	0.677	0.073	0.000
2.2944	0.300	0.689	0.086	0.000
2.3333	0.300	0.700	0.099	0.000
2.3722	0.300	0.712	0.113	0.000
2.4111	0.300	0.724	0.128	0.000
2.4500	0.300	0.735	0.142	0.000
2.4889	0.300	0.747	0.158	0.000
2.5278	0.300	0.759	0.236	0.000
2.5667	0.300	0.770	0.436	0.000
2.6056	0.300	0.782	0.707	0.000
2.6444	0.300	0.794	1.032	0.000
2.6833	0.300	0.805	1.399	0.000
2.7222	0.300	0.817	1.800	0.000
2.7611	0.300	0.829	2.225	0.000
2.8000	0.300	0.841	2.665	0.000
2.8389	0.300	0.852	3.109	0.000
2.8778	0.300	0.864	3.550	0.000
2.9167	0.300	0.876	3.976	0.000
2.9556	0.300	0.887	4.380	0.000
2.9944	0.300	0.899	4.753	0.000
3.0333	0.300	0.911	5.088	0.000
3.0722	0.300	0.922	5.382	0.000
3.1111	0.300	0.934	5.633	0.000
3.1500	0.300	0.946	5.841	0.000
3.1889	0.300	0.957	6.013	0.000
3.2278	0.300	0.969	6.159	0.000
3.2667	0.300	0.981	6.370	0.000
3.3056	0.300	0.992	6.526	0.000
3.3444	0.300	1.004	6.677	0.000
3.3833	0.300	1.016	6.826	0.000
3.4222	0.300	1.027	6.971	0.000
3.4611	0.300	1.039	7.113	0.000
3.5000	0.300	1.051	7.252	0.000
3.5389	0.300	1.062	7.389	0.000
3.5778	0.000	0.000	7.523	0.000

Volume of detention vault = 45,781 cf

Vault 2

Width:	157.4738 ft.
Length:	157.4738 ft.
Depth:	5.5 ft.
Discharge Structure	
Riser Height:	4.5 ft.
Riser Diameter:	18 in.
Notch Type:	Rectangular
Notch Width:	0.500 ft.
Notch Height:	0.045 ft.
Orifice 1 Diameter:	1.3 in. Elevation:0 ft.
Element Flows To:	
Outlet 1	Outlet 2

Vault 2 treats multifamily basin and has been upsized to provide detention for bypass from Pioneer Frontage

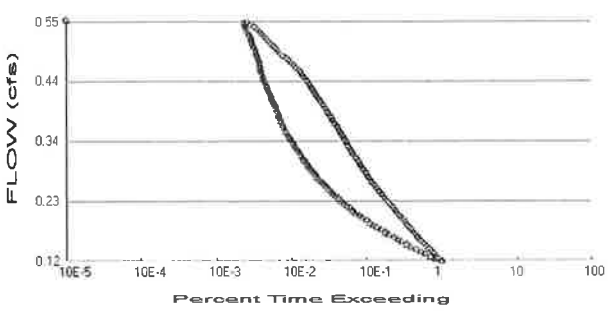
Min. Vault Height is 7' per Ecology Manual. The City is willing to allow a 5.5' deep vault provided an AMR is submitted to document the revision. [Storm Rpt; Pg 114 of 148]

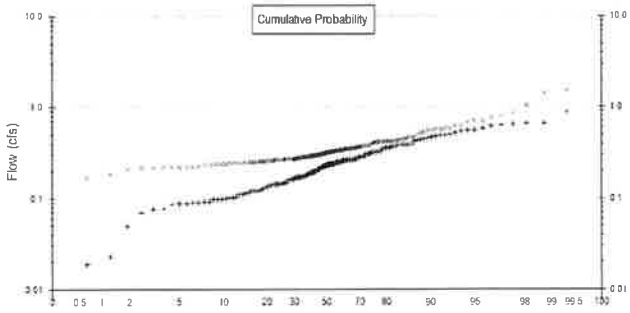
Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.569	0.000	0.000	0.000
0.0611	0.569	0.034	0.011	0.000
0.1222	0.569	0.069	0.016	0.000
0.1833	0.569	0.104	0.019	0.000
0.2444	0.569	0.139	0.022	0.000
0.3056	0.569	0.173	0.025	0.000
0.3667	0.569	0.208	0.027	0.000
0.4278	0.569	0.243	0.030	0.000
0.4889	0.569	0.278	0.032	0.000
0.5500	0.569	0.313	0.034	0.000
0.6111	0.569	0.347	0.035	0.000
0.6722	0.569	0.382	0.037	0.000
0.7333	0.569	0.417	0.039	0.000
0.7944	0.569	0.452	0.040	0.000
0.8556	0.569	0.487	0.042	0.000
0.9167	0.569	0.521	0.043	0.000
0.9778	0.569	0.556	0.045	0.000
1.0389	0.569	0.591	0.046	0.000
1.1000	0.569	0.626	0.048	0.000
1.1611	0.569	0.661	0.049	0.000
1.2222	0.569	0.695	0.050	0.000
1.2833	0.569	0.730	0.052	0.000
1.3444	0.569	0.765	0.053	0.000
1.4056	0.569	0.800	0.054	0.000
1.4667	0.569	0.834	0.055	0.000
1.5278	0.569	0.869	0.056	0.000
1.5889	0.569	0.904	0.057	0.000
1.6500	0.569	0.939	0.058	0.000
1.7111	0.569	0.974	0.060	0.000
1.7722	0.569	1.008	0.061	0.000
1.8333	0.569	1.043	0.062	0.000
1.8944	0.569	1.078	0.063	0.000
1.9556	0.569	1.113	0.064	0.000
2.0167	0.569	1.148	0.065	0.000
2.0778	0.569	1.182	0.066	0.000
2.1389	0.569	1.217	0.067	0.000
2.2000	0.569	1.252	0.068	0.000
2.2611	0.569	1.287	0.069	0.000
2.3222	0.569	1.322	0.069	0.000

2.3833	0.569	1.356	0.070	0.000
2.4444	0.569	1.391	0.071	0.000
2.5056	0.569	1.426	0.072	0.000
2.5667	0.569	1.461	0.073	0.000
2.6278	0.569	1.496	0.074	0.000
2.6889	0.569	1.530	0.075	0.000
2.7500	0.569	1.565	0.076	0.000
2.8111	0.569	1.600	0.076	0.000
2.8722	0.569	1.635	0.077	0.000
2.9333	0.569	1.669	0.078	0.000
2.9944	0.569	1.704	0.079	0.000
3.0556	0.569	1.739	0.080	0.000
3.1167	0.569	1.774	0.081	0.000
3.1778	0.569	1.809	0.081	0.000
3.2389	0.569	1.843	0.082	0.000
3.3000	0.569	1.878	0.083	0.000
3.3611	0.569	1.913	0.084	0.000
3.4222	0.569	1.948	0.084	0.000
3.4833	0.569	1.983	0.085	0.000
3.5444	0.569	2.017	0.086	0.000
3.6056	0.569	2.052	0.087	0.000
3.6667	0.569	2.087	0.087	0.000
3.7278	0.569	2.122	0.088	0.000
3.7889	0.569	2.157	0.089	0.000
3.8500	0.569	2.191	0.090	0.000
3.9111	0.569	2.226	0.090	0.000
3.9722	0.569	2.261	0.091	0.000
4.0333	0.569	2.296	0.092	0.000
4.0944	0.569	2.330	0.092	0.000
4.1556	0.569	2.365	0.093	0.000
4.2167	0.569	2.400	0.094	0.000
4.2778	0.569	2.435	0.094	0.000
4.3389	0.569	2.470	0.095	0.000
4.4000	0.569	2.504	0.096	0.000
4.4611	0.569	2.539	0.097	0.000
4.5222	0.569	2.574	0.166	0.000
4.5833	0.569	2.609	0.496	0.000
4.6444	0.569	2.644	0.983	0.000
4.7056	0.569	2.678	1.577	0.000
4.7667	0.569	2.713	2.239	0.000
4.8278	0.569	2.748	2.935	0.000
4.8889	0.569	2.783	3.627	0.000
4.9500	0.569	2.818	4.278	0.000
5.0111	0.569	2.852	4.855	0.000
5.0722	0.569	2.887	5.337	0.000
5.1333	0.569	2.922	5.712	0.000
5.1944	0.569	2.957	5.991	0.000
5.2556	0.569	2.991	6.281	0.000
5.3167	0.569	3.026	6.525	0.000
5.3778	0.569	3.061	6.761	0.000
5.4389	0.569	3.096	6.989	0.000
5.5000	0.569	3.131	7.210	0.000
5.5611	0.569	3.165	7.424	0.000
5.6222	0.000	0.000	7.631	0.000

Analysis Results
POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 10.978
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 3.2888
Total Impervious Area: 7.6972

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.2336
5 year	0.365386
10 year	0.437253
25 year	0.510549
50 year	0.554176
100 year	0.590081

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.317985
5 year	0.444361
10 year	0.547069
25 year	0.701028
50 year	0.835106
100 year	0.987453

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.170	0.336
1903	0.141	0.376
1904	0.271	0.430
1905	0.111	0.251
1906	0.050	0.237
1907	0.355	0.329
1908	0.263	0.269
1909	0.260	0.294
1910	0.358	0.329
1911	0.233	0.328

1912	0.882	0.531
1913	0.369	0.240
1914	0.090	0.869
1915	0.149	0.249
1916	0.231	0.378
1917	0.077	0.182
1918	0.247	0.300
1919	0.183	0.219
1920	0.235	0.278
1921	0.263	0.270
1922	0.264	0.349
1923	0.212	0.262
1924	0.097	0.399
1925	0.120	0.215
1926	0.229	0.332
1927	0.145	0.273
1928	0.179	0.260
1929	0.375	0.417
1930	0.236	0.425
1931	0.218	0.257
1932	0.171	0.250
1933	0.165	0.271
1934	0.485	0.707
1935	0.225	0.216
1936	0.195	0.299
1937	0.324	0.375
1938	0.190	0.230
1939	0.012	0.282
1940	0.211	0.411
1941	0.100	0.416
1942	0.317	0.699
1943	0.163	0.340
1944	0.318	0.471
1945	0.264	0.351
1946	0.161	0.288
1947	0.090	0.232
1948	0.497	0.334
1949	0.426	0.442
1950	0.121	0.242
1951	0.149	0.370
1952	0.657	0.471
1953	0.586	0.447
1954	0.211	0.266
1955	0.173	0.237
1956	0.085	0.213
1957	0.300	0.261
1958	0.625	0.746
1959	0.387	0.571
1960	0.103	0.240
1961	0.389	0.627
1962	0.209	0.283
1963	0.100	0.217
1964	0.110	0.587
1965	0.435	1.052
1966	0.122	0.248
1967	0.192	0.330
1968	0.191	0.292
1969	0.190	0.275

1970	0.298	0.295
1971	0.469	0.314
1972	0.304	0.808
1973	0.388	0.505
1974	0.226	0.379
1975	0.492	0.559
1976	0.261	0.422
1977	0.088	0.208
1978	0.438	0.360
1979	0.120	0.319
1980	0.248	0.341
1981	0.238	0.308
1982	0.097	0.261
1983	0.389	0.367
1984	0.159	0.347
1985	0.258	0.378
1986	0.231	0.240
1987	0.449	0.348
1988	0.280	0.245
1989	0.252	0.217
1990	0.285	0.263
1991	0.223	0.358
1992	0.319	0.325
1993	0.309	0.364
1994	0.464	0.296
1995	0.089	0.256
1996	0.519	0.320
1997	0.195	0.272
1998	0.232	0.320
1999	0.019	0.298
2000	0.176	0.304
2001	0.090	0.221
2002	0.364	0.426
2003	0.281	0.282
2004	0.262	0.339
2005	0.553	0.635
2006	0.144	0.316
2007	0.144	0.369
2008	0.246	0.300
2009	0.169	0.241
2010	0.143	0.309
2011	0.116	0.281
2012	0.168	0.295
2013	0.131	0.269
2014	0.098	0.252
2015	0.187	0.415
2016	0.075	0.273
2017	0.356	0.446
2018	0.656	1.525
2019	0.632	0.435
2020	0.197	0.334
2021	0.321	0.319
2022	0.133	0.423
2023	0.270	0.518
2024	0.648	0.551
2025	0.238	0.272
2026	0.389	0.327
2027	0.140	0.349

2028	0.121	0.151
2029	0.264	0.265
2030	0.489	0.418
2031	0.162	0.168
2032	0.088	0.242
2033	0.141	0.292
2034	0.139	0.248
2035	0.552	1.411
2036	0.291	0.249
2037	0.068	0.334
2038	0.245	0.322
2039	0.023	0.567
2040	0.127	0.267
2041	0.171	0.309
2042	0.543	0.582
2043	0.259	0.359
2044	0.350	0.298
2045	0.238	0.231
2046	0.279	0.672
2047	0.205	0.289
2048	0.266	0.260
2049	0.238	0.351
2050	0.171	0.287
2051	0.248	0.408
2052	0.142	0.282
2053	0.255	0.262
2054	0.324	0.465
2055	0.100	0.283
2056	0.113	0.360
2057	0.175	0.222
2058	0.222	0.344
2059	0.391	0.417

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.8818	1.5246
2	0.6569	1.4108
3	0.6560	1.0517
4	0.6478	0.8693
5	0.6323	0.8082
6	0.6255	0.7458
7	0.5861	0.7067
8	0.5531	0.6986
9	0.5515	0.6716
10	0.5431	0.6346
11	0.5186	0.6273
12	0.4974	0.5866
13	0.4919	0.5818
14	0.4891	0.5712
15	0.4845	0.5673
16	0.4692	0.5588
17	0.4643	0.5508
18	0.4489	0.5311
19	0.4384	0.5184
20	0.4354	0.5051
21	0.4261	0.4706
22	0.3909	0.4705

23	0.3891	0.4647
24	0.3889	0.4470
25	0.3889	0.4458
26	0.3880	0.4418
27	0.3870	0.4353
28	0.3751	0.4296
29	0.3689	0.4255
30	0.3639	0.4246
31	0.3581	0.4232
32	0.3562	0.4216
33	0.3548	0.4178
34	0.3497	0.4175
35	0.3243	0.4166
36	0.3239	0.4160
37	0.3209	0.4152
38	0.3188	0.4109
39	0.3179	0.4076
40	0.3172	0.3993
41	0.3092	0.3792
42	0.3042	0.3779
43	0.2997	0.3775
44	0.2983	0.3764
45	0.2907	0.3748
46	0.2848	0.3702
47	0.2806	0.3690
48	0.2798	0.3671
49	0.2789	0.3636
50	0.2713	0.3604
51	0.2699	0.3596
52	0.2658	0.3587
53	0.2644	0.3578
54	0.2636	0.3513
55	0.2635	0.3509
56	0.2630	0.3488
57	0.2629	0.3487
58	0.2623	0.3477
59	0.2610	0.3469
60	0.2599	0.3444
61	0.2592	0.3413
62	0.2580	0.3403
63	0.2548	0.3392
64	0.2517	0.3362
65	0.2485	0.3343
66	0.2476	0.3342
67	0.2471	0.3341
68	0.2456	0.3317
69	0.2449	0.3297
70	0.2383	0.3294
71	0.2381	0.3286
72	0.2379	0.3280
73	0.2375	0.3266
74	0.2360	0.3251
75	0.2351	0.3224
76	0.2334	0.3201
77	0.2318	0.3196
78	0.2315	0.3192
79	0.2309	0.3190
80	0.2292	0.3157

81	0.2262	0.3144
82	0.2247	0.3091
83	0.2230	0.3088
84	0.2216	0.3083
85	0.2183	0.3043
86	0.2121	0.2999
87	0.2111	0.2998
88	0.2106	0.2993
89	0.2089	0.2980
90	0.2054	0.2979
91	0.1969	0.2958
92	0.1954	0.2951
93	0.1949	0.2946
94	0.1918	0.2945
95	0.1908	0.2922
96	0.1904	0.2918
97	0.1901	0.2893
98	0.1874	0.2883
99	0.1827	0.2871
100	0.1792	0.2835
101	0.1764	0.2829
102	0.1750	0.2824
103	0.1726	0.2820
104	0.1712	0.2818
105	0.1709	0.2811
106	0.1706	0.2777
107	0.1696	0.2752
108	0.1686	0.2731
109	0.1681	0.2726
110	0.1649	0.2723
111	0.1632	0.2718
112	0.1616	0.2709
113	0.1612	0.2702
114	0.1585	0.2687
115	0.1486	0.2686
116	0.1486	0.2671
117	0.1453	0.2664
118	0.1442	0.2652
119	0.1437	0.2631
120	0.1435	0.2624
121	0.1424	0.2622
122	0.1415	0.2612
123	0.1411	0.2607
124	0.1398	0.2603
125	0.1392	0.2598
126	0.1328	0.2574
127	0.1313	0.2556
128	0.1270	0.2519
129	0.1221	0.2510
130	0.1212	0.2503
131	0.1208	0.2490
132	0.1204	0.2487
133	0.1203	0.2480
134	0.1159	0.2480
135	0.1126	0.2451
136	0.1110	0.2419
137	0.1102	0.2418
138	0.1030	0.2409

139	0.1004	0.2400
140	0.1003	0.2399
141	0.1002	0.2396
142	0.0978	0.2370
143	0.0972	0.2369
144	0.0969	0.2323
145	0.0903	0.2311
146	0.0903	0.2304
147	0.0901	0.2217
148	0.0890	0.2208
149	0.0879	0.2187
150	0.0879	0.2169
151	0.0846	0.2169
152	0.0770	0.2159
153	0.0746	0.2148
154	0.0685	0.2135
155	0.0497	0.2078
156	0.0229	0.1823
157	0.0187	0.1677
158	0.0119	0.1513

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1168	53933	54453	100	Pass
0.1212	49257	45279	91	Pass
0.1256	45994	39384	85	Pass
0.1301	42298	33069	78	Pass
0.1345	39539	28753	72	Pass
0.1389	37008	25146	67	Pass
0.1433	34099	21274	62	Pass
0.1477	31961	18698	58	Pass
0.1521	29462	15978	54	Pass
0.1566	27601	14205	51	Pass
0.1610	25955	12676	48	Pass
0.1654	24116	10942	45	Pass
0.1698	22820	9795	42	Pass
0.1742	21257	8471	39	Pass
0.1787	20105	7584	37	Pass
0.1831	18725	6631	35	Pass
0.1875	17728	6044	34	Pass
0.1919	16742	5478	32	Pass
0.1963	15523	4831	31	Pass
0.2007	14681	4397	29	Pass
0.2052	13684	3928	28	Pass
0.2096	12975	3600	27	Pass
0.2140	12260	3329	27	Pass
0.2184	11451	2999	26	Pass
0.2228	10809	2784	25	Pass
0.2272	10088	2549	25	Pass
0.2317	9546	2368	24	Pass
0.2361	8920	2133	23	Pass
0.2405	8421	1999	23	Pass
0.2449	7989	1877	23	Pass
0.2493	7501	1723	22	Pass
0.2538	7113	1617	22	Pass
0.2582	6626	1509	22	Pass
0.2626	6305	1419	22	Pass
0.2670	5961	1306	21	Pass
0.2714	5717	1225	21	Pass
0.2758	5469	1164	21	Pass
0.2803	5186	1076	20	Pass
0.2847	4943	1024	20	Pass
0.2891	4674	971	20	Pass
0.2935	4495	916	20	Pass
0.2979	4342	880	20	Pass
0.3024	4130	821	19	Pass
0.3068	3939	787	19	Pass
0.3112	3720	751	20	Pass
0.3156	3549	719	20	Pass
0.3200	3368	676	20	Pass
0.3244	3227	649	20	Pass
0.3289	3117	619	19	Pass
0.3333	2994	585	19	Pass
0.3377	2897	558	19	Pass
0.3421	2757	529	19	Pass
0.3465	2625	512	19	Pass

0.3510	2521	493	19	Pass
0.3554	2404	471	19	Pass
0.3598	2320	452	19	Pass
0.3642	2198	430	19	Pass
0.3686	2091	419	20	Pass
0.3730	1994	403	20	Pass
0.3775	1904	395	20	Pass
0.3819	1826	385	21	Pass
0.3863	1720	379	22	Pass
0.3907	1646	363	22	Pass
0.3951	1586	349	22	Pass
0.3995	1514	340	22	Pass
0.4040	1447	335	23	Pass
0.4084	1361	318	23	Pass
0.4128	1295	311	24	Pass
0.4172	1231	299	24	Pass
0.4216	1181	293	24	Pass
0.4261	1112	283	25	Pass
0.4305	1072	273	25	Pass
0.4349	1028	268	26	Pass
0.4393	976	259	26	Pass
0.4437	935	249	26	Pass
0.4481	878	242	27	Pass
0.4526	824	234	28	Pass
0.4570	787	230	29	Pass
0.4614	737	222	30	Pass
0.4658	699	219	31	Pass
0.4702	636	214	33	Pass
0.4747	602	210	34	Pass
0.4791	551	208	37	Pass
0.4835	511	207	40	Pass
0.4879	476	201	42	Pass
0.4923	427	194	45	Pass
0.4967	394	193	48	Pass
0.5012	362	187	51	Pass
0.5056	339	184	54	Pass
0.5100	317	174	54	Pass
0.5144	298	170	57	Pass
0.5188	278	166	59	Pass
0.5233	254	162	63	Pass
0.5277	241	160	66	Pass
0.5321	221	150	67	Pass
0.5365	209	147	70	Pass
0.5409	197	141	71	Pass
0.5453	178	135	75	Pass
0.5498	159	133	83	Pass
0.5542	142	128	90	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.1828 acre-feet
On-line facility target flow:	0.101 cfs.
Adjusted for 15 min:	0.101 cfs.
Off-line facility target flow:	0.0641 cfs.
Adjusted for 15 min:	0.0641 cfs.

Water Quality needed to be provided to treat combined output from Vault 1 and Vault 2

WQ facilities downstream of detention must be sized for the 2yr release rate. [Storm Rpt; Pg 125 of 148]

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	☐	461.86			☐	0.00			
Total Volume Infiltrated		461.86	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

Facility has been designed to pass LID standards

For some reason, Vault 2/3 is not included in the LID Performance Standard Analysis/Report, so the results ("Pass") may not be accurate. [Storm Rpt; Pg 126 of 148]

NOTE: At this phase (landuse application) of the project it is not necessary to show MR5 compliance if 100% detention is proposed and the preliminary design meets the stream duration standard. However, it will be necessary to show MR5 compliance at time of civil application. [Storm Rpt; Pg 126 of 148]

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

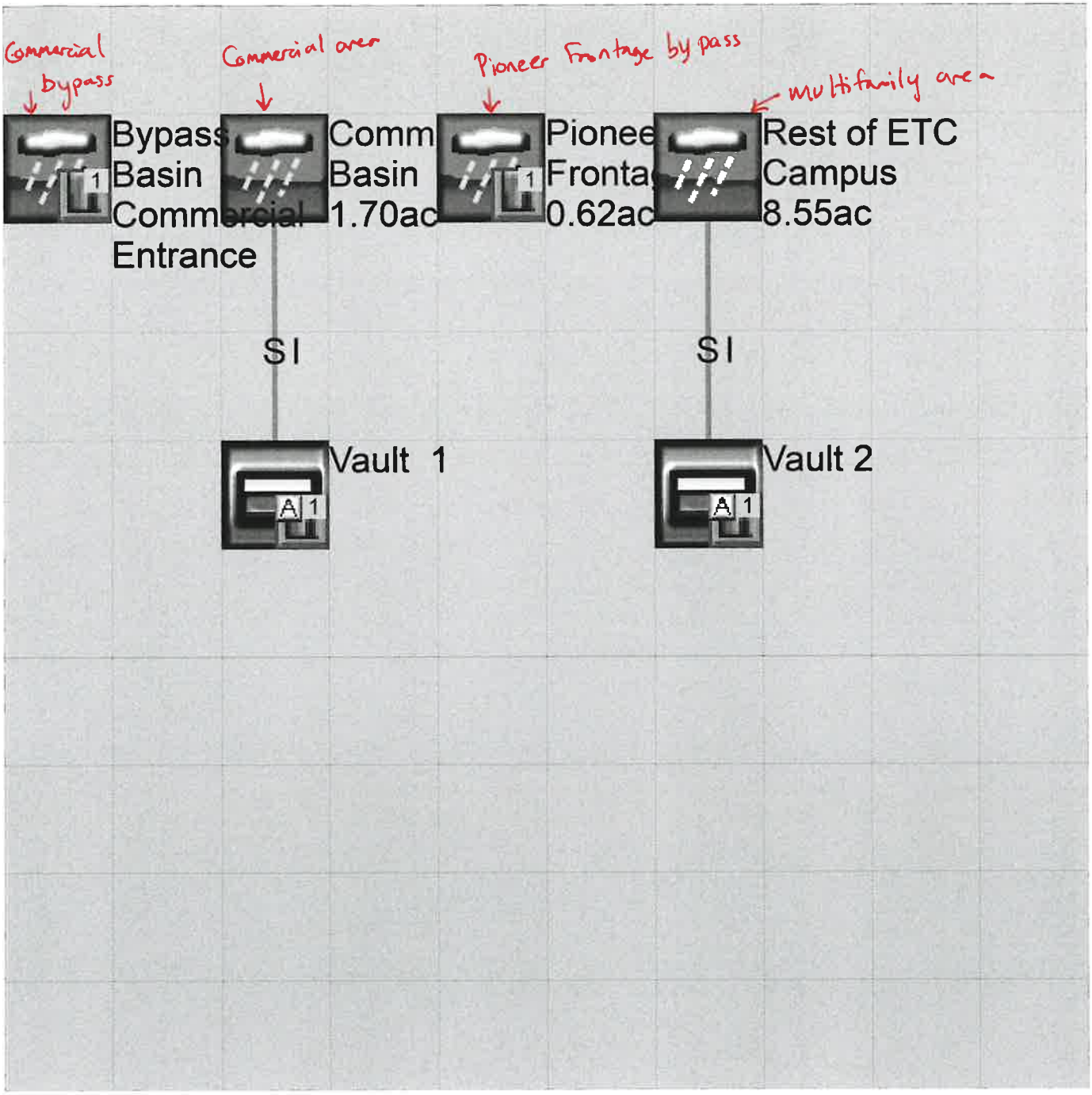
No PERLND changes have been made.

IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic

Mitigated Schematic



Appendix 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.

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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.

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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

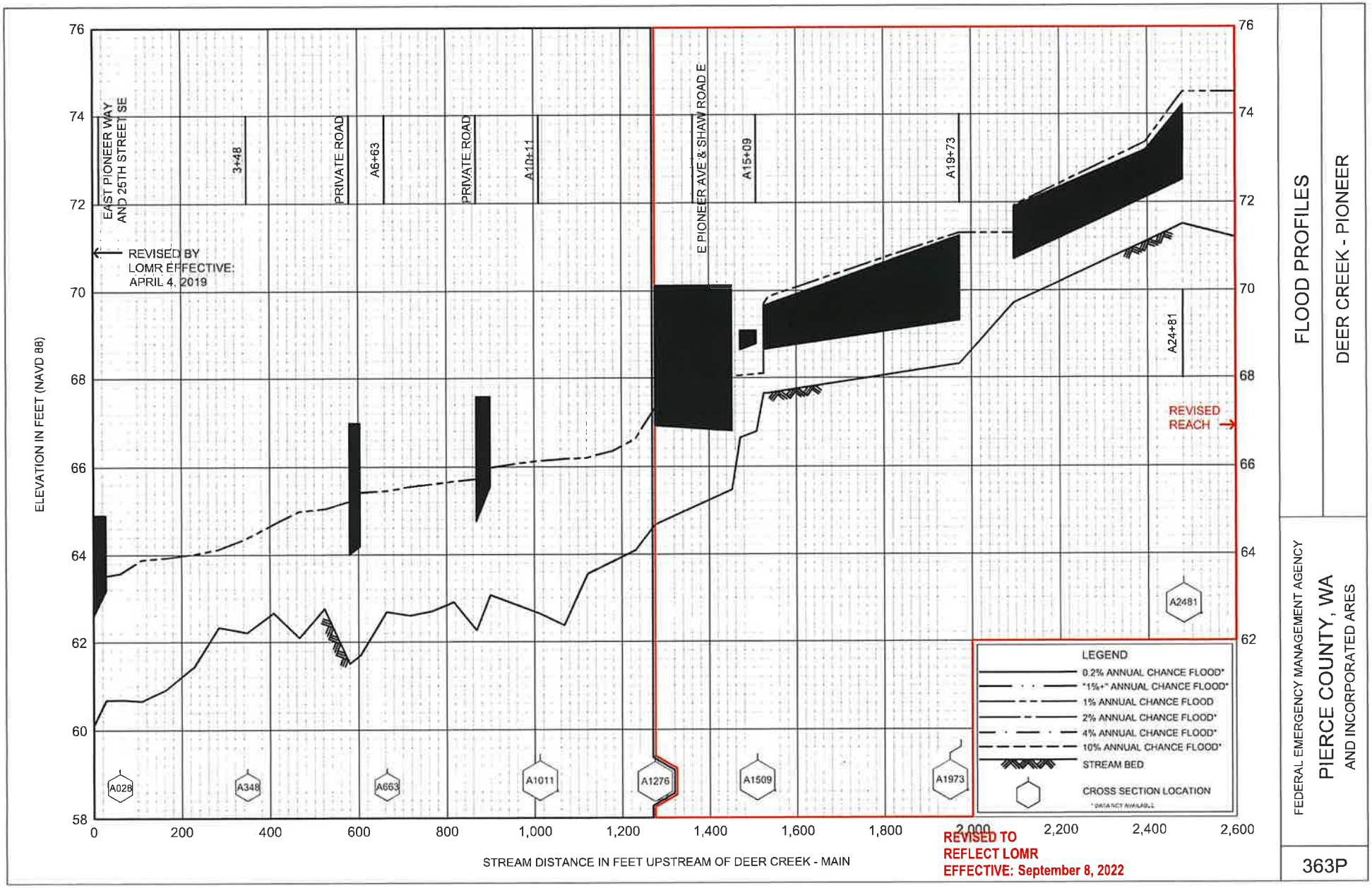
REVISED TO
REFLECT LOMR
EFFECTIVE: April 4,
2019

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

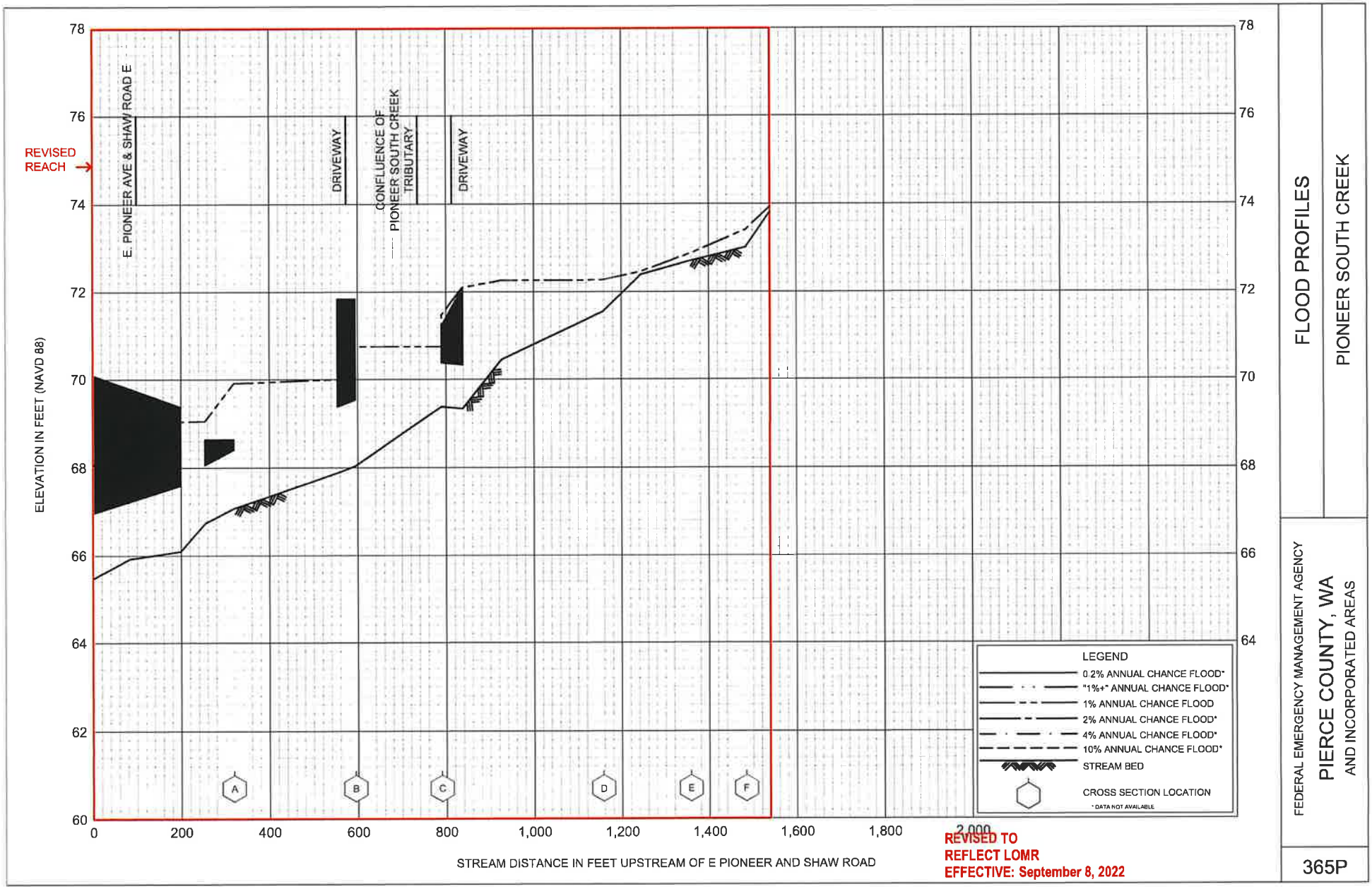
DEER CREEK - PIONEER

FEDERAL EMERGENCY MANAGEMENT AGENCY

PIERCE COUNTY, WA

AND INCORPORATED ARES

363P



REVISED TO REFLECT LOMR EFFECTIVE: September 8, 2022

FLOOD PROFILES

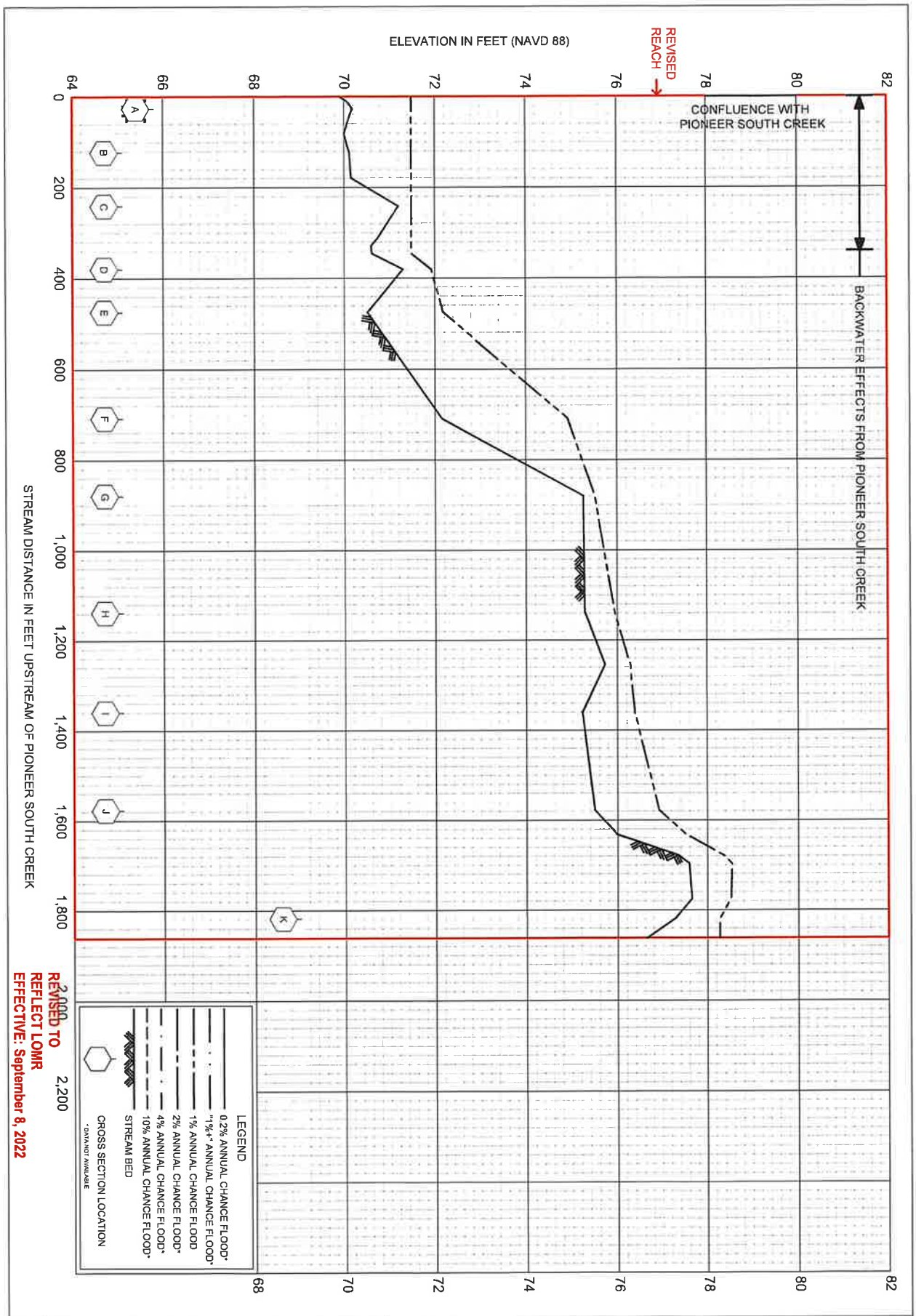
PIONEER SOUTH CREEK

FEDERAL EMERGENCY MANAGEMENT AGENCY

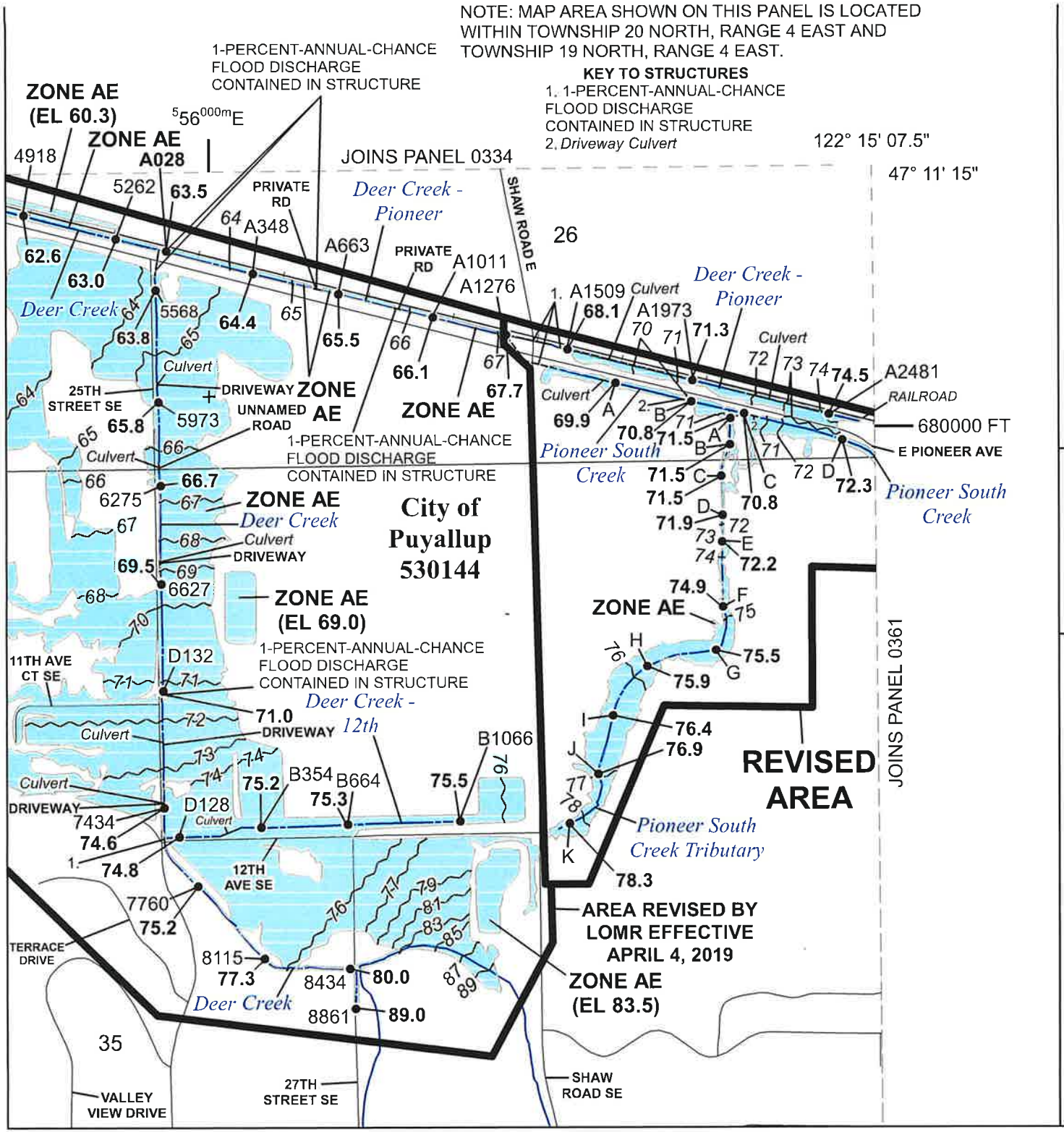
PIERCE COUNTY, WA

AND INCORPORATED AREAS

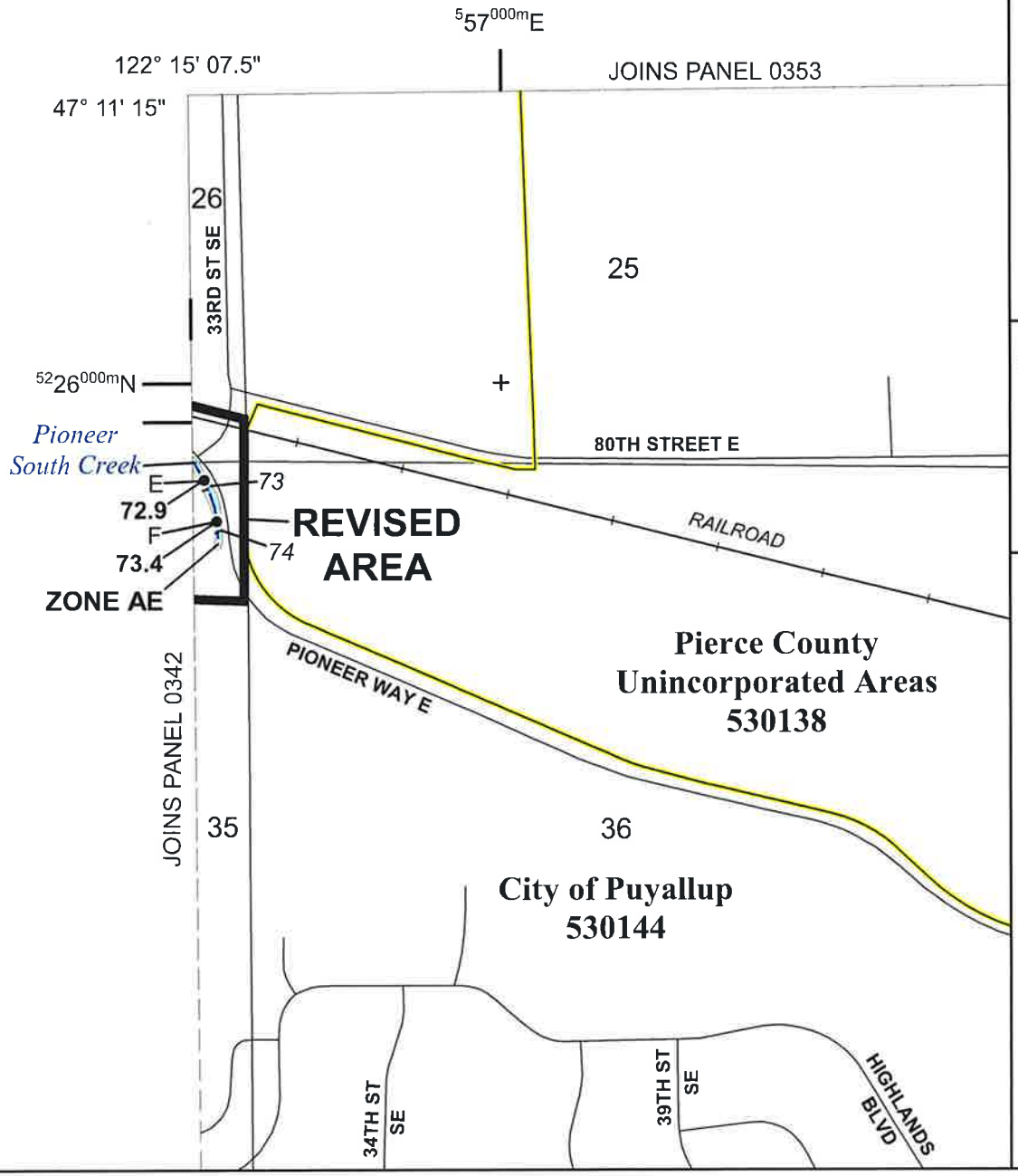
365P



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”