

# Shao Short Plat Drainage Report

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## **Contractor**

Not yet selected

April 21, 2026

### **Project Engineer's Certification**

I hereby state that this stormwater site plan for this 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 the City of Puyallup does not and will not assume liability for the sufficiency, suitability, or performance of drainage facilities designed by me.

This report has been prepared for review by the City of Puyallup (City) in accordance with the Department of Ecology's 2019 Stormwater Management Manual for Western Washington as adopted by PMC 21.10.040 (Manual).



# Table of Contents

## Drainage Report

|                                                                |    |
|----------------------------------------------------------------|----|
| Section 1: Proposed Project Overview.....                      | 1  |
| Project Thresholds .....                                       | 1  |
| Minimum Requirements.....                                      | 2  |
| Preparation of Stormwater Site Plan.....                       | 3  |
| Construction Stormwater Pollution Prevention .....             | 3  |
| Source Control of Pollution.....                               | 3  |
| Preservation of Natural Drainage Systems and Outfalls.....     | 3  |
| On-Site Stormwater Management.....                             | 3  |
| Runoff Treatment.....                                          | 5  |
| Performance Goals and Target Surfaces.....                     | 5  |
| Water Quality Measures and Sizing.....                         | 6  |
| Flow Control.....                                              | 6  |
| Wetlands Protection .....                                      | 8  |
| Operation and Maintenance .....                                | 8  |
| Section 2: Existing Conditions .....                           | 8  |
| Topography .....                                               | 8  |
| Hydrologic Patterns .....                                      | 8  |
| Threshold Discharge Areas.....                                 | 9  |
| Section 3: Soil Investigations and Characteristics .....       | 9  |
| Section 4: Wells and Septic Systems .....                      | 10 |
| Section 5: Fuel Tanks .....                                    | 10 |
| Section 6: Subbasin Description.....                           | 10 |
| Section 7: Floodplain Analysis .....                           | 10 |
| Section 8: Aesthetic Considerations for Facilities.....        | 10 |
| Section 9: Facility Sizing and Downstream Analysis.....        | 10 |
| Facility Sizing.....                                           | 10 |
| Downspout Infiltration Trenches.....                           | 10 |
| Permeable Pavement.....                                        | 11 |
| Sheet Flow Dispersion .....                                    | 11 |
| Conveyance Sizing .....                                        | 12 |
| Downstream Analysis .....                                      | 12 |
| Shaw Road TDA .....                                            | 12 |
| Crystal Ridge TDA.....                                         | 12 |
| Section 10: Utilities .....                                    | 13 |
| Section 11: Covenants, Dedications, and Easements .....        | 13 |
| Section 12: Other Permits or Conditions Placed on Project..... | 13 |

## List of Figures

|                                                        |     |
|--------------------------------------------------------|-----|
| Figure A-1: Determination of Minimum Requirements..... | A-2 |
| Figure A-2: Minimum Requirement #5 .....               | A-3 |
| Figure A-3: FEMA Map.....                              | A-4 |
| Figure A-4: Downstream Flow Path.....                  | A-5 |

|                                              |     |
|----------------------------------------------|-----|
| Figure A-5: Pre-Development Conditions ..... | A-6 |
| Figure A-6: Post-Development Conditions..... | A-7 |

## List of Tables

|                                         |   |
|-----------------------------------------|---|
| Table 1: Project Location.....          | 1 |
| Table 2: Project Threshold Summary..... | 2 |

## Appendixes

|                                                              |     |
|--------------------------------------------------------------|-----|
| Appendix A: Figures and Maps.....                            | A-1 |
| Appendix B: Project Plans .....                              | B-1 |
| Appendix C: Construction SWPPP .....                         | C-1 |
| Appendix D: Soils Report.....                                | D-1 |
| Appendix E: Flow Control and Water Quality Calculations..... | E-1 |
| Appendix F: Conveyance Calculations .....                    | F-1 |



## Section 1: Proposed Project Overview

This drainage report has been prepared to support development permit applications associated with the build-out of a recently approved infill short plat. The subject property was previously a single piece of land that has been divided into five contiguous parcels, four of which are building lots and one of which is a private tract for access and utilities. Table 1 contains identifiers for the subject property in effect at this time.

**Table 1: Project Location**

| <b>Tax Parcel No.</b> | <b>Address No.</b> | <b>Short Plat Lot No.</b>  |
|-----------------------|--------------------|----------------------------|
| 0419025023            | 3109               | 1                          |
| 0419025024            | 3117               | 2                          |
| 0419025025            | 3125               | 3                          |
| 0419025026            | 3133               | 4                          |
| 0419025027            | NA                 | Access and Utilities Tract |

The combined property has an overall area of about 1.578 acres according to a recent survey of the site. It is zoned RS-10 Residential. The site is located in the Northeast Quarter of Section 2, Township 19 North, Range 04 East, W.M. A vicinity map is included with the plans.

The scope of the present proposal is to construct the required street improvements on 24<sup>th</sup> Avenue Court Southeast. This includes curb, gutter, sidewalk, and paving improvements and street trees. In addition, sewer and water connections will be stubbed to each of the new lots. The work also includes construction of on-site drainage systems that will make each lot “build-ready.” Individual lot driveways and sidewalks are deferred to the building permit stage along with the buildings themselves.

The scope of this report will be not only to provide code analysis for the street improvements, but also to show that stormwater codes can be satisfied using reasonable assumptions about build-out of the individual lots, even though the exact details of that future work are still forthcoming.

### ***Project Thresholds***

The project will create or permit hard surfaces on-site and “off-site.” Off-site work is defined to be any work within the public right-of-way. The site area is the total area of the subject property. The project site area is defined as the portion of the subject property and parts of adjacent right-of-way which are affected by construction activities.

Table 2 shows a summary of the regulated surfaces for the proposed project. Figure A-5 shows the existing conditions and Figure A-6 shows the proposed, developed conditions.

**Table 1: Project Threshold Summary**

| Description                                                      | Area (SF)          |                      |                    |
|------------------------------------------------------------------|--------------------|----------------------|--------------------|
|                                                                  | Shaw Road TDA      | Crystal Ridge Dr TDA | Total              |
| <i>Existing Conditions</i>                                       |                    |                      |                    |
| Site Area (ft <sup>2</sup> )                                     | 4,650              | 72,233               | 76,883             |
| Project Site Area (ft <sup>2</sup> )                             | 4,650              | 43,103               | 47,753             |
| Total Hard Surface (ft <sup>2</sup> )                            | 4,650              | 3,922                | 8,572              |
| Native Vegetation (ft <sup>2</sup> )                             | 0                  | 0                    | 0                  |
| Non-Native Vegetation and Pasture (ft <sup>2</sup> )             | 0                  | 19,590               | 19,590             |
| Lawn and Landscape (ft <sup>2</sup> )                            | 0                  | 19,591               | 19,591             |
| Hard Surface Coverage (%)                                        | 100                | 9.1                  | 18.0               |
| <i>Proposed Conditions</i>                                       |                    |                      |                    |
| New PGHS <sup>1</sup> (ft <sup>2</sup> ) (678+6000-3266 = 3412)  | 0                  | 3,412                | 3,412              |
| New Non-PGHS (ft <sup>2</sup> ) (9600+1800-656 = 10744)          | 980                | 10,744               | 11,724             |
| Total New Hard Surfaces                                          | 980                | 14,156               | 15,136             |
| Replaced PGHS (ft <sup>2</sup> )                                 | 2,387              | 3,266                | 5,653              |
| Replaced Non-PGHS (ft <sup>2</sup> )                             | 0                  | 656                  | 656                |
| Total Replaced Hard Surfaces                                     | 2,387              | 3,922                | 6,309              |
| New + Replaced Hard Surface (ft <sup>2</sup> )                   | 3,367              | 18,078               | 21,445             |
| New + Replaced PGHS (ft <sup>2</sup> )                           | 2,387              | 6,678                | 9,065              |
| Vegetation (Any) to Lawn/Landscape (ft <sup>2</sup> )            | 0                  | 3,007                | 3,007              |
| Native Vegetation to Pasture (ft <sup>2</sup> )                  | 0                  | 0                    | 0 <sup>2</sup>     |
| New + Replaced HS + Converted Vegetation (ft <sup>2</sup> )      | 3,367              | 21,085               | 24,452             |
| New HS + Converted Vegetation (ft <sup>2</sup> )                 | 980                | 17,163               | 18,143             |
| Existing Hard Surface Converted to Vegetation (ft <sup>2</sup> ) | 0                  | 0                    | 0                  |
| Existing Native Vegetation to Remain (ft <sup>2</sup> )          | 0                  | 0                    | 0 <sup>2</sup>     |
| Existing Vegetation to Remain (ft <sup>2</sup> )                 | 0                  | 0                    | 0                  |
| Existing Hard Surface to Remain Unaltered (ft <sup>2</sup> )     | 2,524              | 0                    | 2,524 <sup>4</sup> |
| Existing Lawn and Landscape to Remain (ft <sup>2</sup> )         | 1,186              | 19,591               | 20,777             |
| Land Disturbed (ft <sup>2</sup> )                                | 4,553 <sup>3</sup> | 40,676 <sup>3</sup>  | 45,229             |

1. Pollution-generating hard surface
2. Pre-development condition undeveloped areas assumed to be 50% lawn and landscaping, 50% non-native vegetation
3. Reflects a slight change in areas between TDAs
4. Area of grind and overlay is not considered a replaced surface

### Minimum Requirements

The site is currently developed and in use as a single-family residence. But because the total impervious area of the site is less than 35 percent, we interpret the project to be regulated as new development from a stormwater perspective. Therefore, the determination of applicable minimum requirements is made using Figure I-3.1. According to that figure (see Figure A-1), all minimum requirements apply to the new and replaced hard surfaces and converted vegetation.

The following narrative demonstrates how the project meets each of the minimum requirements.

#### *Minimum Requirement #1 – Preparation of Stormwater Site Plan*

This document and its accompanying attachments satisfy this requirement.

#### *Minimum Requirement #2 – Construction Stormwater Pollution Prevention*

The attached Construction Stormwater Pollution Prevention Plan document and the project plans satisfy this requirement.

#### *Minimum Requirement #3 – Source Control of Pollution*

The end use of the site is single-family residential. The development of detailed source control specifications for homeowners is not required. This is reserved for commercial and industrial sites with special uses that present a greater risk to contamination of stormwater. Some basic source control measures for homeowners can be included in the project's separate operation and maintenance document.

#### *Minimum Requirement #4 – Preservation of Natural Drainage Systems and Outfalls*

The proposed project would not alter any existing drainage systems or flow paths. The prevailing topography of the property will not be changed.

A small amount of undeveloped surface area within the City's right-of-way is currently part of the Crystal Ridge Drive threshold discharge area (TDA). The entire area within the City's right-of-way adjacent to the project site will be converted to the Shaw Road TDA. The redirection affects an area of about 2,400 square feet, which is about 5 percent of the overall project site area and 3 percent of the total property area. This redirection is necessary to accommodate the City's required right-of-way improvements (primarily sidewalk). It has no material impact on downstream receiving waters or municipal storm systems.

#### *Minimum Requirement #5 – On-Site Stormwater Management*

According to Figure I-3.3 of the Manual (see Figure A-2), this project is required to either apply BMPs from List #2 or satisfy the Low-Impact Development (LID) Standard per Section 2.4.5 of Volume 1. The project has chosen to apply BMPs from List #2. The narrative below demonstrates how BMPs are selected from the list for each regulated surface type.

1. Lawn and landscape areas: Application of BMP T5.13 for soil preservation and amendment is feasible and will be used for these areas.

2. Roof Surfaces: BMP T5.10A Downspout Full Infiltration is feasible and will be used for all new roof surfaces on the individual lots.
3. Other hard surfaces

Target hard surfaces in this category include:

- The regulated street and sidewalk surfaces associated with utility connections and street improvements within 24<sup>th</sup> Avenue Court Southeast
- The on-site, private driveway and parking areas
- Areas of uncovered sidewalks

The exact configuration and amount of regulated hard surfaces on each building lot is not known at this time. The feasibility or infeasibility of specific BMPs can only be determined once the exact amount and configuration of surfaces are known, which will occur at building permit stage. However, we can make reasonable assumptions about these parameters now to prove the feasibility of the project in general. These assumptions are shown on Figure A-6. In general:

- We have assumed that all driveway and parking surfaces on individual lots up to the back of walk will be constructed of permeable material infiltrating to 100 percent
- We have assumed that non-roof, non-PGHS surfaces like sidewalks, patios, decks, etc. can be treated using sheet flow dispersion

The following feasibility analysis is based on Figure A-6 and the foregoing assumptions.

- a. BMP T5.30 Full Dispersion  
Full dispersion of the target surfaces in this category is not feasible at this property because the property does not contain sufficient native vegetation downstream of the surfaces.
- b. BMP T5.15 Permeable Pavement  
Permeable pavement is feasible for the private driving and parking surfaces to be built on each lot. The feasibility of permeable pavement for non-PGHS surfaces on each lot will need to be evaluated at time of building permit. For example, a patio might be able to be constructed from pavers, but an elevated deck would not be able to use this BMP to meet MR5.

Permeable pavement is not appropriate for use within the public right-of-way because the pavement is directly adjacent/contiguous to existing, conventional pavement. Introduction of water into the subbase would accelerate the pavement lifecycle for the remaining conventional pavement adjacent to the new permeable pavement. Permeable pavement is not

proposed for a small amount of driveway replacement on Lot 1 for the same reason.

c. BMP T7.30 Bioretention

Bioretention is not a practical option for the remaining sidewalk target surfaces because it is not practical to collect the runoff from these small, scattered areas. Additionally, the factored infiltration rate for the areas where bioretention could be installed are very low (0.18 inches per hour), according to the geotechnical report. Given the limited space available for bioretention, the systems would not be effective for anything but the smallest of storm events.

Add commentary specifically addressing the replaced driveway on Lot 1 and bioretention feasibility.

d. BMP T5.12 Sheet Flow Dispersion

Sheet flow dispersion is assumed to be likely feasible for most or all of the future non-PGHS surfaces on individual lots, but the feasibility must be verified at time of building permit application.

Sheet flow dispersion is feasible and proposed for a small portion of Lot 1 driveway private surfaces to be re-configured for installation of utilities and connection to the new street improvements.

Sheet flow dispersion for target surfaces within the right-of-way is not feasible because space for an adequate dispersion flow path is lacking.

*Minimum Requirement #6 – Runoff Treatment*

Since this project is distributed between two TDAs, each TDA is examined individually for thresholds that would trigger stormwater treatment.

- In the Shaw Road TDA, the amount of total new and replaced PGHS is less than 5,000 square feet. Therefore, stormwater treatment is not required in the Shaw Road TDA.
- The total new and replaced PGHS within the Crystal Ridge Drive TDA exceeds 5,000 square feet, so stormwater treatment is required for PGHS within this TDA.

See Figure A-6 for both TDAs in post-development condition.

*Performance Goals and Target Surfaces*

This project is residential in nature. By definition, it is not a commercial or industrial site. It is not a multi-family residential site either, especially as it relates to residential density and traffic. Low-density residential is not considered a high-load contributor of dissolved metals. The project discharges indirectly through groundwater, dispersion, and a City municipal system to Upper Deer Creek.

The project does not reach thresholds for compliance with oil control or phosphorus treatment. Therefore in light of the foregoing, we interpret the project to be subject to basic water quality requirements, with treatment focused on the removal of suspended solids.

#### *Water Quality Measures and Sizing*

Sand filtration is proposed to meet the water quality requirement for this project. The Manual allows for the installation of a 6-inch thick, clean sand layer at the bottom of permeable pavement structures for the purposes of meeting water quality. The sand filtration layer does not require sizing; 6 inches thickness is the standard, prescriptive size.

Modeling included in Appendix E shows that 100 percent of the influent runoff can be successfully infiltrated by the system. Water quality is considered to have been met when at least 91 percent of the influent runoff file is infiltrated. It should be noted that this sizing is general in nature, intended to prove feasibility for a specific pavement section. This pavement section should be strictly enforced for each individual lot building permit unless further engineering can show equivalent performance through some other allowable method.

*A note on the replaced driveway surface for lot 1:* The small amount of replaced PGHS on Lot 1 associated with removal and replacement of the private driveway surface is proposed to be mitigated using sheet flow dispersion. A minimum of 20 feet of dispersion path through adjacent vegetation is required for the sheet flow dispersion BMP. Suspended solids in shallow sheet flow will settle out of stormwater as it traverses the vegetation through conversion to interflow and vegetative filtration.

#### *Minimum Requirement #7 – Flow Control*

Just like for Minimum Requirement #6, this minimum requirement is evaluated individually for each TDA.

- The total of new and replaced surfaces within the Shaw Road TDA is 3,367 square feet. Therefore, Minimum Requirement #7 is automatically satisfied for this TDA.
- The total of new and replaced surfaces within the Crystal Ridge Drive TDA is 21,455 square feet. Therefore, each of the flow control thresholds needs to be evaluated for this TDA.

The following narrative examines the three thresholds for flow control in the Crystal Ridge Drive TDA.

- **The project generates 10,000 square feet or more of effective hard surface**  
The Manual defines an *effective hard surface* as one whose runoff is neither fully dispersed nor completely infiltrated. As shown through attached modeling, all of

the future surfaces associated with roofs and driveways will be completely infiltrated through the use of infiltration BMPs on-site. If this is the case, then the total *effective* hard surfaces within the Crystal Ridge Drive TDA is 2,478 square feet, which is less than the 10,000 square-foot threshold. Note that this conservatively assumes that none of the future non-PGHS, non-roof surfaces on individual lots can be mitigated as permeable pavement.

- **The project converts  $\frac{3}{4}$  of an acre or more of native vegetation to lawn/landscape, or the project converts 2.5 acres or more of native vegetation to pasture**

The project site area contains no native vegetation. As shown by Figure A-5, the undeveloped portion of the project site area is a mixture of lawn, landscaping, and “non-native vegetation.” The existing project site area contains about 19,600 square feet of non-native vegetation, or about 0.45 acre.

Calculating the amount of converted vegetation is not exactly straightforward because it depends on whether the existing non-native vegetation area becomes lawn and landscaping or impervious surface. As the existing non-native vegetation surfaces are located on individual lots, the exact configurations of surfaces on each lot are not known. However, even if we conservatively assume that all of the existing non-native vegetation becomes lawn and landscaping, this falls beneath the 2.5-acre threshold for flow control duration standards.

- **The project creates more than a 0.15 cubic feet per second (cfs) increase in the peak 100-year flow rate through a combination of pervious and impervious surfaces.**

To determine whether this threshold is exceeded, we modeled the site using continuous runoff simulation software. The pre-development benchmark to be used in this analysis is the more hydrologically conservative of either 1) the immediate, pre-project condition, or 2) the condition of the site when flow control regulations were originally adopted.

For simplicity, we used a fully forested condition for the pre-development benchmark. This is not necessary. But if the project passes this benchmark using the fully forested condition, then it would pass the benchmark on any other pre-development condition.

When calculated according to the foregoing parameters, the proposed condition actually results in a slight *decrease* in the 100-year peak flow. This is underneath the allowed maximum *increase* of 0.15 cfs. Therefore, the Crystal Ridge Drive TDA of the project does not trigger this flow control threshold. Figure A-6 shows the modeling assumptions used to complete the calculations. The calculations are included in Appendix E.

Based on the foregoing, the project does not need to meet flow duration standards in either TDA.



### *Minimum Requirement #8 – Wetlands Protection*

This project is not known to discharge directly or indirectly to a wetland.

### *Minimum Requirement #9 – Operation and Maintenance*

The creation of maintenance and source control documents should be deferred to the building permit stage so that each lot can benefit from an individualized map and instructions. Only a general, non-specific maintenance document could be generated at this time since the nature and configuration of future building permit surfaces is not known.

If the City would prefer a non-specific maintenance document, please include instructions for the preparation of the document with review.

## **Section 2: Existing Conditions**

The project site is currently developed and in use as a single-family residence. Land cover at the site consists of a mix of developed areas, lawn and landscaping, and brushy areas that we interpret as “non-native vegetation,” hydrologically characteristic of a pasture-type land cover. The property is irregular in shape, with a large rectangular area and a smaller rectangular “off-shoot” on its easy side. The site’s existing access point is from 24<sup>th</sup> Avenue Court Southeast, near the southwest corner of the site. There are no critical areas on the site.

### ***Topography***

Revise-See Short Plat AFN  
202511185002 Note 1, Pg 2 of 2.

The property is gently to moderately sloped. Slopes range from flat to about 50 percent in some isolated areas. There are no regulated steep slope areas on the site. Even though the site has some steeply sloped areas, the total vertical relief in these areas is less than 10 feet. The slopes are localized. Slopes are concentrated primarily along the north property line and on the far east part of the site, away from development activities.

the infiltration facilities appear to be located adjacent to a 40%+ slope with relief greater than 10 feet.

The general trend for topography slopes downward from the south and west to the north and east. The total relief across the site is 40 feet. The total relief across the developed portion of the site is about 10 feet.

### ***Hydrologic Patterns***

Provide geotechnical confirmation that the proposed onsite infiltration trenches will not negatively affect the adjacent downstream slope (min. setback, erosion, stability, etc).

There are no obvious signs of historical flooding. According to maps obtained from the FEMA Flood Map Service Center, the project area is not located within an area of significant flooding concern. We did not note any signs of significant erosion caused by concentrated surface flows. The site is part of an aquifer recharge area.



### ***Threshold Discharge Areas***

The project area is comprised of two separate threshold discharge areas. The dividing line between the two threshold discharge areas is approximately coincident with the extent of the public road driving surface in 24<sup>th</sup> Avenue Court Southeast. After improvements to the street, the dividing line will be at the back of the new sidewalk, which is coincident with the south property line of the subject property.

Drainage originating to the south of the dividing line is tributary to the City's Shaw Road drainage system. This drainage travels north through the Shaw Road corridor. Therefore, this TDA is referred to as the Shaw Road TDA. Drainage from the rest of the project site area is indirectly tributary to the City's drainage system in Crystal Ridge Drive or Upper Deer Creek. This TDA is referred to as the Crystal Ridge Drive TDA. The vast majority of the project site area is within the Crystal Ridge Drive TDA, both in the pre- and post-development condition.

### **Section 3: Soils Investigation and Characteristics**

Soils on the site were studied by a licensed geotechnical engineer several times beginning in early 2024. The first course of study at the site included the observation and logging of eight test pits evenly distributed across the site area and one small-scale pilot infiltration test located in the rear yard of the existing home. The depth of exploration varied, but generally was around 7 feet below ground surface.

The test holes generally found that the majority of the site has been filled in the past. Fill material was documented as being relatively clean and free of debris. The geotechnical engineer classified the fill material as silty sand, sometimes with cobbles. The fill layers were mixed with topsoil layers, in some cases interwoven more than once in the same test hole. Underlying native soils were found to be glacial till except on the east side of the site, where soils more consistent with recessional outwash were documented.

The results of the first small-scale PIT returned a design rate of 0.18 inches per hour after application of safety factors, the selection of which is documented by the geotechnical engineer. This low rate is reasonable given the variability of soils across the site and the presence of undocumented fill that is somewhat inconsistent in thickness across the site.

The geotechnical engineer returned to the site in the latter part of 2024 to complete a second small-scale PIT near the more favorable soils encountered in test holes 7 and 8 on the east side of the site during the first course of explorations. The goal of this exploration was to find soils which would better support infiltration, since the first infiltration test resulted in such a low factored rate.

The soils on the east side of the site were found to be a better candidate for infiltration, with soils being more uniform, less altered by previous development, and having a higher rate. The small-scale PIT returned a factored rate of 4.2 inches per hour for trenches located on the east side of the site near the test location.

A complete soils report is attached as Appendix D.

## **Section 4: Wells and Septic Systems**

There are no wells or septic systems on or nearby the site, to the best of our knowledge.

## **Section 5: Fuel Tanks**

No fuel tanks are known to exist at the site and none are proposed for this project.

## **Section 6: Subbasin Description**

The site is generally part of a developed, suburban upland area with no remarkable or noteworthy drainage characteristics. Runoff is expected to follow prevailing topographic trends to the north and east as unconcentrated sheet flow or interflow.

The potential for significant run-on to the site is limited. Runoff which might otherwise enter the site from the south and west is intercepted by City drainage systems within the improved streets on those sides of the property. Only incidental, unconcentrated sheet flow from undeveloped areas is expected from the northwest side of the site. The same is true for the southeast side of the site.

Runoff leaving the site is expected to travel north and east, either as unconcentrated surface flow or as interflow. See Section 9 for a complete downstream analysis.

## **Section 7: Floodplain Analysis**

According to maps obtained from the FEMA Flood Map Service Center, there are no regulated flood hazards on or near the property. Figure A-3 includes a FEMA map.

## **Section 8: Aesthetic Considerations for Facilities**

No aesthetic themes beyond the typical and customary have been considered for this project.

## **Section 9: Facility Sizing and Downstream Analysis**

### ***Facility Sizing***

Stormwater facilities and BMPs which require sizing are as follows:

- Downspout infiltration trenches
- Permeable pavement
- Sheet flow dispersion

### ***Downspout Infiltration Trenches***

Downspout infiltration trenches are located on the east side of the site, as close as possible to the second infiltration test completed at the site for purposes of designing these trenches. The trenches are sized for 100 percent infiltration using a contributing roof surface area of

3,200 square feet. Since the exact sizes of future buildings to be built on each lot are not known, this estimate represents a reasonable, speculative maximum roof surface area. Modeling attached in Appendix E shows that the proposed trenches achieve 100 percent infiltration. The modeling assumes that the maximum roof area allowed is constructed on each building lot.

#### *Permeable Pavement*

Modeling in Appendix E contains calculations for the proposed permeable pavement. This modeling is generalized to provide a standard pavement section that can be used to review future building permit applications. The modeling uses the following parameters:

- A total area of 6,000 square feet is assumed, consistent with Figure A-6.
- The modeling uses the less favorable rate of 0.18 inches per hour obtained through the first infiltration test, which more conservatively represents the site and allows for the most flexibility in actual routing of the driveways for future building permits
- Because the native soil infiltration rate is less than the filtration rate through the sand filter, the sand filter is not included in the model. This is a slightly conservative simplification because in reality, the sand filter would add a small (but not negligible) amount of storage to the permeable pavement system.
- The pavement is modeled with a slope of 2 percent.

The City should consider that the pavement is essentially “self-mitigating.” The basis for using 6,000 square feet of estimated driveway surface for the project is clearly illustrated on Figure A-6. But if more driveway surface is constructed, the effect is to decrease flows leaving the site. With the inclusion of the sand filter, water quality requirements are satisfied. Therefore, the 6,000 square-foot estimate should not be interpreted as a maximum allowable, provided all surfaces are permeable.

While the intent of this analysis is to minimize the amount of engineering and technical review required for each permit, some detailing will be necessary at the building permit stage to accommodate the finished grades of each site. If the infiltration rates were more favorable, slopes would not be as important to the analysis. But given the poor rate of infiltration, sloped areas need to be properly stepped or dammed and the modeling should be adjusted for each site-specific parameter as the lot build-out becomes clear.

#### *Sheet Flow Dispersion*

Figure A-6 shows the area of sheet flow dispersion being used for the driveway replacement area on Lot 1. Sheet flow dispersion is sized prescriptively, requiring 10 feet of dispersion pathway for every 20 feet of contributing impervious surface as measured parallel to the flow’s direction.

It is conservatively assumed that all future non-roof, non-PGHS surfaces on individual building lots will employ sheet flow dispersion for mitigation on the individual lot (such as patios, sidewalks, decks, etc.). The feasibility of permeable pavement should be evaluated

for each surface under each building permit application. But for now and for the most conservative analysis possible, we assumed sheet flow dispersion, as that would provide less flow control credit.

The overall calculations in Appendix E treat sheet flow dispersion areas as land cover C Lawn. From the calculations, it is clear that even if the maximum allowable surfaces are realized and absolutely no infiltration BMPs are feasible, the project will still be very conservatively within the limits of applicable flow control thresholds.

### ***Conveyance Sizing***

This project does not include any significant collection systems that require involved sizing calculations. The only conveyance systems proposed for the project are small-diameter roof drain pipes which will carry roof runoff from each lot to the infiltration systems. These pipes are proposed to be PVC 4 inches in diameter laid at a minimum slope of 2 percent. A calculation is included in Appendix F to verify that the proposed piping is adequate for the maximum 3,200 square feet of conveyed roof surfaces.

### ***Downstream Analysis***

Because this project has two threshold discharge areas, there are two downstream analyses completed for the project. A map of the downstream flow paths is included as Figure A-4.

#### ***Shaw Road TDA***

The Shaw Road TDA consists exclusively of improvements within the public right-of-way in 24<sup>th</sup> Avenue Court Southeast. Drainage from this area enters the City storm system from catch basins within 24<sup>th</sup> Avenue Court Southeast which direct flow underground to the Shaw Road drainage system. Pipes within 24<sup>th</sup> Avenue Court Southeast are 12 inches in diameter.

The first main-line pipe diameter the flow encounters within Shaw Road is 18 inches in diameter. The pipe increases to 24 inches in diameter at the intersection of 23<sup>rd</sup> Avenue Southeast and Shaw Road, about 500 feet downstream of 24<sup>th</sup> Avenue Court Southeast. Once north of the intersection, the pipe actually decreases steadily in diameter from 24 to 18 to 12 inches, but the slope of the pipe system increases significantly through this stretch of Shaw Road. The system ultimately daylight to Upper Deer Creek, a distance of about 1,800 feet north of the project area, or just over 1/3 of a mile downstream.

#### ***Crystal Ridge Drive TDA***

The Crystal Ridge TDA consists of the entire project site area besides the right-of-way in 24<sup>th</sup> Avenue Court Southeast. For intents and purposes of review, it is the private property part of the site. While it is expected that no significant surface flows will leave the site due to implementation of stormwater management BMPs on the site, any surface runoff that did leave the site would leave to the north and east as unconcentrated sheet flow. The rest of

the drainage in this part of the site will be converted to interflow or subsurface/ groundwater.

Regardless of the manner in which drainage leaves the site, it is expected to directly or indirectly reach Upper Deer Creek to the north and east, at about the location where Crystal Ridge Drive passes over the creek. Any surface drainage would be intercepted by the City's system in Crystal Ridge Drive Southeast. The City's drainage system in this corridor consists of main-line pipe diameters of 12 inches for all segments. The last stretch of the system is surface channels north and east of catch basin D4-03974 to Upper Deer Creek. The total distance of flow from the site to this point is about ¼ mile.

Flow from the Crystal Ridge TDA flows within Upper Deer Creek to the north and west for a distance of about 1,500 feet along the creek route before it reaches the point at which flows from the Shaw Road TDA reach the creek. Since this point of recombination is more than ¼ mile from the project site as measured along either flow path, this analysis confirms that the two TDAs are in fact legally separated, as defined by the Manual.

A figure of the downstream flow path is shown in Figure A-4.

## **Section 10: Utilities**

The new buildings will be connected to public water, sewer, and power utilities. Natural gas is located in 14<sup>th</sup> Avenue Court Southeast. Connections to natural gas are not anticipated at this time. Utility connections will be completed during the short plat improvements phase and will be stubbed to each lot.

## **Section 11: Covenants, Dedications, and Easements**

The City should require the development of plat covenants to ensure that the division of maintenance responsibility is clear between owners. This is important because some BMPs will be shared, but some will serve single lots only. Additionally, BMPs which provide benefits to the lots are not all located on the respective lots that they benefit. Therefore, easements will also be important. An attorney should be retained to develop these documents with the assistance of the civil engineer and surveyor.

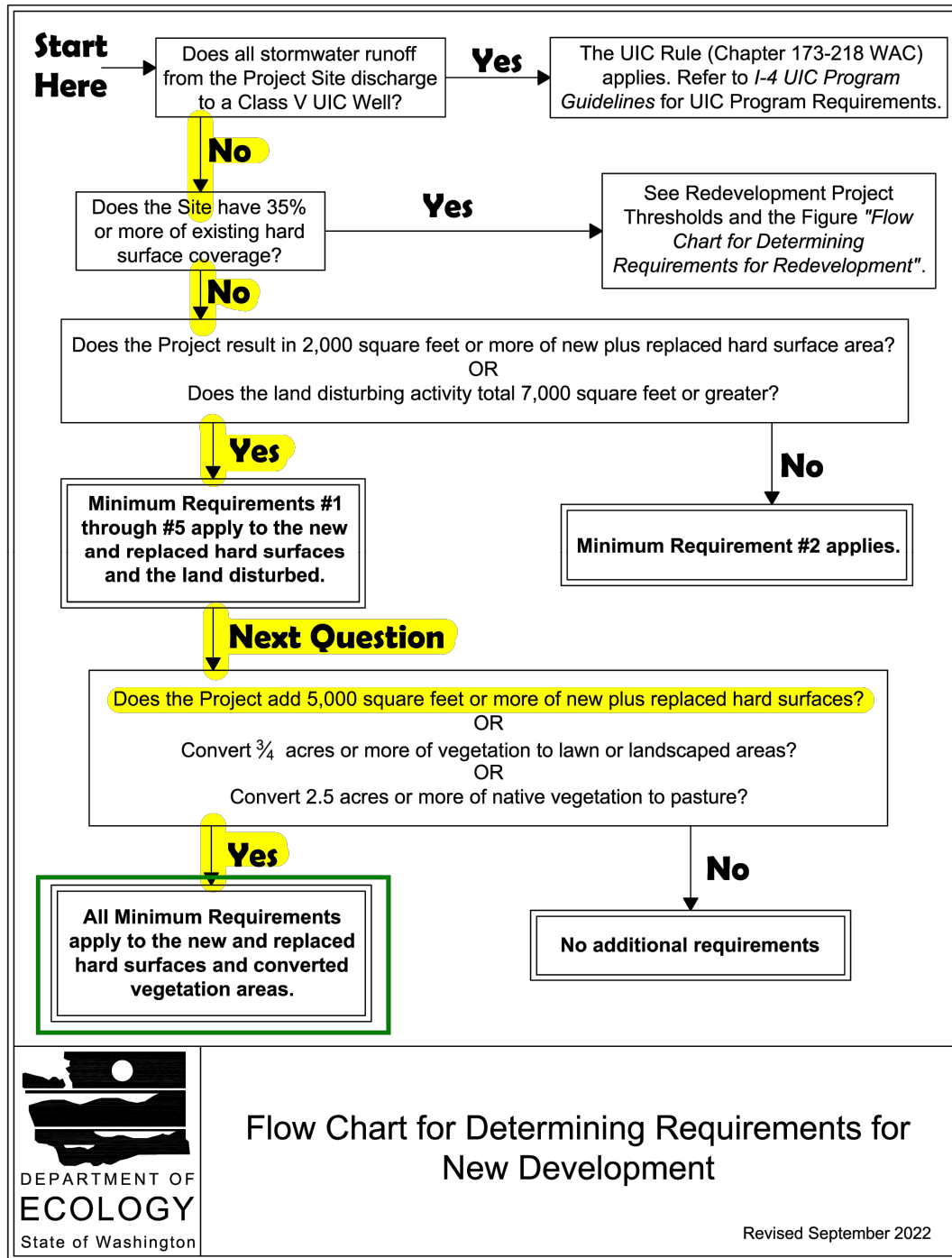
## **Section 12: Other Permits or Conditions Placed on Project**

Coverage under the State's Construction Stormwater General Permit will be required because the cumulative disturbed area for the project exceeds one acre. Besides that, permits and approvals from other agencies are not known to be needed for this project.

## **Appendix A: Figures and Maps**

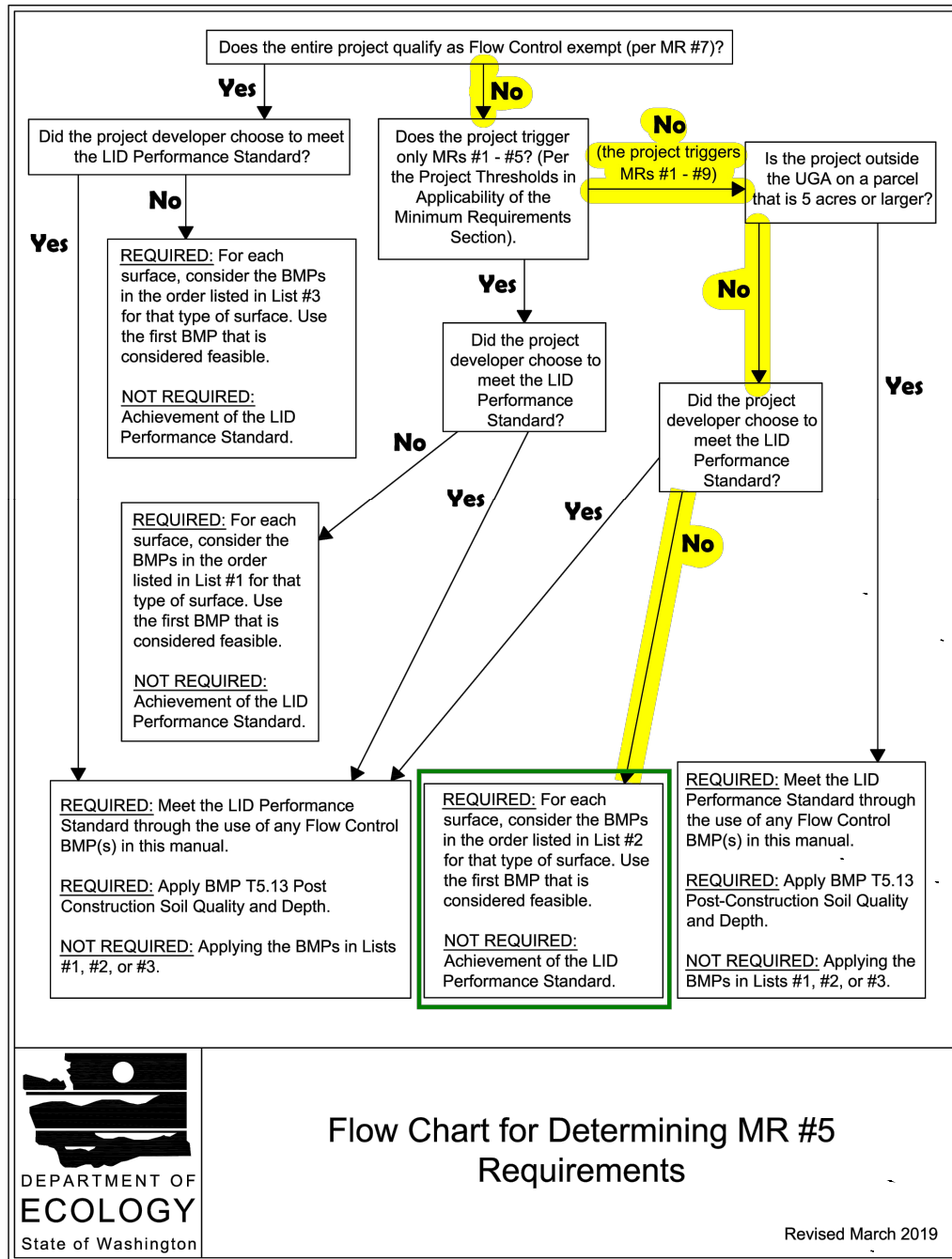
*Attached*

**Figure I-3.1: Flow Chart for Determining Requirements for New Development**

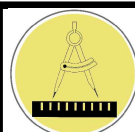


SHAO SHORT PLAT  
3109 24TH AVENUE COURT SE  
PUYALLUP, WA 98374  
TAX PARCEL NO. 0419025023

**Figure I-3.3: Flow Chart for Determining MR #5 Requirements**



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PUYALLUP, WA 98374  
TAX PARCEL NO. 0419025023



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STORMWATER SITE PLAN  
MINIMUM REQUIREMENT #5

PROJECT NO: 2026-001

DATE: APRIL 21, 2026

FIGURE

A-2

PAGE

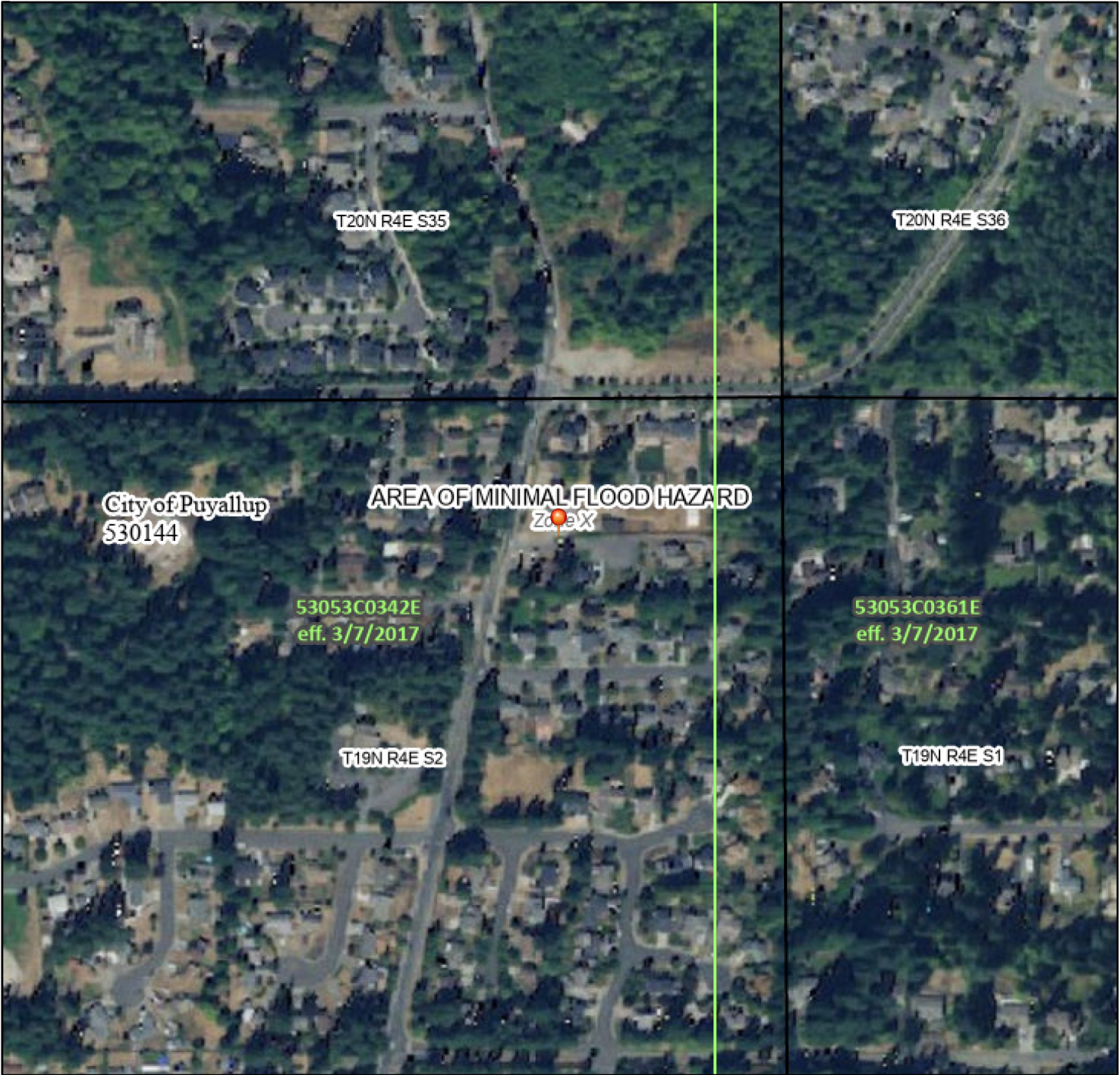
A-3



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# National Flood Hazard Layer FIRMette

122°15'28"W 47°10'20"N



## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

|                             |  |                                                                                                                                                                   |
|-----------------------------|--|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SPECIAL FLOOD HAZARD AREAS  |  | Without Base Flood Elevation (BFE)<br>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                                                                                                      |
|                             |  | Area with Flood Risk due to Levee Zone D                                                                                                                          |
| OTHER AREAS                 |  | NO SCREEN Area of Minimal Flood Hazard Zone X                                                                                                                     |
|                             |  | Effective LOMRs                                                                                                                                                   |
|                             |  | Area of Undetermined Flood Hazard Zone D                                                                                                                          |
| GENERAL STRUCTURES          |  | Channel, Culvert, or Storm Sewer                                                                                                                                  |
|                             |  | Levee, Dike, or Floodwall                                                                                                                                         |
| OTHER FEATURES              |  | 20.2 Cross Sections with 1% Annual Chance Water Surface Elevation                                                                                                 |
|                             |  | 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation                                                                                                 |
|                             |  | Coastal Transect                                                                                                                                                  |
|                             |  | Base Flood Elevation Line (BFE)                                                                                                                                   |
|                             |  | Limit of Study                                                                                                                                                    |
|                             |  | Jurisdiction Boundary                                                                                                                                             |
|                             |  | Coastal Transect Baseline                                                                                                                                         |
| MAP PANELS                  |  | Digital Data Available                                                                                                                                            |
|                             |  | No Digital Data Available                                                                                                                                         |
|                             |  | Unmapped                                                                                                                                                          |
|                             |  | The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.                              |

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/21/2026 at 9:10 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



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TAX PARCEL NO. 0419025023

STORMWATER SITE PLAN  
FEMA MAP

PROJECT NO: 2026-001

DATE: APRIL 21, 2026

FIGURE  
A-3

PAGE  
A-4



POINT OF RECOMBINATION FOR  
FLOWS FROM EACH TDA IS  $> \frac{1}{4}$  MILE  
DOWNSTREAM ON BOTH FLOW PATHS

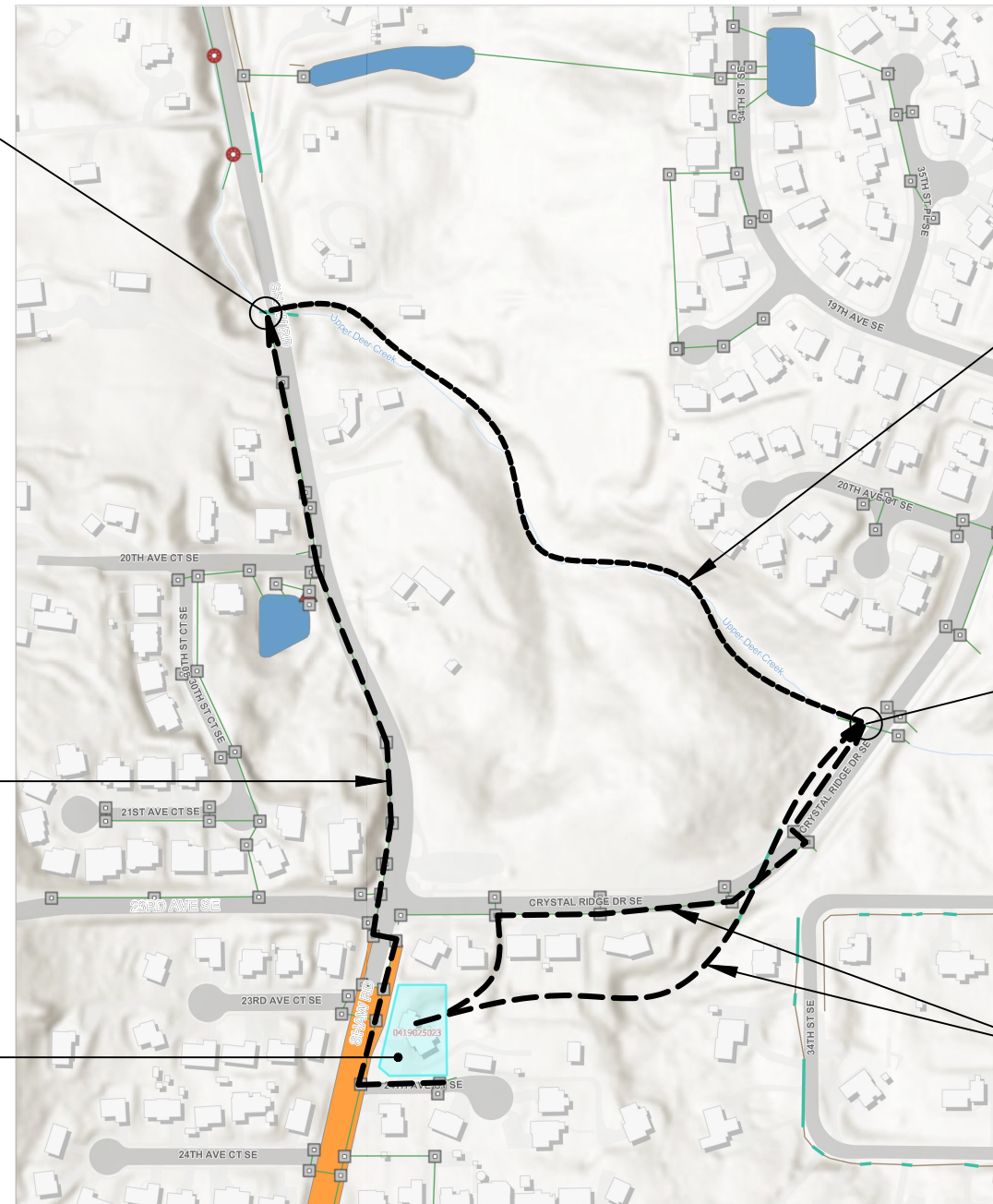
DOWNSTREAM FLOW PATH  
SHAW ROAD TDA  
1,800 FT TO CREEK

PROJECT SITE

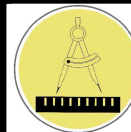
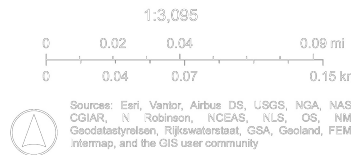
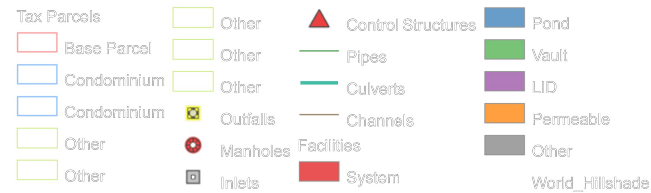
CRYSTAL RIDGE TDA FLOWS  
NEED TO TRAVEL ABOUT  
1,500 FT WITHIN CREEK TO  
REACH SHAW ROAD

ABOUT  $\frac{1}{4}$  MILE TO UPPER  
DEER CREEK FOR CRYSTAL  
RIDGE TDA FLOWS

FLOWS FROM CRYSTAL  
RIDGE TDA CAN TAKE  
TWO PATHWAYS TO GET  
TO UPPER DEER CREEK



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STORMWATER SITE PLAN  
DOWNSTREAM FLOW PATH

PROJECT NO: 2026-001

DATE: APRIL 21, 2026

FIGURE  
A-4  
PAGE  
A-5

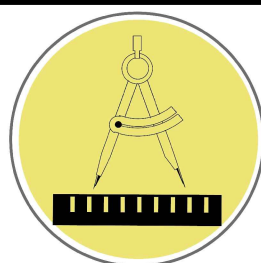
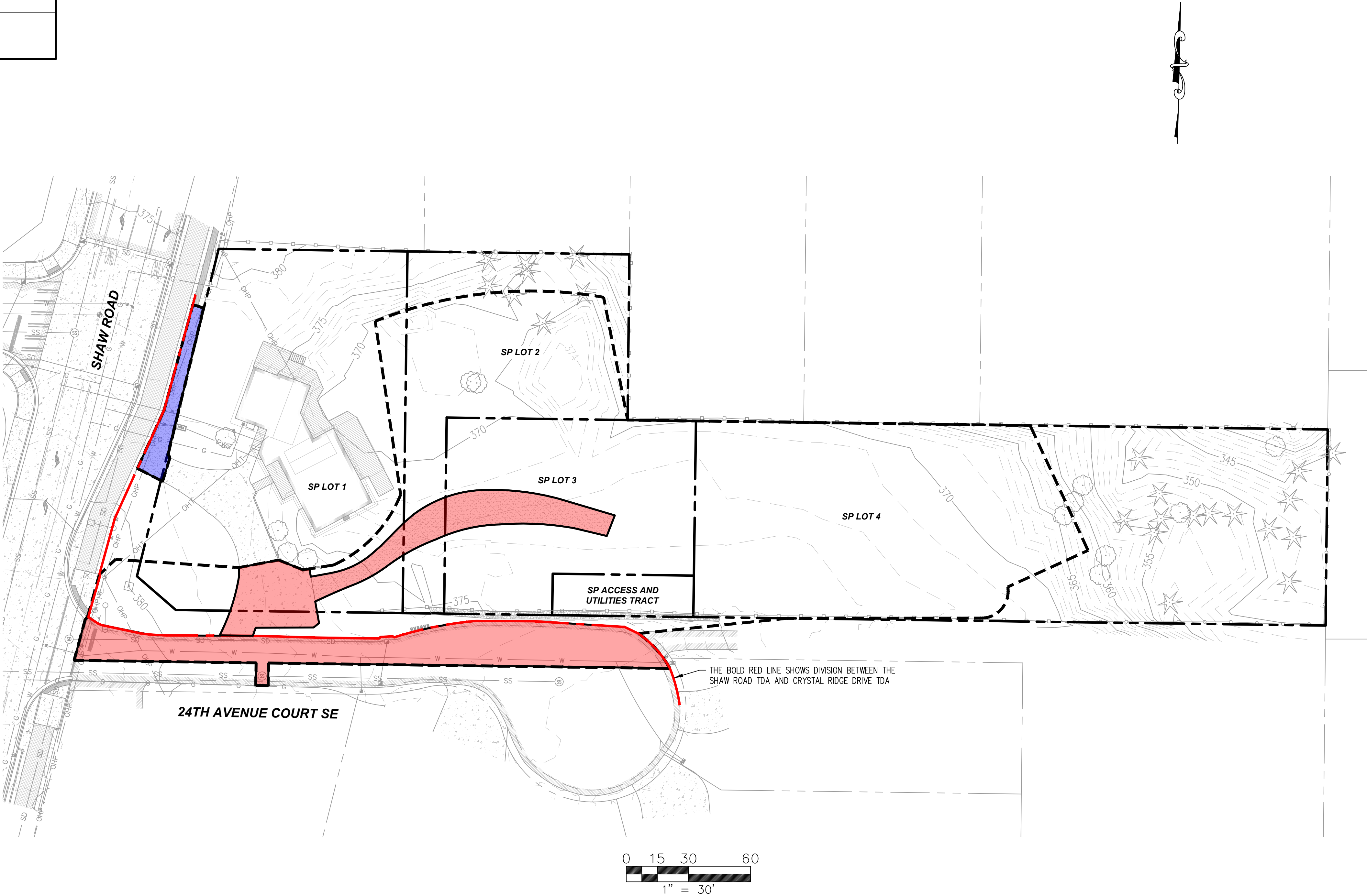


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| SHADING LEGEND                                                                    |                                                                                 |               |              |                                                                       |
|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------|--------------|-----------------------------------------------------------------------|
| LEGEND/COLOR                                                                      | DESCRIPTION                                                                     | AREA (SF)     |              | SWMM DESIGNATION                                                      |
|                                                                                   |                                                                                 | SHAW ROAD TDA | CR DRIVE TDA |                                                                       |
|  | NON-PGHS GRAVEL                                                                 | 0             | 656          | EXISTING NON-PGHS                                                     |
|  | POLLUTION-GENERATING HARD SURFACES                                              | 4,650         | 3,266        | EXISTING PGHS                                                         |
|  | PERVIOUS AREAS ASSUMED TO BE 50% LAWN AND LANDSCAPING 50% NON-NATIVE VEGETATION | 0             | 39,181       | ASSUMED TO BE 50% LAWN AND LANDSCAPE, 50% NON-NATIVE VEGETATION COVER |
|  | TOTAL PROJECT SITE AREA                                                         | 4,650         | 43,103       |                                                                       |

NOTES

1. RETAINING WALLS ARE NOT CONSIDERED TO BE IMPERVIOUS SURFACES UNLESS SUBSTANTIALLY ADJACENT TO AND CONTIGUOUS WITH A HORIZONTAL IMPERVIOUS SURFACE.



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SHAO SHORT PLAT  
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TAX PARCEL NO. 0419025023

STORMWATER SITE PLAN  
PRE-DEVELOPMENT CONDITIONS

PROJECT NO: 2026-001

DATE: APRIL 20, 2026

FIGURE

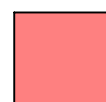
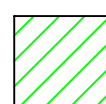
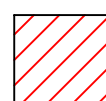
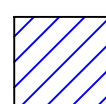
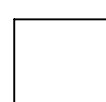
A-5

PAGE

A-6

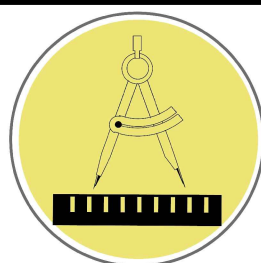
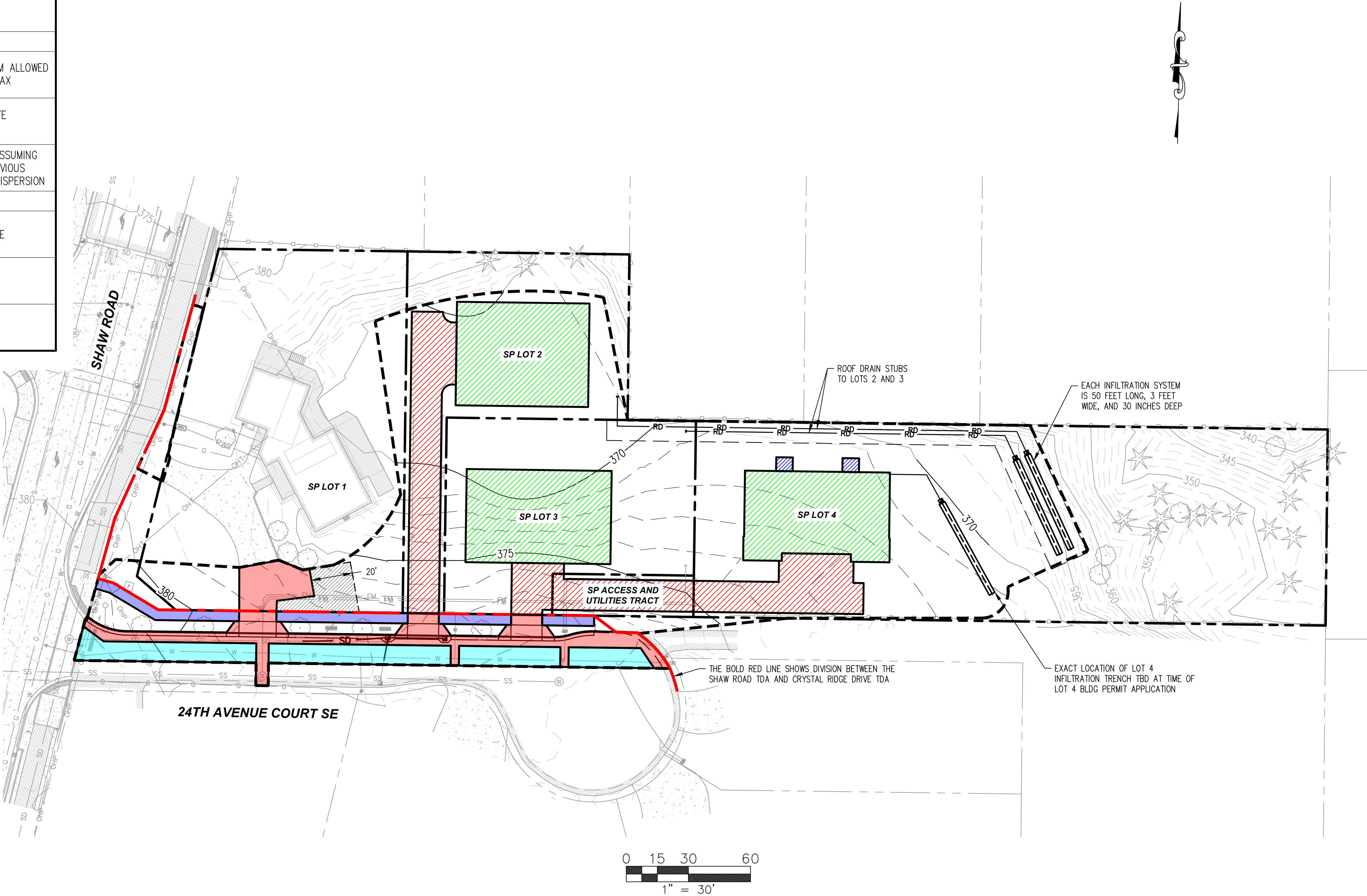


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| SHADING LEGEND                                                                    |                                                           |               |                 |                                                                                    |
|-----------------------------------------------------------------------------------|-----------------------------------------------------------|---------------|-----------------|------------------------------------------------------------------------------------|
| LEGEND/COLOR                                                                      | DESCRIPTION                                               | AREA (SF)     |                 | SWMM DESIGNATION                                                                   |
|                                                                                   |                                                           | SHAW ROAD TDA | CR DRIVE TDA    |                                                                                    |
| SHORT PLAT IMPROVEMENTS PHASE                                                     |                                                           |               |                 |                                                                                    |
|  | SIDEWALKS                                                 | 980           | 0               |                                                                                    |
|  | ROAD AND DRIVEWAY SURFACES                                | 2,387         | (0.02ac) 678    |                                                                                    |
|  | GRIND AND OVERLAY<br>NOT A REGULATED SURFACE              | 2,524         | 0               |                                                                                    |
| FUTURE BUILDING PERMIT PHASE                                                      |                                                           |               |                 |                                                                                    |
|  | ROOF SURFACES                                             | 0             | (0.22ac) 9,600  | REPRESENTS MAXIMUM ALLOWED<br>3,200 SF PER LOT MAX                                 |
|  | DRIVEWAY SURFACES                                         | 0             | (0.14ac) 6,000  | REASONABLE ESTIMATE<br>SEE NOTE 2                                                  |
|  | SIDEWALK/PATIO OR OTHER NON-PGHS<br>AMENITY TYPE SURFACES | 0             | (0.04ac) 1,800  | MAXIMUM ALLOWED ASSUMING<br>CONVENTIONAL IMPERVIOUS<br>USING SHEET FLOW DISPERSION |
| PROJECT SITE AREA TOTALS                                                          |                                                           |               |                 |                                                                                    |
|  | AMENDED SOILS                                             | 1,186         | (0.52ac) 22,598 | MODELED AS PASTURE                                                                 |
|  | TOTAL PROJECT SITE AREA                                   | 7,077         | (0.93ac) 40,676 |                                                                                    |
|  | SOFT SURFACE AREA USED FOR SHEET<br>FLOW DISPERSION       | NA            |                 |                                                                                    |

NOTES

1. THE BUILDING ENVELOPES, DRIVEWAY ALIGNMENTS, AND ASSOCIATED IMPERVIOUS SURFACES DEPICTED ON THIS FIGURE ARE CONCEPTUAL AND THEORETICAL IN NATURE. THESE SHAPES ARE INTENDED SOLELY TO ESTABLISH A CONSERVATIVE BASIS FOR HYDROLOGIC MODELING TO DEMONSTRATE THAT FLOW CONTROL AND WATER QUALITY REQUIREMENTS CAN BE ACHIEVED WITHIN THE PROJECT LIMITS. FINAL CONFIGURATIONS, DIMENSIONS, AND EXACT LOCATIONS OF IMPROVEMENTS ARE SUBJECT TO CHANGE DURING THE INDIVIDUAL BUILDING PERMIT PROCESS. ALL FUTURE SITE DEVELOPMENT SHALL BE REVIEWED BY THE CITY FOR CONSISTENCY WITH THE TOTAL ALLOWABLE IMPERVIOUS AREA AND INFILTRATION LIMITATIONS ESTABLISHED BY THIS REPORT.
2. THE THEORETICAL DRIVEWAY SURFACES DEPICTED ON THIS FIGURE REPRESENT A REASONABLE ESTIMATE FOR FLOW CONTROL CALCULATIONS. BECAUSE PERMEABLE SURFACES REDUCE RUNOFF VOLUMES RELATIVE TO THE MODELING BASIS, ANY INCREASE IN PERMEABLE AREA BEYOND THESE CONCEPTUAL FOOTPRINTS IS CONSIDERED INHERENTLY COMPLIANT WITH THE ESTABLISHED FLOW CONTROL AND WATER QUALITY STANDARDS.
3. MAXIMUM ALLOWABLE NON-ROOF, NON-PGHS IS A CUMULATIVE AMOUNT ACROSS ALL LOTS. ANY PROPOSED NON-PGHS AMENITY AREA WHICH EXCEEDS THE CUMULATIVE MAXIMUM MAY BE CONSIDERED IF THE SURFACE USES PERMEABLE CONSTRUCTION OR OTHER APPROVED INFILTRATION MEASURES.
4. CONNECTION OF DRAINAGE FROM NON-PGHS, NON-ROOF AREAS TO THE INFILTRATION TRENCHES ON THIS PLAN MAY BE CONSIDERED ON A CASE-BY-CASE BASIS IF THE TRENCH HAS CAPACITY. ROOF AREA MAY BE EXCHANGED FOR NON-ROOF AREA AT A RATE OF 1:1, BUT THE TOTAL AREA DRAINING TO THE INFILTRATION TRENCH MAY NOT EXCEED 3,200 SQUARE FEET.
5. DRAINAGE FROM DRIVEWAY SURFACES MAY NOT BE CONNECTED TO THE INFILTRATION TRENCHES SHOWN ON THIS PLAN UNDER ANY CIRCUMSTANCE, REGARDLESS OF TRENCH CAPACITY.



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SHAO SHORT PLAT  
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PUYALLUP, WA 98374  
TAX PARCEL NO. 0419025023

STORMWATER SITE PLAN  
POST-DEVELOPMENT CONDITIONS

PROJECT NO: 2026-001      DATE: APRIL 21, 2026

FIGURE  
A-6  
  
PAGE  
A-7

## **Appendix B: Project Plans**

Project plans are provided as a separate, attached document.

## **Appendix C: Construction SWPPP**

The Construction Stormwater Pollution Prevention Plan is provided as a separate, attached document. Temporary erosion and sediment control drawings are part of the project plans under Appendix B.

## **Appendix D: Soils Report**

*Attached*

# Ages Engineering

A Geotechnical Engineering Services Company

P.O. Box 935  
Puyallup, WA. 98371

(253) 845-7000

[www.agesengineering.com](http://www.agesengineering.com)

---

## GEOTECHNICAL REPORT

### Shaw Road Residential

2317 Shaw Road  
Puyallup, Washington

Project No. A-1692

#### Prepared For:

Mingqi Shao  
12319 NE 68<sup>th</sup> Place  
Kirkland, WA 98033

February 24, 2024  
Revised August 6, 2024



# Ages Engineering

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February 24, 2024  
Revised August 6, 2024  
Project No. A-1692

Mingqi Shao  
12319 NE 68<sup>th</sup> Place  
Kirkland, WA 98033

Subject: Geotechnical Report  
Shaw Road Residential  
2317 Shaw Road  
Puyallup, Washington  
Parcel Number: 0419021061

Dear Mr. Shao,

As requested, we have conducted a geotechnical study for the subject project. The attached report presents our findings and recommendations for the geotechnical aspects of project design and construction.

Our field exploration indicates the site is generally underlain with either Old Fill soils or sand with silt consistent with Recessional Outwash overlying silty sand with gravel consistent with glacial till. We did not encounter groundwater seepage in any of our explorations.

In our opinion, the soil and groundwater conditions at the site are suitable for the planned development. The new structures can be supported on typical spread footing foundations bearing on the organic-free native soils observed at 0.0 to 5.5 feet below surface grades. Infiltration of the development storm water is feasible.

NTE-Section 5.1 indicates infiltration is not feasible.

Detailed recommendations addressing these issues and other geotechnical design considerations are presented in the attached report. We trust the information presented is sufficient for your current needs. If you have any questions or require additional information, please call.

Respectfully Submitted,

Ages Engineering

Bernard P. Knoll, II  
Principal

BPK:bpk



# TABLE OF CONTENTS

|                                           |    |
|-------------------------------------------|----|
| 1.0 PROJECT DESCRIPTION.....              | 1  |
| 2.0 SCOPE .....                           | 1  |
| 3.0 SITE CONDITIONS .....                 | 2  |
| 3.1 Surface .....                         | 2  |
| 3.2 Soils .....                           | 2  |
| 3.3 Mapped Soils .....                    | 3  |
| 3.4 Groundwater .....                     | 4  |
| 4.0 GEOLOGIC HAZARDS .....                | 4  |
| 4.1 General.....                          | 4  |
| 4.2 Erosion.....                          | 4  |
| 4.3 Landslide .....                       | 5  |
| 4.4 Seismic.....                          | 6  |
| 5.0 CONCLUSIONS AND RECOMMENDATIONS ..... | 7  |
| 5.1 General .....                         | 7  |
| 5.2 Site Preparation and Grading .....    | 7  |
| 5.3 Excavations .....                     | 8  |
| 5.4 Foundations.....                      | 10 |
| 5.5 Slab-On-Grade.....                    | 10 |
| 5.6 Lower-Level and Building Walls.....   | 11 |
| 5.7 Storm Water.....                      | 12 |
| 5.8 Permanent Slopes and Embankments..... | 13 |
| 5.9 Site Drainage .....                   | 13 |
| 6.0 ADDITIONAL SERVICES .....             | 14 |
| 7.0 LIMITATIONS .....                     | 14 |

## Figures

|                                 |          |
|---------------------------------|----------|
| Site Vicinity Map .....         | Figure 1 |
| Exploration Location Plan ..... | Figure 2 |
| Geologic Map .....              | Figure 3 |
| USDA NRCS Map .....             | Figure 4 |

## Appendix

|                        |            |
|------------------------|------------|
| Site Exploration ..... | Appendix A |
| PIT Test .....         | Appendix B |

**Geotechnical Report  
Shaw Road Residential  
2317 Shaw Road  
Puyallup, Washington**

**1.0 PROJECT DESCRIPTION**

The project will consist of a residential development. We were provided with a preliminary site plan showing the planned development. Based on the plan provided to us, we understand the site will be divided into four single-family residential lots. The lots will extend east from Shaw Road. The existing residence on the western end of the site will remain and be remodeled. The development storm water on each lot will discharge to infiltration facilities constructed on each lot.

The conclusions and recommendations presented in this report are based on our understanding of the above-stated site and the planned project design features. If actual site conditions differ, the planned project design features are different than we expect, or if changes are made, we should review them in order to modify or supplement our conclusions and recommendations as necessary.

**2.0 SCOPE**

On February 1, 2024, we excavated one hand-augured test holes to a maximum depth of 3.0 feet below surface grades. We returned to the site on February 13, 2024, to excavate seven additional machine-excavated test pits to a maximum depth of 7.0 feet, install groundwater monitoring wells, and perform one Small Pilot Infiltration Test. Using the information obtained from our subsurface exploration, we developed geotechnical design and construction recommendations for the project. Specifically, this Geotechnical Report addresses the following:

- Reviewing the available geologic, hydrogeologic and geotechnical data for the site area, and conducting a geologic reconnaissance of the site area.
- Addressing the appropriate geotechnical regulatory requirements for the planned site development, including a Geologic Hazard evaluation.
- Advancing eight hand-augured test holes in the planned new development area to a maximum depth of approximately 7.0 feet below surface grades.
- Providing geotechnical recommendations for site grading including site preparation, subgrade preparation, fill placement criteria, suitability of on-site soils for use as structural fill, temporary and permanent cut and fill slopes, and drainage and erosion control measures.
- Providing geotechnical recommendations for design and construction of new foundations and floor slabs, including allowable bearing capacity and estimates of settlement.
- Providing geotechnical recommendations for lower-level building or retaining walls, including backfill and drainage requirements, lateral design loads, and lateral resistance values.
- Providing geotechnical recommendations for new site retaining walls.



- Performing one Small Pilot Infiltration Test (Small PIT) on the site.
- Providing preliminary recommendations for the discharge of the development storm water.
- Providing recommendations for site drainage.

After visiting the site on February 1, 2024, to explore the subsurface conditions on the site, it was determined that groundwater monitoring would be required. Therefor our scope was expanded to include the following:

- Performing periodic monitoring of the groundwater levels in the groundwater monitoring wells installed on the site.

### **3.0 SITE CONDITIONS**

#### **3.1 Surface**

The subject site is a 1.63-acre irregularly shaped residential parcel located at 2317 Shaw Road in Puyallup, Washington. The site is currently occupied with a single-family residence located in the western end of the site, a detached structure to the SE of the residence, and a barn in the central eastern portion of the site. A short roadway with a cul-de-sac exists along the south property line. The cul-de-sac ends near the center of the site, and an easement driveway extends from the cul-de-sac to a single-family residence located along the south side of the eastern end of the site. The subject site is bordered by residential parcels to the north, east, and to the south of the eastern end of the site. The remaining portions to the south of the site consist of a roadway with cul-de-sac. The location of the site is shown on the Site Vicinity Map provided in Figure 1. The current site layout is shown on the Exploration Location Plan provided in Figure 2.

In general surface grades in the vicinity of the site slope down to the north and east. Surface grades on the west end of the subject site are flat in the front yard of the existing residence. Behind the residence, the site slopes down to the east at inclinations ranging from 10 to 13 percent. The center of the site is generally flat to sloping down to the north at an approximate 2 to 5 percent grade. Behind the barn along the east end of the site, the surface slopes down to the east at an inclination of 10 to 33 percent. Site vegetation around the residence that occupies the site consists of typical landscape bushes and trees. The center of the site is a grass field. The east end of the site consists of native medium sized evergreen and deciduous with moderately thin underbrush.

#### **3.2 Mapped Soils**

According to *The Geologic Map of Seattle- A Progress Report*, by Kathy Goetz Troost, Derek B. Booth, Aaron P. Wisher, and Scott A. Shimel, the surface soils in the vicinity of the site are mapped as Recessional Outwash (Qvr). Glacial Till (Qvt) is mapped as being under the Recessional Outwash. The Recessional Outwash and Glacial Till were deposited during the Vashon Stade of the Frasier Glaciation that occurred 12,000 to 15,000 years ago. The Glacial Till was deposited beneath the advancing glacial ice sheet and was consequently overridden by the glacial ice mass.

The Recessional Outwash deposited by meltwaters and streams that emanated from the receding glacial ice mass. The Glacial Till will typically be found in a very dense condition where undisturbed and the Recessional Outwash in a medium dense condition where undisturbed. The near surface soils at the site have been disturbed by natural weathering processes that have occurred since their deposition. No springs or groundwater seepage was observed on the surface of the site at the time of our site visit. A copy of the Geologic Map for the subject site is provided in Figure 3.

The United States Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) maps the soils in the vicinity of the site as Kitsap Silt Loam (20C) soils that form on 8 to 15 percent slopes. According to the USDA NRCS, the site soil will have a moderate potential erosion when exposed.

### **3.3 Soils**

The soils we observed at the site generally consist of Recessional Outwash at the east and west ends and Old Fill soils overlying glacial till along the majority of the center of the site.

The soils observed in Test Hole TH-1 consisted of 12 inches of topsoil overlying Old Fill soils consisting of reddish orange silty sand with gravel and cobbles.

In Test Hole TH-2, we encountered 2.0 feet of Old Fill soils consisting of tan, gray and brown silty sand with gravel and cobbles to 8 inches. Below 2.0 feet, we encountered topsoil to a depth of 3.0 feet below surface grades. Below 3.0 feet, the soil became native reddish-orange, medium dense to dense, slightly cemented silty sand with gravel consistent with glacial till.

In Test Hole TH-3, we encountered 6 inches of topsoil overlying Old Fill soils consisting of brown, reddish-orange and gray and silty sand with gravel and cobbles to 8 inches to a depth of 4.5 feet below surface grades. Below 4.5 feet we encountered 6 inches of topsoil. Below 5.0 feet, the soil became native tan and gray mottled reddish-orange, medium dense to dense, slightly cemented silty sand with gravel consistent with glacial till.

In Test Hole TH-4, we encountered 5.5 feet of Old Fill soils consisting of tan, gray and brown silty sand with gravel and cobbles to 8 inches. At a depth of 5.5 feet, we encountered a boulder that could be excavated past.

In Test Hole TH-5, we encountered 3.5 feet of Old Fill soils consisting of tan, gray and brown silty sand with gravel and cobbles to 8 inches. Below 3.5 feet, we encountered topsoil to a depth of 4.5 feet below surface grades. Below 4.5 feet, the soil became native gray, medium dense to dense, slightly cemented silty sand with gravel consistent with glacial till.

In Test Hole TH-6, we encountered 4.0 feet of Old Fill soils consisting of tan, gray and brown silty sand with gravel and cobbles to 8 inches. Below 4.0 feet, we encountered topsoil to a depth of 5.0 feet below surface grades. Below 5.0 feet, the soil became native gray, medium dense to dense, slightly cemented silty sand with gravel consistent with glacial till.

In Test Hole TH-7, we encountered 7.0 feet of sand with varying amounts of silt consistent with Recessional Outwash. The Outwash was predominantly medium grained, tan in the upper 3.0 feet



and gray in the lower 4.0 feet. Below 7.0 feet, the soil became native gray, medium dense to dense, slightly cemented silty sand with gravel consistent with glacial till.

In Test Hole TH-8, we encountered 12 inches of topsoil overlying reddish orange silty sand and tan sand with silt consistent with Recessional Outwash.

Figures A-1 and A-2 present more detailed descriptions of the subsurface conditions encountered in the test holes. The approximate test hole and test boring locations are shown on the Exploration Location Plan provided in Figure 2.

### **3.4 Groundwater**

We did not encounter groundwater during our site exploration on (February 13, 2024) to the depths explored. We installed groundwater monitoring wells in six of the eight test pits on the site. The wells were extended through the upper loose to medium dense soils and into the underlying dense glacial till. We returned to the site on February 17<sup>th</sup> and 23<sup>rd</sup> to check the water levels in the wells. At no time did we find groundwater had accumulated in the well. We did not find a seasonal perched water table beneath the site. The groundwater levels and flow rates will fluctuate seasonally and typically reach their highest levels during and shortly following the wet winter months (October through May).

## **4.0 GEOLOGIC HAZARDS**

### **4.1 General**

According to Chapter 21.06.1210 in the City of Puyallup Municipal Code (PMC) geologic hazard areas are defined as “...areas that, because of their susceptibility to erosion, sliding, earthquake, or other geological events, are not suited to the siting of commercial, residential, or industrial development consistent with public health or safety concerns.”

### **4.2 Erosion**

According to Chapter 21.06.1210 in the City of Puyallup Municipal Code (PMC) Erosion Hazard Areas are defined as “...those areas identified by the U.S. Department of Agriculture’s Natural Resources Conservation Service or identified by a special study as having a “moderate to severe,” “severe,” or “very severe” erosion potential.”

According to the USDA NRCS, the soils on the subject site are classified as having a “moderate” potential for erosion when exposed. According to the USDA NRCS classification of the site, the site is not classified as having erosion hazard areas.

Regardless of the erosion classification on the site, Temporary Erosion and Sediment Control (TESC) measures must be in place prior to and maintained during construction activity at the site. In our opinion, the potential for erosion is not a limiting factor in site development. Erosion hazards can be mitigated by applying Best Management Practices (BMPs) outlined in the Washington State Department of Ecology’s (Ecology) *Stormwater Management Manual for Western Washington*.

Temporary Erosion and Sediment Control (TESC) measures, as required by the City of Puyallup, should be in place prior to the start of construction activities at the site.

#### **4.3 Landslide**

According to Chapter 21.06.1210 in the City of Puyallup Municipal Code (PMC) Landslide Hazard Areas are defined as "...areas include areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors. They include any areas susceptible to landslide because of any combination of bedrock, soil, slope (gradient), slope aspect, structure, hydrology, or other factors, and include, at a minimum, the following:

(i) Areas of historic failures, such as:

(A) Those areas delineated by the United States Department of Agriculture Natural Resources Conservation Service as having a significant limitation for building site development;

(B) Those coastal areas mapped as class u (unstable), uos (unstable old slides), and urs (unstable recent slides) in the Department of Ecology Washington coastal atlas; or

(C) Areas designated as quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington Department of Natural Resources.

(ii) Areas with all three of the following characteristics:

(A) Slopes steeper than 15 percent;

(B) Hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock; and

(C) Springs or groundwater seepage.

(iii) Areas that have shown movement during the Holocene epoch (from 10,000 years ago to the present) or which are underlain or covered by mass wastage debris of this epoch;

(iv) Slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials;

(v) Slopes having gradients steeper than eighty percent subject to rockfall during seismic shaking;

(vi) Areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones;

(vii) Areas that show evidence of, or are at risk from snow avalanches;

(viii) Areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding; and

- (ix) Any area with a slope of 40 percent or steeper and with a vertical relief of 10 or more feet except areas composed of bedrock. A slope is delineated by establishing its toe and top and measured by averaging the inclination over at least 10 feet of vertical relief.

The site does not contain areas of historic failures. The United States Department of Agriculture Natural Resources Conservation Service does not describe the site as having a significant limitation for building site development. The site is not located on a coastal shoreline and is therefore not mapped by the Department of Ecology Washington coastal atlas. We observed no areas having quaternary slumps, earthflows, mudflows, lahars, or landslides on maps published by the United States Geological Survey or Washington Department of Natural Resources. We observed no areas that have shown movement during the holocene epoch (from 10,000 years ago to the present) or which are underlain or covered by mass wastage debris of this epoch. We observed no slopes that are parallel or subparallel to planes of weakness (such as bedding planes, joint systems, and fault planes) in subsurface materials. We observed no slopes having gradients steeper than eighty percent subject to rockfall during seismic shaking. We observed no areas potentially unstable as a result of rapid stream incision, stream bank erosion, and undercutting by wave action, including stream channel migration zones. We observed no areas that show evidence of, or are at risk from, snow avalanches. We observed no areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding. The site does not have slopes with an inclination of 40 percent or more within a vertical elevation change of at least 10 feet. The site does have slopes steeper than 15 percent and hillsides intersecting geologic contacts with a relatively permeable sediment overlying a relatively impermeable sediment or bedrock. We did not observe groundwater seepage on the site. Based on these factors, according to the City of Puyallup, the site is not classified as a landslide hazard area.

Regardless of the landslide hazard classification of the site, the site appears stable. Based on these soil and slope conditions, the potential for a landslide to occur at this site should be considered negligible.

NTE-Per Short Plat AFN  
202511185002 Note 1, there is a  
steep slope/landslide hazard area.

#### **4.4 Seismic**

According to Chapter 21.06.1210 in the City of Puyallup Municipal Code (PMC) Landslide Hazard Areas are defined as "...areas that are subject to severe risk of damage as a result of earthquake-induced ground shaking, slope failure, settlement, or soil liquefaction."

Liquefaction can be described as a phenomenon where there is a reduction or complete loss of soil strength due to an increase in pore water pressure. The increase in water pressure is typically induced by vibrations. Liquefaction mainly affects geologically recent deposits of loose, fine-grained sands that are below the groundwater table.

The site is located in an area underlain with medium dense, predominantly medium-grained Recessional Outwash soils and dense glacial till soils. Based on the medium dense to dense consistency and relatively well-graded nature of the native soils that underly the site, the risk for liquefaction to occur at the site should be considered negligible. According to the City of Puyallup Municipal Code, the site is located in a seismic hazard area.

The state of Washington has adopted the International Building Code (IBC). Based on the soil conditions encountered and the local geology, per the IBC, site class “D” can be used in structural design. This is based on the inferred range of SPT (Standard Penetration Test) blow counts for the upper 100 feet of the site relative to hand excavation progress and probing with a ½-inch diameter steel probe rod. The presence of glacially consolidated soil conditions were assumed to be representative for the site conditions beyond the depths explored.

## **5.0 CONCLUSIONS AND RECOMMENDATIONS**

### **5.1 General**

NTE-The Introduction Page 1, and Section 5.7 indicates infiltration is feasible.

Based on our study, in our opinion, soil and groundwater conditions at the site are suitable for the proposed development. The new residences can be supported on conventional spread footing foundations bearing on the native soils underlying the site. We found no seasonal groundwater table underlying the site. Infiltration of the development storm water will not be feasible.

Based on our evaluation, it appears the subsurface soils along the center of the site previously consisted of Recessional outwash similar to the soils observed along the eastern and western ends of the site. This soil was likely excavated and removed from the site. The existing fill soils we observed in our explorations were brought to the site to restore grades. The fill is a relatively consistent depth across the center of the site but appears to become much deeper behind the barn along the crest of the sites’ eastern slope area. We reviewed past aerial photos and according to the USDA NRCS, this slope should be inclined at a much shallower slope inclination. We believe the fill soils used to restore grades were extended eastward past the barn area and created the current 33 percent slope. Additionally, the native deciduous trees along the slope crest are typical for those that naturally grow quickly in cleared or filled areas.

The native soils encountered at the site contain a high enough percentage of fines (silt and clay-size particles) that will make them difficult to compact as structural fill when too wet. Accordingly, the ability to use the soils from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time of construction. If grading activities take place during the winter season, the owner should be prepared to import free-draining granular material for use as structural fill and backfill.

The following sections provide detailed recommendations regarding these issues and other geotechnical design considerations. These recommendations should be incorporated into the final design drawings and construction specifications.

### **5.2 Site Preparation and Grading**

To prepare the site for construction, all vegetation, organic surface soils, and other deleterious materials including any existing structures, foundations or abandoned utility lines should be stripped and removed from the new development areas. Organic topsoil will not be suitable for use as structural fill but may be used for limited depths in non-structural areas. The Old Fill soil observed in the upper 3.0 to 5.5 feet of the site will not be suitable for supporting structural

elements. Prior to construction these soils should be removed from under new foundation and slab areas.

Once clearing and stripping operations are complete, cut and fill operations can be initiated to establish desired grades. To achieve proper compaction of structural fill, and to provide adequate foundation and floor slab support, the existing subgrade must be in a stable condition. Due to the depth and consistency of the fill underlying the site, compaction of structural fill will be very difficult. If structural fill is necessary, it will likely have to be placed on a prepared subgrade surface consisting of either reinforcement fabric or quarry rock, or a combination of both. Once final design details become evident, we can provide specific recommendations for any structural fill on the site.

Our study indicates the native surface soils encountered at the site contain a sufficient percentage of fines (silt and clay-size particles) that will make them difficult to compact as structural fill when too wet. Accordingly, the ability to use the soil from site excavations as structural fill will depend on their moisture content and the prevailing weather conditions at the time of construction. If grading activities are planned during the wet winter months, or the on-site soil becomes too wet to achieve adequate compaction, the owner should be prepared to import a wet-weather structural fill. For wet weather structural fill, we recommend importing a granular soil that meets the following gradation requirements:

| <b>U. S. Sieve Size</b> | <b>Percent Passing</b> |
|-------------------------|------------------------|
| 6 inches                | 100                    |
| No. 4                   | 75 maximum             |
| No. 200                 | 5 maximum*             |

\* Based on the ¾ inch fraction

Prior to use, Ages Engineering should examine and test all materials to be imported to the site for use as structural fill.

Structural fill should be placed in uniform loose layers not exceeding 12 inches and compacted to a minimum of 95 percent of the soils' laboratory maximum dry density as determined by American Society for Testing and Materials (ASTM) Test Designation D-1557 (Modified Proctor). The moisture content of the soil at the time of compaction should be within two percent of its optimum, as determined by this same ASTM standard. In non-structural areas, the degree of compaction can be reduced to 90 percent.

### **5.3 Excavations**

#### ***General,***

The inclination for a safe and stable excavation slope cut is determined based on two factors, the current Washington State Safety and Health Administration (WSHA) regulations for confined spaces and global stability of the slope cut. Most often, the WSHA regulations are more conservative than the global stability requirements.



According to WAC 296-809-099, a confined space is defined as: “A space that is all of the following:

- (a) Large enough and arranged so an employee could fully enter the space and work.
- (b) Has limited or restricted entry or exit. Examples of spaces with limited or restricted entry are tanks, vessels, silos, storage bins, hoppers, vaults, excavations, and pits.
- (c) Not primarily designed for human occupancy.”

In the context of site excavation and grading, the Washington State Department of Labor and Industries considers a confined space as a space in which a worker enters an excavation that is tall enough and/or narrow enough to inundate the worker and cause bodily harm if a cave-in occurs. This does not include excavations that are less than 4.0 feet in depth.

#### ***WSHA Approved Slope Cuts,***

All excavations at the site associated with confined spaces, such as utility trenches and lower level building and retaining walls, must be completed in accordance with local, state, and/or federal requirements. Based on current Washington State Safety and Health Administration (WSHA) regulations, the existing Old Fill and Recessional Outwash soils are classified as Type C soils. The deeper unweathered till soils are classified as Type A soils.

According to WSHA, for temporary excavations of less than 20 feet in depth, the side slopes in Type C soils should be laid back at a slope inclination of 1.5:1 (Horizontal:Vertical) or flatter from the toe to the crest of the slope and the side slopes in Type A soils should be laid back at a slope inclination of 0.75:1 (Horizontal:Vertical) or flatter from the toe to the crest of the slope. All exposed slope faces should be covered with a durable reinforced plastic membrane during construction to prevent slope raveling and rutting during periods of precipitation. These guidelines assume that all surface loads are kept at a minimum distance of at least one half the depth of the cut away from the top of the excavation slope and that significant seepage is not present on the slope face. Flatter cut slopes will be necessary where significant raveling or seepage occurs, or if construction materials will be stockpiled along the slope crest. If these safe temporary slope inclinations cannot be achieved due to property line constraints, shoring may be necessary.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Ages Engineering assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

#### ***Global Stability Excavations,***

Based on the composition and consistency of the site soils, stable slope cuts to provide adequate global stability can be steeper than WSHA standards in areas that are not considered confined spaces. Excavations into the native glacial till soils on the site that will not result in WSHA regulated confined spaces can be cut to an inclination of 0.5:1. Some raveling of the gravel and cobbles exposed on the slope surface may occur at an inclination of 0.5:1. Due to the potential for raveling to occur, and to prevent erosion, the slope face should be covered with durable plastic sheeting.

This information is provided solely for the benefit of the owner and other design consultants and should not be construed to imply that Ages Engineering assumes responsibility for job site safety. It is understood that job site safety is the sole responsibility of the project contractor.

#### **5.4 Foundations**

The new residential foundations may be supported on conventional spread footing foundations bearing on the existing organic-free native soils, or on new structural fill placed above the existing site soils. Foundation subgrades should be prepared as recommended in the “Site Preparation and Grading” section of this report. As discussed in the “Site Preparation and Grading” section of this report, the existing topsoil and fill observed in the upper 0.5 to 1.0 feet of the site will not be suitable for support of structural elements. Prior to construction, these old fill soils should be removed from under new foundation areas.

Perimeter foundations exposed to the weather should bear at a minimum depth of 1.5 feet below final exterior grades for frost protection. Interior foundations can be constructed at any convenient depth below the floor slab. We recommend designing new foundations for a net allowable bearing capacity of 2,500 pounds per square foot (psf). For short-term loads, such as wind and seismic, a one-third increase in this allowable capacity can be used. With the anticipated loads and this bearing stress applied, building settlements should be less than one-half inch total and one-quarter inch differential.

For designing foundations to resist lateral loads, a base friction coefficient of 0.35 can be used. Passive earth pressures acting on the sides of the footings can also be considered. We recommend calculating this lateral resistance using an equivalent fluid weight of 300 pounds per cubic foot (pcf). We recommend not including the upper 12 inches of soil in this computation because it can be affected by weather or disturbed by future grading activity. This value assumes the foundations will be constructed neat against competent soil and backfilled with structural fill, as described in the “Site Preparation and Grading” section of this report. The values recommended include a safety factor of 1.5.

| <b>Foundation Parameter Summary</b> |                      |
|-------------------------------------|----------------------|
| <b>Description</b>                  | <b>*Design Value</b> |
| Net Allowable Bearing Capacity      | 2,500 psf            |
| Friction Coefficient                | 0.35                 |
| Lateral Resistance                  | 300 pcf              |

\*Details regarding the use of these parameters are provided in the section above.

#### **5.5 Slab-On-Grade**

Slab-on-grade floors should be supported on subgrades prepared as recommended in the “Site Preparation and Grading” section of this report. As discussed in the “Site Preparation and Grading” section of this report, the existing topsoil and fill observed in the upper 0.5 to 1.0 feet of the site

will not be suitable for support of structural elements. Prior to construction, these old fill soils should be removed from under new slab areas.

Immediately below the floor slab, we recommend placing a four-inch-thick capillary break layer of clean, free-draining, coarse sand or fine gravel that has less than three percent passing the No. 200 sieve. This material will reduce the potential for upward capillary movement of water through the underlying soil and subsequent wetting of the floor slabs. The drainage material should be placed in one lift and compacted to a firm and unyielding condition.

The capillary break layer will not prevent moisture intrusion through the slab caused by water vapor transmission. Where moisture by vapor transmission is undesirable, such as covered floor areas, a common practice is to place a durable plastic membrane on the capillary break layer and then cover the membrane with a layer of clean sand or fine gravel to protect it from damage during construction, and aid in uniform curing of the concrete slab. It should be noted that if the sand or gravel layer overlying the membrane is saturated prior to pouring the slab, it will not assist in uniform curing of the slab and may serve as a water supply for moisture transmission through the slab and affecting floor coverings. Additionally, if the sand is too dry, it can effectively drain the fresh concrete, thereby lowering its strength. Therefore, in our opinion, covering the membrane with a layer of sand or gravel should be avoided.

## **5.6 Lower Level and Building Walls**

The magnitude of earth pressure development on below-grade walls, such as basement or retaining walls, will greatly depend on the quality of the wall backfill and the wall drainage. We recommend placing and compacting wall backfill as structural fill. Wall backfill below structurally loaded areas, such as pavements or floor slabs, should be compacted to a minimum of 95 percent of its maximum dry density, as determined by ASTM Test Designation D-1557 (Modified Proctor). In unimproved areas, the relative compaction can be reduced to 90 percent.

To guard against hydrostatic pressure development, drainage must be installed behind the wall. We recommend that wall drainage consist of a minimum 12 inches of clean sand and/or gravel with less than three percent fines placed against the back of the wall. In addition, a drainage collector system consisting of 4-inch perforated PVC pipe should be placed behind the wall to provide an outlet for any accumulated water. The drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once every year. The wall drainage material should be capped at the ground surface with 1-foot of relatively impermeable soil to prevent surface intrusion into the drainage zone. Alternatively, the 12-inch wide drainage layer placed against the back of the wall can be replaced with a Mirafi G100N Drainage Board, or an approved equivalent. If drainage board is used, the 4-inch perforated PVC pipe should be covered with at least 12 inches of clean washed gravel and the drainage board should be hydraulically connected to drainpipe and surrounding gravel.

With wall backfill placed and compacted as recommended and the wall drainage properly installed, unrestrained walls can be designed for an active earth pressure equivalent to a fluid weighing 35 pcf. For restrained walls, an additional uniform lateral pressure of 100 psf should be included. These values assume a horizontal backfill condition and that no other surcharge loading, such as



traffic, sloping embankments, or adjacent buildings, will act on the wall. If such conditions exist, then the imposed loading must be included in the wall design. Friction at the base of the wall foundation and passive earth pressure will provide resistance to these lateral loads. Values for these parameters are provided in the “Foundations” section of this report.

| <b>Lower Level Building and Retaining Wall Parameter Summary</b> |                  |                          |
|------------------------------------------------------------------|------------------|--------------------------|
| <b>Description</b>                                               | <b>Condition</b> | <b>*Design Value</b>     |
| Earth Pressure                                                   | Unrestrained     | 35 pcf                   |
| Earth Pressure                                                   | Restrained       | Additional 100 psf       |
| Earth Pressure                                                   | Surcharge        | Dependant upon magnitude |

\*Details regarding the use of these parameters are provided in the section above.

## **5.7 Storm Water**

We visited the site to perform one Small PIT in the approximate center of the west end of the subject site. The infiltration test was performed in accordance with the City of Puyallup specifications during the wet season.

To prepare the infiltration test area, we utilized an excavator to excavate the area around the location. The test area was excavated to a depth of 6.0 feet below surface grades to get to the native soils. We then excavated an additional 2.0 feet into the native glacial till soils. The size was approximately 5.0 feet by 4.0 feet equating to a top surface area of 20.0 square feet. The side slopes were laid back at an approximate 0.5:1 inclination to avoid caving during the testing procedure. The bottom of the infiltration test pit measured approximately 4.0 feet by 3.0 feet equating to a surface area of 12.0 square feet. The test was performed in the medium dense till soils.

A vertical measuring rod was placed in the infiltration test hole to allow accurate measuring of the infiltration rate during testing. We utilized a ½ inch diameter garden hose to convey water from the house spigot into the test hole. The water was discharged onto a splash block placed in the center of the infiltration test hole. The infiltration test hole was filled with 12 to 18 inches of water and allowed to soak for 6 hours. During the pre-soak period, the water flow through the hose was slightly altered to try and match the infiltration rate. After the 6-hour soak period, the Steady State period was performed. Water was added to the test hole at a rate that maintained a depth of 12 inches of water in the hole for 1 hour. Every 15 minutes during that hour, we estimated the cumulative volume and instantaneous flow rate (in gallons per minute) necessary to maintain 12 inches of water in the test hole. The hose did not have any devices that were able to accurately measure the cumulative volume and instantaneous flow rate. Therefor we had to calculate these values by periodically placing a one-cup container between the hose and the pit. After the 1-hour Steady State period, the water was turned off and the infiltration rate was measured every 15 minutes for 1 hour. The measured steady state rate in PIT 1 was 0.4 inches per hour. The correction factors are 1.0 for Uniformity of Site Conditions, 0.5 for the small PIT, and 0.9 for Potential Siltation.

We performed the infiltration testing on the site during a period of wet weather near the middle of the wet season. We obtained a soil sample during our site exploration and delivered it to an outside testing laboratory for determination of the cation exchange capacity (CEC) of the soil.

Based on our infiltration testing on the site, it is our opinion the infiltration of the development storm water is feasible. The City of Puyallup requires a minimum measured infiltration rate of 0.30 inches per hour for feasibility. Based on the results of our Small PIT, the measured infiltration rate was 0.4 inches per hour. After correction factors, the rate would be 0.18 in/hr. The completed Pilot Infiltration Test (PIT) Checklist is provided in Appendix B.

## **5.8 Permanent Slopes and Embankments**

All permanent cut and fill slopes should be graded with a finished inclination of no greater than 2:1 (Horizontal:Vertical). Upon completion of grading, the slope face should be appropriately vegetated or provided with other physical means to guard against erosion. Final grades at the top of the slope must promote surface drainage away from the slope crest. Water must not be allowed to flow in an uncontrolled fashion over the slope face. If it is necessary to direct surface runoff towards the slope, it should be controlled at the top of the slope, piped in a closed conduit installed on the slope face, and taken to an appropriate point of discharge beyond the toe.

All fill used for slope and embankment construction should meet the structural fill requirements described in the Site Preparation and Grading section of this report. In addition, if new fills will be placed over existing slopes of 20 percent or greater, the structural fill should be keyed and benched into competent slope soils.

## **5.9 Site Drainage**

### ***Surface,***

Final exterior grades should promote free and positive drainage away from the building area. All ground surfaces, pavements, and sidewalks should be sloped away from the structure. We recommend providing a gradient of at least three percent for a minimum distance of ten feet from the building perimeter, except in paved locations. In paved locations, a minimum gradient of one percent should be provided, unless provisions are included for collection and disposal of surface water adjacent to the structure.

### ***Subsurface,***

We recommend installing a continuous drain along the lower outside edge of the perimeter building foundation. The foundation drain should be tightlined to an approved point of controlled discharge. The roof drain should not be connected to the footing drains unless a backflow device will be installed, or an adequate gradient will prevent backflow into the footing drains.

Subsurface drains must be laid with a gradient sufficient to promote positive flow to the point of discharge. All drains should be provided with cleanouts at easily accessible locations. These cleanouts should be serviced at least once every year.



## **6.0     ADDITIONAL SERVICES**

Ages Engineering should review the final project designs and specifications in order to verify that earthwork and foundation recommendations have been properly interpreted and incorporated into project design. If changes are made in the loads, grades, locations, configurations or types of facilities to be constructed, the conclusions and recommendations presented in this report may not be fully applicable. If such changes are made, we should be given the opportunity to review our recommendations and provide written modifications or verifications, as necessary.

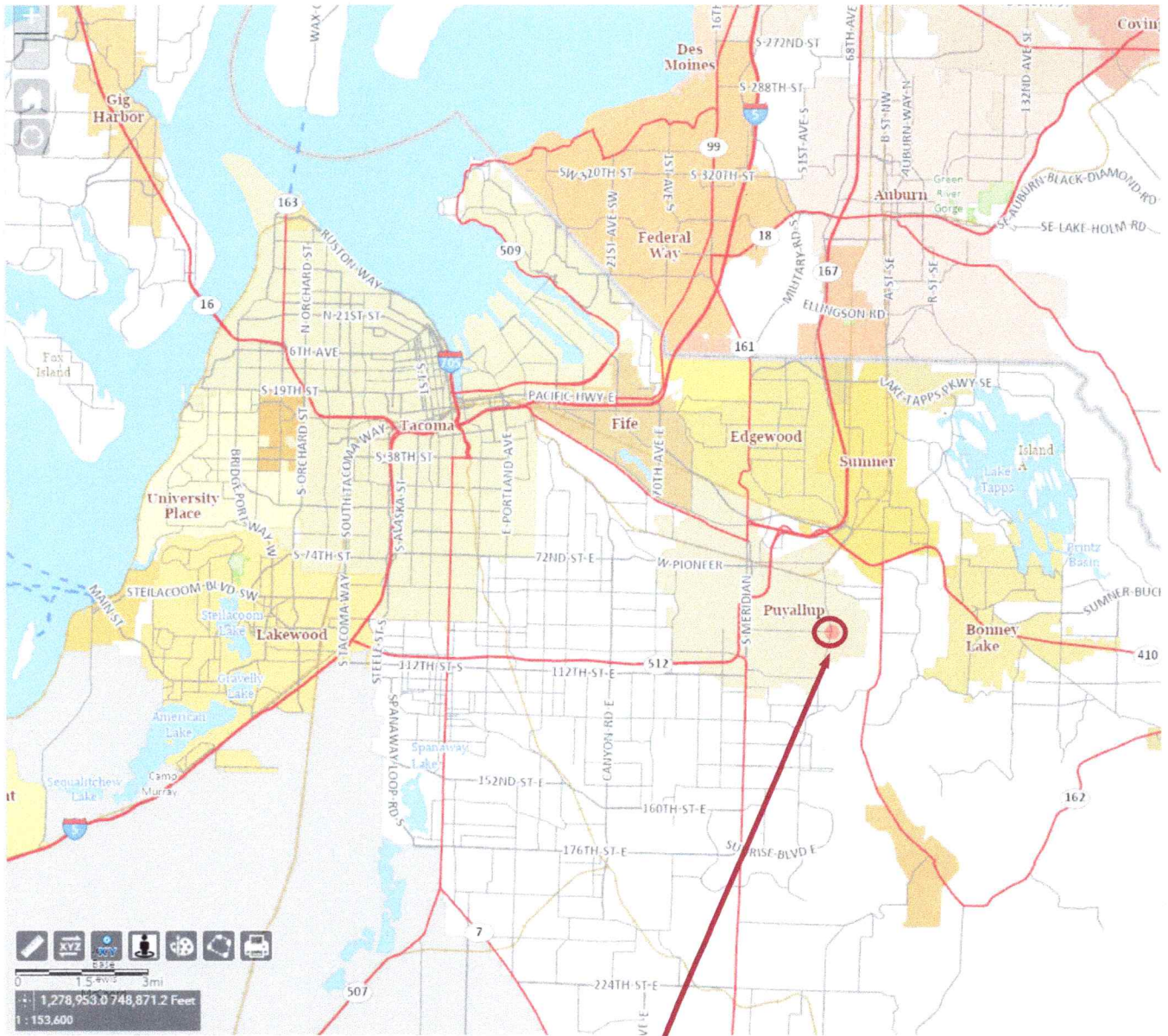
We should also provide geotechnical services during construction to observe compliance with our design concepts, specifications, and recommendations. This will allow for expedient design changes if subsurface conditions differ from those anticipated prior to the start of construction.

## **7.0     LIMITATIONS**

We prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranty, expressed or implied, is made. This report is the copyrighted property of Ages Engineering and is intended for the exclusive use of Mr. Mingqi Shao, and their authorized representatives for use in the design, permitting, and construction portions of this project.

The analysis and recommendations presented in this report are based on data obtained from others and our site explorations and should not be construed as a warranty of the subsurface conditions. Variations in subsurface conditions are possible. The nature and extent of which may not become evident until the time of construction. If variations appear evident, Ages Engineering should be requested to reevaluate the recommendations in this report prior to proceeding with construction. A contingency for unanticipated subsurface conditions should be included in the budget and schedule. Sufficient monitoring, testing and consultation should be provided by our firm during construction to confirm that the conditions encountered are consistent with those indicated during our exploration, to provide recommendations for design changes should the conditions revealed during the work differ from those anticipated, and to evaluate whether earthwork and foundation installation activities comply with contract plans and specifications.

The scope of our services does not include services related to environmental remediation and construction safety precautions. Our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design.



Approximate Site Location



## Ages Engineering

P. O. Box 935  
Puyallup, WA. 98371

Main (253) 845-7000  
www.agesengineering.com

**Site Vicinity Map**  
Shaw Road Residential  
2317 Shaw Road  
Puyallup, Washington

Project No.: A-1692

August 2024

Figure 1





**KEY:**

APPROXIMATE LOCATION OF TEST HOLE

TH-1 ◆

APPROXIMATE LOCATION OF INFILTRATION TEST

IT-1 ◆



**Ages Engineering**

P. O. Box 935  
Puyallup, WA. 98371

Main (253) 845-7000  
www.agesengineering.com

**Exploration Location Plan**

**Shaw Road Residential**

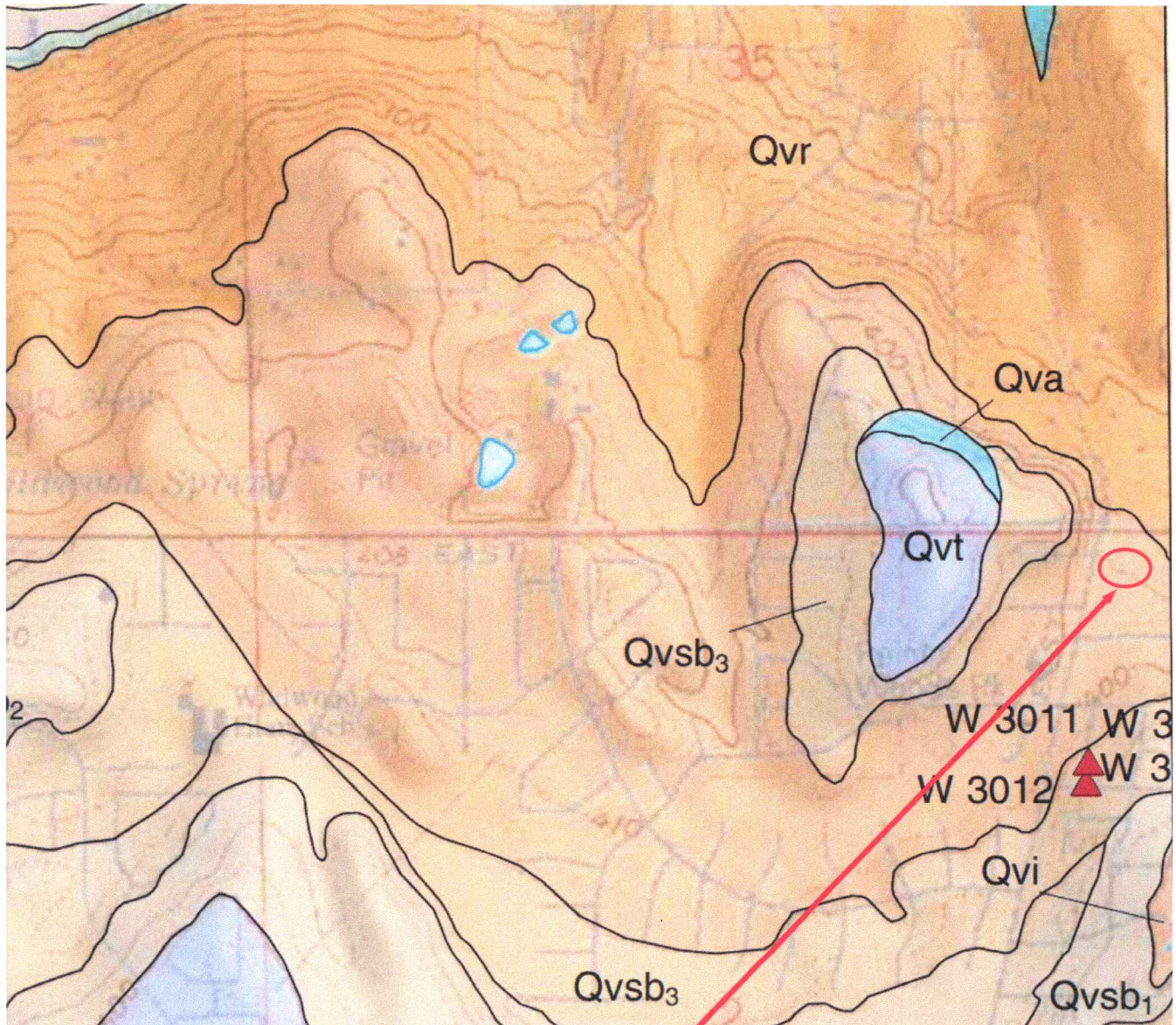
2317 Shaw Road  
Puyallup, Washington

Project No.: A-1692

August 2024

**Figure 2**





Approximate Site Location



## Ages Engineering

P. O. Box 935  
Puyallup, WA. 98371

Main (253) 845-7000  
www.agesengineering.com

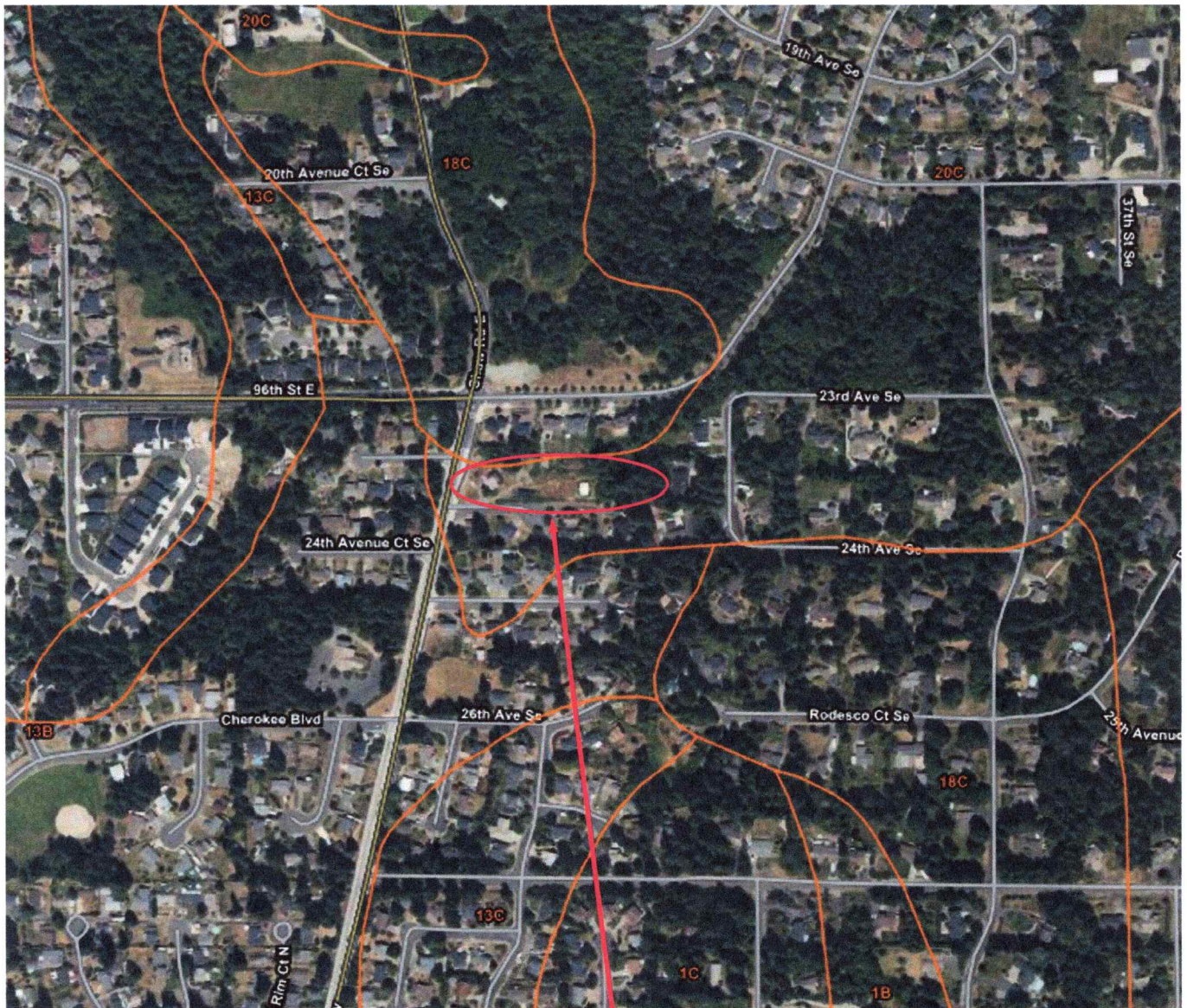
**Geologic Map**  
Shaw Road Residential  
2317 Shaw Road  
Puyallup, Washington

Project No.: A-1692

August 2024

Figure 3





Approximate Site Location



## Ages Engineering

P. O. Box 935  
Puyallup, WA. 98371

Main (253) 845-7000  
[www.agesengineering.com](http://www.agesengineering.com)

**USDA NRCS Map**  
**Shaw Road Residential**  
2317 Shaw Road  
Puyallup, Washington

Project No.: A-1692

August 2024

**Figure 4**

## **APPENDIX A**

### **FIELD EXPLORATION AND LABORATORY TESTING**

#### **Shaw Road Residential Puyallup, Washington**

On February 1, 2024 we explored subsurface conditions at the site by excavating one hand-augured test holes to a maximum depth of 3.0 feet below surface grades. We returned to the site on February 13, 2024 we explored subsurface conditions at the site by excavating seven additional machine-excavated test pits to a maximum depth of 7.0 feet below surface grades. The approximate location of the site is shown on the Site Vicinity map provided in Figure 1. The approximate test hole locations are shown on the Exploration Location Plan provided in Figure 2.

A geotechnical engineering representative from our office conducted the field exploration, maintained a log of each test hole and classified the soils encountered, collected representative soil samples, and observed pertinent site features. All soil samples were visually classified in accordance with the Unified Soil Classification System (USCS) described on Figure A-1. The test hole logs are presented on Figures A-2 through A-4.

Representative soil samples obtained from the test holes were placed in sealed containers and taken to our laboratory for further examination and testing. The moisture content of each sample was measured and is reported on the test hole logs.



# UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS                                                     |                                                                        |                                      | GROUP SYMBOL | GROUP NAME                                              |
|---------------------------------------------------------------------|------------------------------------------------------------------------|--------------------------------------|--------------|---------------------------------------------------------|
| COARSE GRAINED SOILS<br><br>More than 50% Retained on No. 200 Sieve | GRAVEL<br><br>More than 50% Of Coarse Fraction Retained on No. 4 Sieve | GRAVEL WITH < 5 % FINES              | GW           | Well-Graded GRAVEL                                      |
|                                                                     |                                                                        |                                      | GP           | Poorly-Graded GRAVEL                                    |
|                                                                     |                                                                        | GRAVEL WITH BETWEEN 5 AND 15 % FINES | GW-GM        | Well-Graded GRAVEL with silt                            |
|                                                                     |                                                                        |                                      | GW-GC        | Well-Graded GRAVEL with clay                            |
|                                                                     |                                                                        |                                      | GP-GM        | Poorly-Graded GRAVEL with silt                          |
|                                                                     |                                                                        |                                      | GP-GC        | Poorly-Graded GRAVEL with clay                          |
|                                                                     |                                                                        | GRAVEL WITH > 15 % FINES             | GM           | Silty GRAVEL                                            |
|                                                                     |                                                                        |                                      | GC           | Clayey GRAVEL                                           |
|                                                                     | SAND<br><br>More than 50% Of Coarse Fraction Passes No. 4 Sieve        | SAND WITH < 5 % FINES                | SW           | Well-Graded SAND                                        |
|                                                                     |                                                                        |                                      | SP           | Poorly-Graded SAND                                      |
|                                                                     |                                                                        | SAND WITH BETWEEN 5 AND 15 % FINES   | SW-SM        | Well-Graded SAND with silt                              |
|                                                                     |                                                                        |                                      | SW-SC        | Well-Graded SAND with clay                              |
|                                                                     |                                                                        |                                      | SP-SM        | Poorly-Graded SAND with silt                            |
|                                                                     |                                                                        |                                      | SP-SC        | Poorly-Graded SAND with clay                            |
|                                                                     |                                                                        | SAND WITH > 15 % FINES               | SM           | Silty SAND                                              |
|                                                                     |                                                                        |                                      | SC           | Clayey SAND                                             |
| FINE GRAINED SOILS<br><br>More than 50% Passes No. 200 Sieve        | SILT AND CLAY                                                          | Liquid Limit Less than 50            | ML           | Inorganic SILT with low plasticity                      |
|                                                                     |                                                                        |                                      | CL           | Lean inorganic CLAY with low plasticity                 |
|                                                                     |                                                                        |                                      | OL           | Organic SILT with low plasticity                        |
|                                                                     |                                                                        | Liquid Limit 50 or more              | MH           | Elastic inorganic SILT with moderate to high plasticity |
|                                                                     |                                                                        |                                      | CH           | Fat inorganic CLAY with moderate to high plasticity     |
|                                                                     |                                                                        |                                      | OH           | Organic SILT or CLAY with moderate to high plasticity   |
| HIGHLY ORGANIC SOILS                                                |                                                                        |                                      | PT           | PEAT                                                    |

## NOTES:

- (1) Soil descriptions are based on visual field and laboratory observations using the classification methods described in ASTM D-2488. Where laboratory data are available, classifications are in accordance with ASTM D-2487.
- (2) Solid lines between soil descriptions indicate a change in the interpreted geologic unit. Dashed lines indicate stratigraphic change within the unit.
- (3) Fines are material passing the U.S. No. 200 Sieve.

|                                                                                                                                                                                                                                                                                  |                                                                                                                                                                                                                                   |             |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|------------|
| <div style="text-align: center;"> <b>Ages Engineering</b><br/>                     P. O. Box 935<br/>                     Puyallup, WA. 98371<br/><br/>                     Main (253) 845-7000<br/> <a href="http://www.agesengineering.com">www.agesengineering.com</a> </div> | <div style="text-align: center;"> <b>Unified Soil Classification System (USCS)</b><br/> <b>Shaw Road Residential</b><br/>                     2317 Shaw Road<br/>                     Puyallup, Washington                 </div> |             |            |
|                                                                                                                                                                                                                                                                                  | Project No.: A-1692                                                                                                                                                                                                               | August 2024 | Figure A-1 |

## Test Hole TH-1

| DATE: February 1, 2024 |                                                                                                                                           | LOGGED BY: BPK |       | ELEV: |  |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)        | Soil Description                                                                                                                          | Notes          |       |       |  |
|                        |                                                                                                                                           | M%             | Other |       |  |
| 0                      | 6 inches <b>TOPSOIL</b>                                                                                                                   |                |       |       |  |
|                        | <b>FILL:</b> Brown silty sand with gravel , cobbles to 8 inches.                                                                          |                |       |       |  |
|                        | <b>FILL:</b> Tan, reddish-brown and gray silty sand with gravel, moderate cementation, medium dense, moist. (SM) (Weathered Glacial Till) |                |       |       |  |
|                        | Test Hole terminated at a depth of 3.0 feet below surface grades.                                                                         |                |       |       |  |
|                        | No groundwater seepage encountered.                                                                                                       |                |       |       |  |
| 5                      |                                                                                                                                           |                |       |       |  |

## Test Hole TH-2

| DATE: February 13, 2024 |                                                                                                   | LOGGED BY: BPK |       | ELEV: |  |
|-------------------------|---------------------------------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)         | Soil Description                                                                                  | Notes          |       |       |  |
|                         |                                                                                                   | M%             | Other |       |  |
| 0                       | <b>FILL:</b> Tan, gray and brown silty sand with gravel, cobbles to 10 inches, loose, moist. (SM) |                |       |       |  |
|                         | <b>TOPSOIL</b>                                                                                    |                |       |       |  |
|                         | Reddish-orange silty <b>SAND</b> with gravel, slight cementation, medium dense, moist. (SM)       |                |       |       |  |
| 5                       | Test Hole terminated at a depth of 5.0 feet below surface grades.                                 |                |       |       |  |
|                         | No groundwater seepage encountered.                                                               |                |       |       |  |

## Test Hole TH-3

| DATE: February 13, 2024                                           |                                                                                                          | LOGGED BY: BPK |       | ELEV: |  |
|-------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)                                                   | Soil Description                                                                                         | Notes          |       |       |  |
|                                                                   |                                                                                                          | M%             | Other |       |  |
| 0                                                                 | 6 inches <b>TOPSOIL</b>                                                                                  |                |       |       |  |
|                                                                   | <b>FILL:</b> Brown and reddish-orange silty sand with gravel , cobbles to 8 inches, medium dense, moist. |                |       |       |  |
|                                                                   | <b>FILL:</b> Gray and reddish-orange silty sand with gravel , cobbles to 8 inches, medium dense, moist.  |                |       |       |  |
|                                                                   |                                                                                                          |                |       |       |  |
|                                                                   |                                                                                                          |                |       |       |  |
| 5                                                                 | 6 inches <b>TOPSOIL</b>                                                                                  |                |       |       |  |
|                                                                   | Tan and gray mottled reddish-orange silty SAND with gravel, medium dense, moist. (SM) (Glacial Till)     |                |       |       |  |
| Test Hole terminated at a depth of 7.0 feet below surface grades. |                                                                                                          |                |       |       |  |
| No groundwater seepage encountered.                               |                                                                                                          |                |       |       |  |

Figure A-2



## Test Hole TH-4

| DATE: February 13, 2024 |                                                                                              | LOGGED BY: BPK |       | ELEV: |  |
|-------------------------|----------------------------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)         | Soil Description                                                                             | Notes          |       |       |  |
|                         |                                                                                              | M%             | Other |       |  |
| 0                       | <b>FILL:</b> Tan, gray and brown silty sand with gravel, cobbles to 10 inches, loose, moist. |                |       |       |  |
|                         | <b>FILL:</b> Brown silty sand with gravel and topsoil, cobbles to 8 inches, loose, moist.    |                |       |       |  |
| 5                       | Large Boulder at 5.5 feet.                                                                   |                |       |       |  |
|                         | Test Hole terminated at a depth of 6.5 feet below surface grades.                            |                |       |       |  |
|                         | No groundwater seepage encountered.                                                          |                |       |       |  |

## Test Hole TH-5

| DATE: February 13, 2024                                           |                                                                                                   | LOGGED BY: BPK |       | ELEV: |  |
|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)                                                   | Soil Description                                                                                  | Notes          |       |       |  |
|                                                                   |                                                                                                   | M%             | Other |       |  |
| 0                                                                 | <b>FILL:</b> Tan, gray and brown silty sand with gravel, cobbles to 10 inches, loose, moist. (SM) |                |       |       |  |
|                                                                   |                                                                                                   |                |       |       |  |
|                                                                   |                                                                                                   |                |       |       |  |
|                                                                   | <b>TOPSOIL</b> , with cobbles.                                                                    |                |       |       |  |
| 5                                                                 | Gray silty <b>SAND</b> with gravel, medium dense, moist. (SM) (Glacial Till)                      |                |       |       |  |
| Test Hole terminated at a depth of 5.5 feet below surface grades. |                                                                                                   |                |       |       |  |
| No groundwater seepage encountered.                               |                                                                                                   |                |       |       |  |

## Test Hole TH-6

| DATE: February 13, 2024 |                                                                                                   | LOGGED BY: BPK |       | ELEV: |  |
|-------------------------|---------------------------------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)         | Soil Description                                                                                  | Notes          |       |       |  |
|                         |                                                                                                   | M%             | Other |       |  |
| 0                       | <b>FILL:</b> Tan, gray and brown silty sand with gravel, cobbles to 10 inches, loose, moist. (SM) |                |       |       |  |
|                         |                                                                                                   |                |       |       |  |
|                         |                                                                                                   |                |       |       |  |
|                         |                                                                                                   |                |       |       |  |
|                         |                                                                                                   |                |       |       |  |
|                         |                                                                                                   |                |       |       |  |
|                         | <b>TOPSOIL</b> , with cobbles.                                                                    |                |       |       |  |
| 5                       | Gray silty <b>SAND</b> with gravel, medium dense, moist. (SM) (Glacial Till)                      |                |       |       |  |
|                         | Test Hole terminated at a depth of 6.0 feet below surface grades.                                 |                |       |       |  |
|                         | No groundwater seepage encountered.                                                               |                |       |       |  |

Figure A-3

## Test Hole TH-7

| DATE: February 13, 2024                                           |                                                                         | LOGGED BY: BPK |       | ELEV: |  |
|-------------------------------------------------------------------|-------------------------------------------------------------------------|----------------|-------|-------|--|
| Depth<br>(feet)                                                   | Soil Description                                                        | Notes          |       |       |  |
|                                                                   |                                                                         | M%             | Other |       |  |
| 0                                                                 | Tan SAND, trace silt, medium dense, moist. (SP) (Recessional Outwash)   |                |       |       |  |
| 5                                                                 | Gary SAND with silt, medium dense, moist. (SP/SM) (Recessional Outwash) |                |       |       |  |
|                                                                   | Gray silty SAND with gravel, medium dense, moist. (SM) (Glacial Till)   |                |       |       |  |
| Test Hole terminated at a depth of 6.5 feet below surface grades. |                                                                         |                |       |       |  |
| No groundwater seepage encountered.                               |                                                                         |                |       |       |  |

## Test Hole TH-8

| DATE: February 13, 2024                                           |                                                                               | LOGGED BY: BPK |  | ELEV: |       |
|-------------------------------------------------------------------|-------------------------------------------------------------------------------|----------------|--|-------|-------|
| Depth<br>(feet)                                                   | Soil Description                                                              | Notes          |  | M%    | Other |
|                                                                   |                                                                               |                |  |       |       |
| 0                                                                 | Reddish-orange silty <b>SAND</b> with gravel, medium dense, moist. (SM)       |                |  |       |       |
|                                                                   | Tan <b>SAND</b> , trace silt, medium dense, moist. (SP) (Recessional Outwash) |                |  |       |       |
| Test Hole terminated at a depth of 3.0 feet below surface grades. |                                                                               |                |  |       |       |
| No groundwater seepage encountered.                               |                                                                               |                |  |       |       |
| 5                                                                 |                                                                               |                |  |       |       |

Figure A-4

## **APPENDIX B**

### **SMALL PILOT INFILTRATION TEST**

**Shaw Road Residential  
Puyallup, Washington**



## Small Pilot Infiltration Test (Small PIT)

### Excavation:

Test Pit Surface Dimensions

Test Pit Bottom Dimensions

Test Pit Bottom Area

Test Pit Depth

|    |   |             |
|----|---|-------------|
| 4  | 5 | feet        |
| 3  | 4 | feet        |
| 12 |   | square feet |
| 8  |   | feet        |

### Pre-Soak Period:

| Time (hh:mm) | Depth of Water (inches) |
|--------------|-------------------------|
| 10:00        | 16                      |
| 11:00        | 18                      |
| 12:00        | 17                      |
| 13:00        | 18                      |
| 14:00        | 18                      |
| 15:00        | 18                      |
| 16:00        | 18                      |

### Steady-State Period:

| Time of Measurement (hh:mm) | Depth of Water (inches) | Cumulative Volume (gallons) | Flow Rate (gpm) | Infiltration Rate (inches/hour) |
|-----------------------------|-------------------------|-----------------------------|-----------------|---------------------------------|
| 16:00                       | 18                      |                             |                 | 0.3                             |
| 16:15                       | 18                      |                             |                 | 0.4                             |
| 16:30                       | 18                      |                             |                 | 0.4                             |
| 16:45                       | 18                      |                             |                 | 0.4                             |
| 17:00                       | 18                      |                             |                 | 0.4                             |

**Falling Head Period:**

| Time of Measurement<br>15-min intervals | Depth of Water<br>(inches) | Infiltration Rate<br>(inches/hour) |
|-----------------------------------------|----------------------------|------------------------------------|
| 17:00                                   | 18                         | 0                                  |
| 17:15                                   | 17.5                       | 2                                  |
| 17:30                                   | 17                         | 2                                  |
| 17:45                                   | 16.5                       | 2                                  |
| 18:00                                   | 16                         | 2                                  |

**Rate Determination:**

Steady State

0.4 (inches/hour)

Falling Head

2 (inches/hour)

Selected Rate:

0.4 (inches/hour)

Correction Factor:

A

1

B

0.5

C

0.9

Design Rate:

0.18 (inches/hour)

# Ages Engineering

A Geotechnical Engineering Services Company

P.O. Box 935  
Puyallup, WA. 98371

Main (253) 845-7000

www.agesengineering.com

December 23, 2024  
Project No. A-1692

Mingqi Shao  
12319 NE 68<sup>th</sup> Place  
Kirkland, WA 98033

Subject: Infiltration Testing  
Shaw Road Residential  
2317 Shaw Road  
Puyallup, Washington

Reference: Geotechnical Report, Shaw Road Residential, prepared by Ages Engineering, dated August 6, 2024

Dear Mr. Shao,

As requested, we have completed the on-site infiltration testing on Lot 4 for the subject site located at 2317 Shaw Road in Puyallup, Washington. We discussed the project with you and were previously provided with a Site Plan showing the lot locations.

Based on the information provided to us, we understand the project will consist of dividing the site into 4 residential. The existing residence on the south end of the site will remain. The north end of the site will be divided into three additional residential lots. The development storm water for each lot will discharge to infiltration facilities on each lot. The driveways and sidewalks will be constructed using permeable pavement. We previously performed infiltration testing on the site and currently have been requested to perform an additional infiltration test on the north end of Lot 4 adjacent to our previous TH-8 location.

## CONCLUSIONS AND RECOMMENDATIONS

We visited the site to perform one Small PIT in the approximate center of the north end of Lot 4 on the subject site. The infiltration test was performed in accordance with the City of Puyallup specifications.

To prepare the infiltration test area, we excavated the surface area around the test location to 5.0 feet by 4.0 feet. The test area was then excavated to a depth of 4.0 feet below surface grades and the size of the bottom of the test hole was 4.0 feet by 3.0 feet equating to a top surface area of 20 square feet. The side slopes were laid back at an approximate 0.75:1 inclination to avoid caving during the testing procedure. The bottom of the infiltration test pit measured approximately 4.0 feet by 3.0 feet equating to a surface area of 12.0 square feet. The test was performed in medium dense native sand with silt and gravel consistent with Advance Outwash.



A vertical measuring rod was placed in the infiltration test hole to allow accurate measuring of the infiltration rate during testing. We utilized a  $\frac{3}{4}$  inch diameter flexible hose to convey water from a house spigot into a barrel adjacent the the test hole. The water was discharged from the barrel onto a splash block placed in the center of the infiltration test hole. The infiltration test hole was filled with 12 to 13 inches of water and allowed to soak for 6 hours. During the pre-soak period, the water flow through the hose was slightly altered to try and match the infiltration rate. After the 6-hour soak period, the Steady State period was performed. Water was added to the test hole at a rate that maintained a depth of 12 inches of water in the hole for 1 hour. Every 15 minutes during that hour, we estimated the cumulative volume and instantaneous flow rate (in gallons per minute) necessary to maintain 12 inches of water in the test hole. The hose did not have any devices that were able to accurately measure the cumulative volume and instantaneous flow rate. Therefor we had to calculate these values by periodically placing a one-gallon container between the hose and the pit. After the 1-hour Steady State period, the water was turned off and the infiltration rate was measured every 15 minutes for 1 hour. The measured rate in PIT 1 was 9.3 inches per hour, and the maximum falling head rate was 9.5 inches per hour. We utilized the measured rate of 9.3 for our design. The correction factors are 1.0 for Uniformity of Site Conditions, 0.5 for the small PIT, and 0.9 for Potential Siltation. After the correction factors have been applied, the long-term design infiltration rate for the site is 4.2 inches per hour.

We performed the infiltration testing on the site during a period of wet weather in the first month of the wet season. After the testing was complete, the test hole was excavated further but due to light rainfall and dark conditions due to heavy tree canopy coverage, it was nearly impossible to determine how deep the wet soils extended to. We obtained a soil sample during our site exploration and delivered it to an outside testing laboratory for determination of the cation exchange capacity (CEC) of the soil.

Based on our infiltration testing on the site, it is our opinion that the infiltration of the development storm water is feasible. Based on the results of our Small PIT, and the specifications provided by the City of Puyallup, we recommend the infiltration system be sized using a long-term design infiltration rate of 4.2 inches per hour.



We trust this information is sufficient for your current needs. If you have any questions, or require additional information, please call.

Respectfully Submitted,  
Ages Engineering

Bernard P. Knoll, II, P.E.  
Principal

BPK:bpk  
Project No.: A-1591



Small Pilot Infiltration Test (Small PIT)

Project Name: Shaw Road Residential  
Project Number: A-1692

Date: December 18, 2024  
Field Representative BK

Excavation:

|                             |      |     |             |
|-----------------------------|------|-----|-------------|
| Test Pit Surface Dimensions | 3.0  | 5.0 | feet        |
| Test Pit Bottom Dimensions  | 3.0  | 4.0 | feet        |
| Test Pit Bottom Area        | 12.0 |     | square feet |
| Test Pit Depth              | 4.0  |     | feet        |

Pre-Soak Period:

| Time (hh:mm) | Depth of Water (inches) |
|--------------|-------------------------|
| 9:00         | 8.5                     |
| 9:30         | 10.5                    |
| 10:00        | 11.0                    |
| 10:30        | 12.0                    |
| 11:00        | 12.0                    |
| 11:30        | 13.5                    |
| 12:00        | 12.0                    |
| 12:30        | 13.0                    |
| 1:00         | 12.0                    |
| 2:30         | 12.0                    |

Steady-State Period:

|                    |           |         |            |
|--------------------|-----------|---------|------------|
| On-Site Rate Test: | Container | 1       | Gallon Jug |
|                    | Volume    | 0.13368 | ft^3       |
|                    |           | 0.00    | in^3       |
|                    | Time      | 0:52:00 | 0.87 min   |
|                    |           | 0:52:00 | 0.87 min   |
|                    |           | 0:52:00 | 0.87 min   |

| Time of Measurement (hh:mm) | Depth of Water (inches) | Cumulative Volume (gallons) | Flow Rate (gpm) | Infiltration Rate (inches/hour) |
|-----------------------------|-------------------------|-----------------------------|-----------------|---------------------------------|
| 1:30                        | 14.0                    | 0                           |                 |                                 |
| 1:45                        | 14.0                    | 17.31                       | 1.15            | 9.3                             |
| 2:00                        | 14.0                    | 17.31                       | 1.15            | 9.3                             |
| 2:15                        | 14.0                    | 17.31                       | 1.15            | 9.3                             |
|                             |                         |                             |                 |                                 |
|                             |                         |                             |                 |                                 |
|                             |                         |                             |                 |                                 |

Falling Head Period:

| Time of<br>Measurement<br>15-min intervals | Depth of Water<br>(inches) | Infiltration Rate<br>(inches/hour) |
|--------------------------------------------|----------------------------|------------------------------------|
| 4:30                                       | 12.0                       |                                    |
| 4:45                                       | 6.5                        | 9.5                                |
| 5:00                                       | 1.0                        | 9.5                                |
| 5:15                                       | 0.0                        | 5.0                                |
| 5:30                                       | 0.0                        | 4.0                                |

**Rate Determination:**

Steady State  (inches/hour)

Falling Head  (inches/hour)

Selected Rate:  (inches/hour)

Correction Factor:

|   |                                  |
|---|----------------------------------|
| A | <input type="text" value="1"/>   |
| B | <input type="text" value="0.5"/> |
| C | <input type="text" value="0.9"/> |

**Design Rate:**  (inches/hour)

## **Appendix E: Flow Control and Water Quality Calculations**

*Attached*



Green text indicates commentary from modeler.

## MGS FLOOD PROJECT REPORT

Program Version: MGSFlood 4.69  
Program License Number: 202010013  
Project Simulation Performed on: 04/21/2026 4:39 PM  
Report Generation Date: 04/21/2026 4:39 PM

Input File Name: 2026-001 Shao Short Plat Rev0.fld  
Project Name: 2026-001 Shao Short Plat  
Analysis Title: Rev 0  
Comments: WQ and Flow Control

### PRECIPITATION INPUT

Computational Time Step (Minutes): 15

Extended Precipitation Time Series Selected

Full Period of Record Available used for Routing

Climatic Region Number: 43  
Precipitation Station : 910040 Pierce Co. East 40 in 10/01/1939-10/01/2147  
Evaporation Station : 911040 Pierce Co. East 40 in

Evaporation Scale Factor : 0.750

HSPF Parameter Region Number: 1  
HSPF Parameter Region Name : Ecology Default

\*\*\*\*\* Default HSPF Parameters Used (Not Modified by User) \*\*\*\*\*

### \*\*\*\*\* WATERSHED DEFINITION \*\*\*\*\*

#### Predevelopment/Post Development Tributary Area Summary

|                                                | Predeveloped | Post Developed |
|------------------------------------------------|--------------|----------------|
| Total Subbasin Area (acres)                    | 0.990        | 0.795          |
| Area of Links that Include Precip/Evap (acres) | 0.000        | 0.138          |
| Total (acres)                                  | 0.990        | 0.933          |

#### -----SCENARIO: PREDEVELOPED

Number of Subbasins: 1

----- Subbasin : Subbasin 1 -----  
-----Area (Acres) -----  
C, Forest, Mod 0.990

A pre-development benchmark is  
used, even though not required.

Subbasin Total 0.990

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 4

----- Subbasin : Lot 4 Roof -----  
-----Area (Acres) -----  
ROOF TOPS/FLAT 0.073  
-----  
Subbasin Total 0.073

----- Subbasin : Lot 3 Roof -----  
-----Area (Acres) -----  
ROOF TOPS/FLAT 0.073  
-----  
Subbasin Total 0.073

----- Subbasin : Lot 2 Roof -----  
-----Area (Acres) -----  
ROOF TOPS/FLAT 0.073  
-----  
Subbasin Total 0.073

----- Subbasin : Amended Soils/Sheet Flow -----  
-----Area (Acres) -----  
C, Pasture, Flat 0.519  
C, Lawn, Flat 0.057  
-----  
Subbasin Total 0.576

The total modeled area in post-development is slightly less than pre-development because of the small change in TDA areas. This accurately models changes in flow that are experienced by the receiving point of Upper Deer Creek.

\*\*\*\*\* LINK DATA \*\*\*\*\*

-----SCENARIO: PREDEVELOPED

Number of Links: 0

\*\*\*\*\* LINK DATA \*\*\*\*\*

-----SCENARIO: POSTDEVELOPED

Number of Links: 5

-----  
**Link Name: POC**  
Link Type: Copy  
Downstream Link: None

-----  
**Link Name: Lot 4 DS Trench**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 60.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 2.50  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 4.20

---

**Link Name: Lot 2 DS Trench**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 60.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 2.50  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 4.20

---

**Link Name: Lot 3 DS Trench**

Link Type: Infiltration Trench  
Downstream Link Name: POC

Trench Type : Trench on Embankment Sideslope  
Trench Length (ft) : 60.00  
Trench Width (ft) : 3.00  
Trench Depth (ft) : 2.50  
Trench Bottom Elev (ft) : 100.00  
Trench Rockfill Porosity (%) : 30.00

Constant Infiltration Option Used  
Infiltration Rate (in/hr): 4.20

---

**Link Name: General Permeable DW**

Link Type: Porous Pavement Structure  
Downstream Link Name: POC

Pavement Length (ft) : 15.00  
Pavement Width (ft) : 400.00  
Pavement Slope (ft/ft) : 0.020  
Pavement Infiltration Rate (in/hr) : 20.000  
Number of Infiltration Cells : 1

The objective of this model is to show that there is a reasonable permeable pavement solution. At flat slopes, 6 inches of ballast rock is enough to produce 100 percent infiltration. Detailing and thicker section is required for more sloped areas. TBD at time of building permits when driveway layout can be known.

Trench Cell Length (ft) : 15.00  
Trench Cell Width (ft) : 400.00  
Trench Cell Depth (ft) : 0.50  
Trench Gravel Porosity (%) : 30.00  
Trench Bed Slope (ft/ft) : 0.020  
Native Soil Infiltration Rate (in/hr) : 0.180

\*\*\*\*\*FLOOD FREQUENCY AND DURATION STATISTICS\*\*\*\*\*

-----SCENARIO: PREDEVELOPED

Number of Subbasins: 1

Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Subbasins: 4

Number of Links: 5

\*\*\*\*\* Subbasin: Lot 4 Roof \*\*\*\*\*

Flood Frequency Data (cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs) Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 3.037E-02 |
| 5-Year   | 4.227E-02 |
| 10-Year  | 4.987E-02 |
| 25-Year  | 6.087E-02 |
| 50-Year  | 7.543E-02 |
| 100-Year | 8.290E-02 |
| 200-Year | 8.729E-02 |
| 500-Year | 9.514E-02 |

\*\*\*\*\* Subbasin: Lot 3 Roof \*\*\*\*\*

Flood Frequency Data (cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs) Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 3.037E-02 |
| 5-Year   | 4.227E-02 |
| 10-Year  | 4.987E-02 |
| 25-Year  | 6.087E-02 |
| 50-Year  | 7.543E-02 |
| 100-Year | 8.290E-02 |
| 200-Year | 8.729E-02 |
| 500-Year | 9.514E-02 |

\*\*\*\*\* Subbasin: Lot 2 Roof \*\*\*\*\*

Flood Frequency Data (cfs)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs) Flood Peak (cfs)



|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 3.037E-02 |
| 5-Year   | 4.227E-02 |
| 10-Year  | 4.987E-02 |
| 25-Year  | 6.087E-02 |
| 50-Year  | 7.543E-02 |
| 100-Year | 8.290E-02 |
| 200-Year | 8.729E-02 |
| 500-Year | 9.514E-02 |

\*\*\*\*\* Subbasin: Amended Soils/Sheet Flow \*\*\*\*\*

Flood Frequency Data (cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 2.024E-02 |
| 5-Year   | 3.692E-02 |
| 10-Year  | 5.135E-02 |
| 25-Year  | 8.133E-02 |
| 50-Year  | 0.126     |
| 100-Year | 0.156     |
| 200-Year | 0.171     |
| 500-Year | 0.197     |

\*\*\*\*\* Link: POC

\*\*\*\*\* Link Inflow

Frequency Stats  
 Flood Frequency Data (cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 2.024E-02 |
| 5-Year   | 3.692E-02 |
| 10-Year  | 5.510E-02 |
| 25-Year  | 8.134E-02 |
| 50-Year  | 0.140     |
| 100-Year | 0.156     |
| 200-Year | 0.171     |
| 500-Year | 0.197     |

\*\*\*\*\* Link: Lot 4 DS Trench \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data (cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 3.037E-02 |
| 5-Year   | 4.227E-02 |
| 10-Year  | 4.987E-02 |
| 25-Year  | 6.087E-02 |
| 50-Year  | 7.543E-02 |
| 100-Year | 8.290E-02 |

|          |           |
|----------|-----------|
| 200-Year | 8.729E-02 |
| 500-Year | 9.514E-02 |

\*\*\*\*\* Link: Lot 4 DS Trench \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data (cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs) Flood Peak (cfs)

=====

|          |           |
|----------|-----------|
| 2-Year   | 1.564E-06 |
| 5-Year   | 3.517E-06 |
| 10-Year  | 4.768E-06 |
| 25-Year  | 7.191E-06 |
| 50-Year  | 9.308E-06 |
| 100-Year | 1.049E-05 |
| 200-Year | 1.123E-05 |
| 500-Year | 1.181E-05 |

\*\*\*\*\* Link: Lot 4 DS Trench \*\*\*\*\* Link WSEL Stats

WSEL Frequency Data(ft)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs) WSEL Peak (ft)

=====

|           |         |
|-----------|---------|
| 1.05-Year | 100.016 |
| 1.11-Year | 100.041 |
| 1.25-Year | 100.110 |
| 2.00-Year | 100.312 |
| 3.33-Year | 100.493 |
| 5-Year    | 100.708 |
| 10-Year   | 100.958 |
| 25-Year   | 101.439 |
| 50-Year   | 101.863 |
| 100-Year  | 102.099 |

\*\*\*\*\* Link: Lot 2 DS Trench \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data (cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

Tr (yrs) Flood Peak (cfs)

=====

|          |           |
|----------|-----------|
| 2-Year   | 3.037E-02 |
| 5-Year   | 4.227E-02 |
| 10-Year  | 4.987E-02 |
| 25-Year  | 6.087E-02 |
| 50-Year  | 7.543E-02 |
| 100-Year | 8.290E-02 |
| 200-Year | 8.729E-02 |
| 500-Year | 9.514E-02 |

\*\*\*\*\* Link: Lot 2 DS Trench \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data (cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 1.564E-06 |
| 5-Year   | 3.517E-06 |
| 10-Year  | 4.768E-06 |
| 25-Year  | 7.191E-06 |
| 50-Year  | 9.308E-06 |
| 100-Year | 1.049E-05 |
| 200-Year | 1.123E-05 |
| 500-Year | 1.181E-05 |

\*\*\*\*\* Link: Lot 2 DS Trench \*\*\*\*\*      Link WSEL Stats

WSEL Frequency Data(ft)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      WSEL Peak (ft)

|           |         |
|-----------|---------|
| =====     |         |
| 1.05-Year | 100.016 |
| 1.11-Year | 100.041 |
| 1.25-Year | 100.110 |
| 2.00-Year | 100.312 |
| 3.33-Year | 100.493 |
| 5-Year    | 100.708 |
| 10-Year   | 100.958 |
| 25-Year   | 101.439 |
| 50-Year   | 101.863 |
| 100-Year  | 102.099 |

\*\*\*\*\* Link: Lot 3 DS Trench \*\*\*\*\*      Link Inflow Frequency Stats

Flood Frequency Data (cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

|          |           |
|----------|-----------|
| =====    |           |
| 2-Year   | 3.037E-02 |
| 5-Year   | 4.227E-02 |
| 10-Year  | 4.987E-02 |
| 25-Year  | 6.087E-02 |
| 50-Year  | 7.543E-02 |
| 100-Year | 8.290E-02 |
| 200-Year | 8.729E-02 |
| 500-Year | 9.514E-02 |

\*\*\*\*\* Link: Lot 3 DS Trench \*\*\*\*\*      Link Outflow 1 Frequency Stats

Flood Frequency Data (cfs)  
 (Recurrence Interval Computed Using Gringorten Plotting Position)  
 Tr (yrs)      Flood Peak (cfs)

|        |           |
|--------|-----------|
| =====  |           |
| 2-Year | 1.564E-06 |
| 5-Year | 3.517E-06 |

|          |           |
|----------|-----------|
| 10-Year  | 4.768E-06 |
| 25-Year  | 7.191E-06 |
| 50-Year  | 9.308E-06 |
| 100-Year | 1.049E-05 |
| 200-Year | 1.123E-05 |
| 500-Year | 1.181E-05 |

\*\*\*\*\* Link: Lot 3 DS Trench \*\*\*\*\* Link WSEL Stats

WSEL Frequency Data(ft)

(Recurrence Interval Computed Using Gringorten Plotting Position)

| Tr (yrs)  | WSEL Peak (ft) |
|-----------|----------------|
| =====     |                |
| 1.05-Year | 100.016        |
| 1.11-Year | 100.041        |
| 1.25-Year | 100.110        |
| 2.00-Year | 100.312        |
| 3.33-Year | 100.493        |
| 5-Year    | 100.708        |
| 10-Year   | 100.958        |
| 25-Year   | 101.439        |
| 50-Year   | 101.863        |
| 100-Year  | 102.099        |

\*\*\*\*\* Link: General Permeable DW \*\*\*\*\* Link Inflow Frequency Stats

Flood Frequency Data (cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

| Tr (yrs) | Flood Peak (cfs) |
|----------|------------------|
| =====    |                  |
| 2-Year   | 0.000E+00        |
| 5-Year   | 0.000E+00        |
| 10-Year  | 0.000E+00        |
| 25-Year  | 0.000E+00        |
| 50-Year  | 0.000E+00        |
| 100-Year | 0.000E+00        |
| 200-Year | 0.000E+00        |
| 500-Year | 0.000E+00        |

\*\*\*\*\* Link: General Permeable DW \*\*\*\*\* Link Outflow 1 Frequency Stats

Flood Frequency Data (cfs)

(Recurrence Interval Computed Using Gringorten Plotting Position)

| Tr (yrs) | Flood Peak (cfs) |
|----------|------------------|
| =====    |                  |
| 2-Year   | 0.000E+00        |
| 5-Year   | 0.000E+00        |
| 10-Year  | 0.000E+00        |
| 25-Year  | 0.000E+00        |
| 50-Year  | 1.820E-03        |
| 100-Year | 2.043E-02        |
| 200-Year | 4.422E-02        |
| 500-Year | 8.863E-02        |



\*\*\*\*\* Link: General Permeable DW \*\*\*\*\* Link WSEL Stats

WSEL Frequency Data(ft)  
(Recurrence Interval Computed Using Gringorten Plotting Position)  
Tr (yrs)          WSEL Peak (ft)

|           |       |
|-----------|-------|
| =====     |       |
| 1.05-Year | 0.226 |
| 1.11-Year | 0.240 |
| 1.25-Year | 0.249 |
| 2.00-Year | 0.287 |
| 3.33-Year | 0.316 |
| 5-Year    | 0.336 |
| 10-Year   | 0.379 |
| 25-Year   | 0.435 |
| 50-Year   | 0.490 |
| 100-Year  | 0.500 |

\*\*\*\*\***Groundwater Recharge Summary**\*\*\*\*\*

Recharge is computed as input to PerInd Groundwater Plus Infiltration in Structures

| Total Predeveloped Recharge During Simulation |                         |
|-----------------------------------------------|-------------------------|
| Model Element                                 | Recharge Amount (ac-ft) |
| -----                                         |                         |
| Subbasin: Subbasin 1                          | 224.530                 |
| -----                                         |                         |
| Total:                                        | 224.530                 |

| Total Post Developed Recharge During Simulation |                         |
|-------------------------------------------------|-------------------------|
| Model Element                                   | Recharge Amount (ac-ft) |
| -----                                           |                         |
| Subbasin: Lot 4 Roof                            | 0.000                   |
| Subbasin: Lot 3 Roof                            | 0.000                   |
| Subbasin: Lot 2 Roof                            | 0.000                   |
| Subbasin: Amended Soils/Sheet                   | 119.458                 |
| Link: POC                                       | 0.000                   |
| Link: Lot 4 DS Trench                           | 43.319                  |
| Link: Lot 2 DS Trench                           | 43.319                  |
| Link: Lot 3 DS Trench                           | 43.319                  |
| Link: General Permeable DW                      | 95.272                  |
| -----                                           |                         |
| Total:                                          | 344.686                 |

**Total Predevelopment Recharge is Less than Post Developed**  
**Average Recharge Per Year, (Number of Years= 208)**  
**Predeveloped: 1.079 ac-ft/year, Post Developed: 1.657 ac-ft/year**

\*\*\*\*\***Water Quality Facility Data**\*\*\*\*\*

-----**SCENARIO: PREDEVELOPED**

Number of Links: 0

-----SCENARIO: POSTDEVELOPED

Number of Links: 5

\*\*\*\*\* Link: POC

\*\*\*\*\*

2-Year Discharge Rate : 0.020 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge

On-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Off-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Infiltration/Filtration Statistics-----

Inflow Volume (ac-ft): 104.07

Inflow Volume Including PPT-Evap (ac-ft): 104.07

Total Runoff Infiltrated (ac-ft): 0.00, 0.00%

Total Runoff Filtered (ac-ft): 0.00, 0.00%

Primary Outflow To Downstream System (ac-ft): 104.07

Secondary Outflow To Downstream System (ac-ft): 0.00

Volume Lost to ET (ac-ft): 0.00

Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 0.00%

\*\*\*\*\* Link: Lot 4 DS Trench \*\*\*\*\*

2-Year Discharge Rate : 0.000 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge

On-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Off-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Infiltration/Filtration Statistics-----

Inflow Volume (ac-ft): 43.32

Inflow Volume Including PPT-Evap (ac-ft): 43.32

Total Runoff Infiltrated (ac-ft): 43.32, 100.00%

Total Runoff Filtered (ac-ft): 0.00, 0.00%

Primary Outflow To Downstream System (ac-ft): 0.00

Secondary Outflow To Downstream System (ac-ft): 0.00

Volume Lost to ET (ac-ft): 0.00

Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* Link: Lot 2 DS Trench \*\*\*\*\*

2-Year Discharge Rate : 0.000 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge

On-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Off-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Infiltration/Filtration Statistics-----

Inflow Volume (ac-ft): 43.32

Inflow Volume Including PPT-Evap (ac-ft): 43.32

Total Runoff Infiltrated (ac-ft): 43.32, 100.00%  
 Total Runoff Filtered (ac-ft): 0.00, 0.00%  
 Primary Outflow To Downstream System (ac-ft): 0.00  
 Secondary Outflow To Downstream System (ac-ft): 0.00  
 Volume Lost to ET (ac-ft): 0.00  
 Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* [Link: Lot 3 DS Trench](#) \*\*\*\*\*

2-Year Discharge Rate : 0.000 cfs

15-Minute Timestep, Water Quality Treatment Design Discharge  
 On-line Design Discharge Rate (91% Exceedance): 0.01 cfs  
 Off-line Design Discharge Rate (91% Exceedance): 0.01 cfs

Infiltration/Filtration Statistics-----

Inflow Volume (ac-ft): 43.32  
 Inflow Volume Including PPT-Evap (ac-ft): 43.32  
 Total Runoff Infiltrated (ac-ft): 43.32, 100.00%  
 Total Runoff Filtered (ac-ft): 0.00, 0.00%  
 Primary Outflow To Downstream System (ac-ft): 0.00  
 Secondary Outflow To Downstream System (ac-ft): 0.00  
 Volume Lost to ET (ac-ft): 0.00  
 Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\* [Link: General Permeable DW](#) \*\*\*\*\*

Infiltration/Filtration Statistics-----

Inflow Volume (ac-ft): 0.00  
 Inflow Volume Including PPT-Evap (ac-ft): 95.27  
 Total Runoff Infiltrated (ac-ft): 95.27, 100.00%  
 Total Runoff Filtered (ac-ft): 0.00, 0.00%  
 Primary Outflow To Downstream System (ac-ft): 0.01  
 Secondary Outflow To Downstream System (ac-ft): 0.00  
 Volume Lost to ET (ac-ft): 0.00  
 Percent Treated (Infiltrated+Filtered+ET)/Total Volume: 100.00%

\*\*\*\*\***Compliance Point Results**\*\*\*\*\*

Scenario Predeveloped Compliance Subbasin: Subbasin 1

Scenario Postdeveloped Compliance Link: POC

\*\*\* **Point of Compliance Flow Frequency Data** \*\*\*

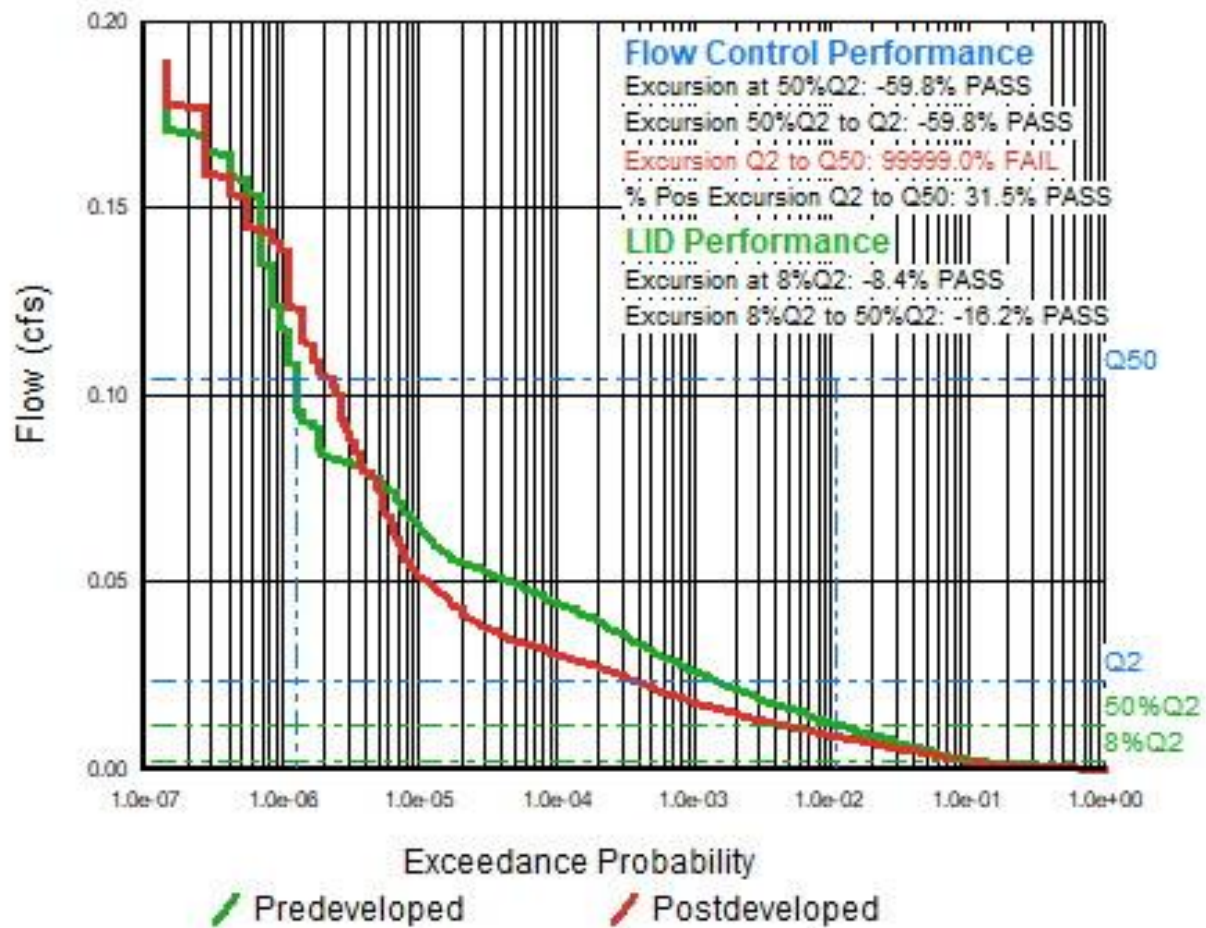
Recurrence Interval Computed Using Gringorten Plotting Position

| Predevelopment Runoff |                 | Postdevelopment Runoff |                 |
|-----------------------|-----------------|------------------------|-----------------|
| Tr (Years)            | Discharge (cfs) | Tr (Years)             | Discharge (cfs) |
| 2-Year                | 2.338E-02       | 2-Year                 | 2.024E-02       |
| 5-Year                | 4.145E-02       | 5-Year                 | 3.692E-02       |
| 10-Year               | 5.429E-02       | 10-Year                | 5.510E-02       |
| 25-Year               | 7.449E-02       | 25-Year                | 8.134E-02       |
| 50-Year               | 0.104           | 50-Year                | 0.140           |

|          |       |          |       |
|----------|-------|----------|-------|
| 100-Year | 0.167 | 100-Year | 0.156 |
| 200-Year | 0.176 | 200-Year | 0.171 |
| 500-Year | 0.189 | 500-Year | 0.197 |

\*\* Record too Short to Compute Peak Discharge for These Recurrence Intervals

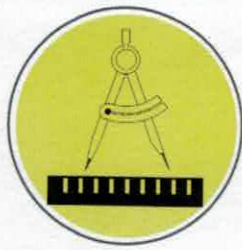
## Flow Duration Plot





## **Appendix F: Conveyance Calculations**

*Attached*



# Valor Civil Engineering, PLLC

Tacoma, Washington  
(253) 861-7741  
valorcivilengineering@hotmail.com

Project Name Shao Short Plot

Task Conveyance Pipe Check

Project No. 2026-001 Date 4/21/2026

Calculations by FJM Page 1 of 1

The roof drain pipe is 4"  $\phi$  SCH 40 PVC at 2% slope.

ID for 4"  $\phi$  SCH 40 PVC = 3.978  $\rightarrow$  use 4 inches

1. Find capacity of 4" pipe flowing full.

$$Q = \frac{1.49}{n} A R^{2/3} \sqrt{S}$$

$n = 0.011$  for PVC  
 $S = 0.02$  ft/ft

$$A = \frac{\pi}{4} D^2 \quad R = \frac{\frac{\pi D^2}{4}}{2\pi R} = \frac{\frac{\pi D^2}{4}}{\pi D} = D/4$$

$$A = \frac{\pi}{4} (4.12)^2 = 0.0873 \text{ ft}^2 \quad R = 0.0833 \text{ ft}$$

$$Q = \frac{1.49}{0.011} (0.0873)(0.0833)^{2/3} \sqrt{0.02} = 0.306 \text{ ft}^3/\text{s}$$

2. Check against design events:  $P_{25} = 3.3$  in  
 $P_{100} = 4.2$  in

Instantaneous Flow rates are calculated using SBA method.  
Calculations attached

$$Q_p(25) = 0.060 \text{ ft}^3/\text{s}$$

$$F.S. = 0.306 / 0.060 = 5.1$$

$$Q_p(100) = 0.077 \text{ ft}^3/\text{s}$$

$$F.S. = 0.306 / 0.077 = 3.97$$

Therefore, 4"  $\phi$  PVC is very adequate for proposed maximum roof.

Roof Analysis for 25-year, 24-hour Event

Total Area (ac)

0.0734619

Area (ft<sup>2</sup>)

3200

Pervious CN

74 Pervious S

3.51 0.2S

0.702

Impervious CN

98 Impervious S

0.204 0.2S

0.0408

T<sub>c</sub> (min)

6.3

w

0.4424779

Perv. Area (ft<sup>2</sup>)

0

Imperv. Area (ft<sup>2</sup>)

3200

dt (min)

10

P (25 yr, 24-hr) (in)

3.3

|                |                |                                  |                           |                           | Pervious                |                          | Impervious              |                          |                   |                         |                        |
|----------------|----------------|----------------------------------|---------------------------|---------------------------|-------------------------|--------------------------|-------------------------|--------------------------|-------------------|-------------------------|------------------------|
| 1              | 2              | 3                                | 4                         | 5                         | 6                       | 7                        | 8                       | 9                        | 10                | 11                      | 12                     |
| Time Increment | Time (minutes) | Rainfall Distribution (fraction) | Incremental Rainfall (in) | Accumulated Rainfall (in) | Accumulated Runoff (in) | Incremenetal Runoff (in) | Accumulated Runoff (in) | Incremenetal Runoff (in) | Total Runoff (in) | Instant Flow Rate (cfs) | Design flow rate (cfs) |
| 1              | 0              | 0                                | 0                         | 0                         | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 2              | 10             | 0.004                            | 0.0132                    | 0.0132                    | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 3              | 20             | 0.004                            | 0.0132                    | 0.0264                    | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 4              | 30             | 0.004                            | 0.0132                    | 0.0396                    | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 5              | 40             | 0.004                            | 0.0132                    | 0.0528                    | 0                       | 0                        | 0.000666667             | 0.000666667              | 0.000666667       | 0.000296296             | 0.0001311              |
| 6              | 50             | 0.004                            | 0.0132                    | 0.066                     | 0                       | 0                        | 0.002770681             | 0.002104014              | 0.002104014       | 0.000935117             | 0.00055996             |
| 7              | 60             | 0.004                            | 0.0132                    | 0.0792                    | 0                       | 0                        | 0.006083168             | 0.003312488              | 0.003312488       | 0.001472217             | 0.00112961             |
| 8              | 70             | 0.004                            | 0.0132                    | 0.0924                    | 0                       | 0                        | 0.010416901             | 0.004333733              | 0.004333733       | 0.001926104             | 0.00163364             |
| 9              | 80             | 0.004                            | 0.0132                    | 0.1056                    | 0                       | 0                        | 0.015621429             | 0.005204527              | 0.005204527       | 0.002313123             | 0.0020637              |
| 10             | 90             | 0.004                            | 0.0132                    | 0.1188                    | 0                       | 0                        | 0.021574468             | 0.00595304               | 0.00595304        | 0.002645795             | 0.00243163             |
| 11             | 100            | 0.004                            | 0.0132                    | 0.132                     | 0                       | 0                        | 0.02817561              | 0.006601142              | 0.006601142       | 0.002933841             | 0.00274861             |
| 12             | 110            | 0.005                            | 0.0165                    | 0.1485                    | 0                       | 0                        | 0.037212993             | 0.009037384              | 0.009037384       | 0.004016615             | 0.00339163             |
| 13             | 120            | 0.005                            | 0.0165                    | 0.165                     | 0                       | 0                        | 0.047000731             | 0.009787738              | 0.009787738       | 0.004350106             | 0.00409228             |
| 14             | 130            | 0.005                            | 0.0165                    | 0.1815                    | 0                       | 0                        | 0.05743107              | 0.010430339              | 0.010430339       | 0.004635706             | 0.00444682             |
| 15             | 140            | 0.005                            | 0.0165                    | 0.198                     | 0                       | 0                        | 0.068415947             | 0.010984876              | 0.010984876       | 0.004882167             | 0.00472303             |
| 16             | 150            | 0.005                            | 0.0165                    | 0.2145                    | 0                       | 0                        | 0.079882685             | 0.011466738              | 0.011466738       | 0.005096328             | 0.00495862             |
| 17             | 160            | 0.005                            | 0.0165                    | 0.231                     | 0                       | 0                        | 0.091770776             | 0.011888092              | 0.011888092       | 0.005283596             | 0.00516335             |
| 18             | 170            | 0.006                            | 0.0198                    | 0.2508                    | 0                       | 0                        | 0.106521739             | 0.014750963              | 0.014750963       | 0.006555983             | 0.00583277             |
| 19             | 180            | 0.006                            | 0.0198                    | 0.2706                    | 0                       | 0                        | 0.12173361              | 0.015211871              | 0.015211871       | 0.006760831             | 0.00656342             |
| 20             | 190            | 0.006                            | 0.0198                    | 0.2904                    | 0                       | 0                        | 0.137346032             | 0.015612422              | 0.015612422       | 0.006938854             | 0.00681689             |
| 21             | 200            | 0.006                            | 0.0198                    | 0.3102                    | 0                       | 0                        | 0.153308745             | 0.015962714              | 0.015962714       | 0.007094539             | 0.00699371             |
| 22             | 210            | 0.006                            | 0.0198                    | 0.33                      | 0                       | 0                        | 0.169579562             | 0.016270817              | 0.016270817       | 0.007231474             | 0.00714353             |
| 23             | 220            | 0.006                            | 0.0198                    | 0.3498                    | 0                       | 0                        | 0.186122807             | 0.016543245              | 0.016543245       | 0.007352553             | 0.00727493             |
| 24             | 230            | 0.007                            | 0.0231                    | 0.3729                    | 0                       | 0                        | 0.205727308             | 0.019604501              | 0.019604501       | 0.008713112             | 0.00794564             |
| 25             | 240            | 0.007                            | 0.0231                    | 0.396                     | 0                       | 0                        | 0.225620601             | 0.019893293              | 0.019893293       | 0.008841463             | 0.00868161             |
| 26             | 250            | 0.007                            | 0.0231                    | 0.4191                    | 0                       | 0                        | 0.245768315             | 0.020147714              | 0.020147714       | 0.00895454              | 0.00887311             |
| 27             | 260            | 0.007                            | 0.0231                    | 0.4422                    | 0                       | 0                        | 0.266141328             | 0.020373013              | 0.020373013       | 0.009054672             | 0.00898948             |
| 28             | 270            | 0.007                            | 0.0231                    | 0.4653                    | 0                       | 0                        | 0.286714797             | 0.020573469              | 0.020573469       | 0.009143764             | 0.00908659             |
| 29             | 280            | 0.007                            | 0.0231                    | 0.4884                    | 0                       | 0                        | 0.307467403             | 0.020752606              | 0.020752606       | 0.009223381             | 0.00917242             |
| 30             | 290            | 0.008                            | 0.0264                    | 0.5148                    | 0                       | 0                        | 0.331380531             | 0.023913128              | 0.023913128       | 0.010628057             | 0.00983906             |
| 31             | 300            | 0.008                            | 0.0264                    | 0.5412                    | 0                       | 0                        | 0.355480068             | 0.024099537              | 0.024099537       | 0.010710905             | 0.01057395             |
| 32             | 310            | 0.008                            | 0.0264                    | 0.5676                    | 0                       | 0                        | 0.379745813             | 0.024265745              | 0.024265745       | 0.010784775             | 0.01072783             |
| 33             | 320            | 0.008                            | 0.0264                    | 0.594                     | 0                       | 0                        | 0.40416038              | 0.024414568              | 0.024414568       | 0.010850919             | 0.01080749             |
| 34             | 330            | 0.008                            | 0.0264                    | 0.6204                    | 0                       | 0                        | 0.428708729             | 0.024548349              | 0.024548349       | 0.010910377             | 0.01087223             |
| 35             | 340            | 0.008                            | 0.0264                    | 0.6468                    | 0                       | 0                        | 0.453377778             | 0.024669049              | 0.024669049       | 0.010964022             | 0.01092973             |
| 36             | 350            | 0.01                             | 0.033                     | 0.6798                    | 0                       | 0                        | 0.484366548             | 0.03098877               | 0.03098877        | 0.013772787             | 0.01220289             |
| 37             | 360            | 0.01                             | 0.033                     | 0.7128                    | 3.31288E-05             | 3.31288E-05              | 0.515506849             | 0.031140301              | 0.031140301       | 0.013840134             | 0.01362198             |
| 38             | 370            | 0.01                             | 0.033                     | 0.7458                    | 0.000539828             | 0.000506699              | 0.546782178             | 0.031275329              | 0.031275329       | 0.013900146             | 0.01384159             |
| 39             | 380            | 0.01                             | 0.033                     | 0.7788                    | 0.00164443              | 0.001104602              | 0.578178344             | 0.031396166              | 0.031396166       | 0.013953851             | 0.01391717             |
| 40             | 390            | 0.01                             | 0.033                     | 0.8118                    | 0.003330582             | 0.001686152              | 0.609683077             | 0.031504733              | 0.031504733       | 0.014002104             | 0.01397098             |
| 41             | 400            | 0.01                             | 0.033                     | 0.8448                    | 0.005582523             | 0.002251941              | 0.641285714             | 0.031602637              | 0.031602637       | 0.014045617             | 0.01401778             |
| 42             | 410            | 0.013                            | 0.0429                    | 0.8877                    | 0.009330977             | 0.003748454              | 0.682500343             | 0.041214628              | 0.041214628       | 0.018317613             | 0.01593268             |
| 43             | 420            | 0.013                            | 0.0429                    | 0.9306                    | 0.013977949             | 0.004646972              | 0.723847175             | 0.041346832              | 0.041346832       | 0.01837637              | 0.01806924             |
| 44             | 430            | 0.013                            | 0.0429                    | 0.9735                    | 0.01949286              | 0.005514911              | 0.765311243             | 0.041464068              | 0.041464068       | 0.018428475             | 0.01836409             |
| 45             | 440            | 0.018                            | 0.0594                    | 1.0329                    | 0.028507592             | 0.009014732              | 0.822893078             | 0.057581834              | 0.057581834       | 0.025591926             | 0.02159074             |
| 46             | 450            | 0.018                            | 0.0594                    | 1.0923                    | 0.039057019             | 0.010549427              | 0.880646953             | 0.057753876              | 0.057753876       | 0.025668389             | 0.02516545             |
| 47             | 460            | 0.034                            | 0.1122                    | 1.2045                    | 0.062929907             | 0.023872888              | 0.990127725             | 0.109480772              | 0.109480772       | 0.048658121             | 0.03578298             |
| 48             | 470            | 0.054                            | 0.1782                    | 1.3827                    | 0.110566848             | 0.047636941              | 1.164820241             | 0.174692515              | 0.174692515       | 0.077641118             | 0.06000124             |
| 49             | 480            | 0.027                            | 0.0891                    | 1.4718                    | 0.138462554             | 0.027895706              | 1.252453211             | 0.08763297               | 0.08763297        | 0.038947987             | 0.0584909              |
| 50             | 490            | 0.018                            | 0.0594                    | 1.5312                    | 0.158456084             | 0.01999353               | 1.310960907             | 0.058507696              | 0.058507696       | 0.02600342              | 0.0354686              |
| 51             | 500            | 0.013                            | 0.0429                    | 1.5741                    | 0.173560259             | 0.015104175              | 1.353254412             | 0.042293506              | 0.042293506       | 0.018797114             | 0.0239037              |
| 52             | 510            | 0.013                            | 0.0429                    | 1.617                     | 0.18920339              | 0.015643131              | 1.395577149             | 0.042322737              | 0.042322737       | 0.018810105             | 0.01939035             |
| 53             | 520            | 0.013                            | 0.0429                    | 1.6599                    | 0.205369952             | 0.016166562              | 1.437927053             | 0.042349904              | 0.042349904       | 0.01882218              | 0.0188822              |
| 54             | 530            | 0.009                            | 0.0297                    | 1.6896                    | 0.216860939             | 0.011490987              | 1.46726114              | 0.029334087              | 0.029334087       | 0.013037372             | 0.01626944             |
| 55             | 540            | 0.009                            | 0.0297                    | 1.7193                    | 0.228590836             | 0.011729896              | 1.496606773             | 0.029345633              | 0.029345633       | 0.013042504             | 0.01341147             |
| 56             | 550            | 0.009                            | 0.0297                    | 1.749                     | 0.24055497              | 0.011964135              | 1.525963414             | 0.029356641              | 0.029356641       | 0.013047396             | 0.01308712             |
| 57             | 560            | 0.009                            | 0.0297                    | 1.7787                    | 0.252748793             | 0.01219382               |                         |                          |                   |                         |                        |

|     |      |       |        |        |             |             |             |             |             |             |            |
|-----|------|-------|--------|--------|-------------|-------------|-------------|-------------|-------------|-------------|------------|
| 84  | 830  | 0.006 | 0.0198 | 2.4321 | 0.571219253 | 0.010882474 | 2.20333514  | 0.019676725 | 0.019676725 | 0.008745211 | 0.00874468 |
| 85  | 840  | 0.006 | 0.0198 | 2.4519 | 0.582168864 | 0.010949611 | 2.223013732 | 0.019678591 | 0.019678591 | 0.008746041 | 0.00874552 |
| 86  | 850  | 0.006 | 0.0198 | 2.4717 | 0.593184857 | 0.011015993 | 2.242694148 | 0.019680416 | 0.019680416 | 0.008746852 | 0.00874634 |
| 87  | 860  | 0.006 | 0.0198 | 2.4915 | 0.604266487 | 0.01108163  | 2.262376348 | 0.0196822   | 0.0196822   | 0.008747644 | 0.00874714 |
| 88  | 870  | 0.006 | 0.0198 | 2.5113 | 0.615413022 | 0.011146535 | 2.282060292 | 0.019683944 | 0.019683944 | 0.00874842  | 0.00874793 |
| 89  | 880  | 0.006 | 0.0198 | 2.5311 | 0.62662374  | 0.011210718 | 2.301745941 | 0.01968565  | 0.01968565  | 0.008749178 | 0.0087487  |
| 90  | 890  | 0.005 | 0.0165 | 2.5476 | 0.636014519 | 0.009390779 | 2.318151926 | 0.016405984 | 0.016405984 | 0.007291549 | 0.00810415 |
| 91  | 900  | 0.005 | 0.0165 | 2.5641 | 0.64544897  | 0.00943445  | 2.334559047 | 0.016407122 | 0.016407122 | 0.007292054 | 0.00738526 |
| 92  | 910  | 0.005 | 0.0165 | 2.5806 | 0.65492669  | 0.00947772  | 2.350967286 | 0.016408239 | 0.016408239 | 0.007292551 | 0.007303   |
| 93  | 920  | 0.005 | 0.0165 | 2.5971 | 0.664447283 | 0.009520593 | 2.367376622 | 0.016409336 | 0.016409336 | 0.007293038 | 0.00729397 |
| 94  | 930  | 0.005 | 0.0165 | 2.6136 | 0.674010359 | 0.009563075 | 2.383787035 | 0.016410413 | 0.016410413 | 0.007293517 | 0.00729336 |
| 95  | 940  | 0.005 | 0.0165 | 2.6301 | 0.683615529 | 0.009605171 | 2.400198507 | 0.016411472 | 0.016411472 | 0.007293987 | 0.00729371 |
| 96  | 950  | 0.005 | 0.0165 | 2.6466 | 0.693262413 | 0.009646884 | 2.416611019 | 0.016412511 | 0.016412511 | 0.00729445  | 0.00729416 |
| 97  | 960  | 0.005 | 0.0165 | 2.6631 | 0.702950633 | 0.00968822  | 2.433024552 | 0.016413533 | 0.016413533 | 0.007294904 | 0.00729462 |
| 98  | 970  | 0.005 | 0.0165 | 2.6796 | 0.712679816 | 0.009729183 | 2.449439088 | 0.016414537 | 0.016414537 | 0.00729535  | 0.00729507 |
| 99  | 980  | 0.005 | 0.0165 | 2.6961 | 0.722449594 | 0.009769778 | 2.465854611 | 0.016415523 | 0.016415523 | 0.007295788 | 0.00729551 |
| 100 | 990  | 0.005 | 0.0165 | 2.7126 | 0.732259602 | 0.009810008 | 2.482271104 | 0.016416492 | 0.016416492 | 0.007296219 | 0.00729595 |
| 101 | 1000 | 0.005 | 0.0165 | 2.7291 | 0.742109481 | 0.009849879 | 2.498688549 | 0.016417445 | 0.016417445 | 0.007296642 | 0.00729637 |
| 102 | 1010 | 0.004 | 0.0132 | 2.7423 | 0.750017853 | 0.007908372 | 2.51182318  | 0.013134631 | 0.013134631 | 0.005837614 | 0.00665102 |
| 103 | 1020 | 0.004 | 0.0132 | 2.7555 | 0.757951335 | 0.007933482 | 2.524958403 | 0.013135223 | 0.013135223 | 0.005837877 | 0.00593131 |
| 104 | 1030 | 0.004 | 0.0132 | 2.7687 | 0.765909748 | 0.007958413 | 2.538094209 | 0.013135806 | 0.013135806 | 0.005838136 | 0.00584874 |
| 105 | 1040 | 0.004 | 0.0132 | 2.7819 | 0.773892916 | 0.007983168 | 2.55123059  | 0.013136381 | 0.013136381 | 0.005838392 | 0.00583947 |
| 106 | 1050 | 0.004 | 0.0132 | 2.7951 | 0.781900664 | 0.008007748 | 2.564367539 | 0.013136949 | 0.013136949 | 0.005838644 | 0.00583863 |
| 107 | 1060 | 0.004 | 0.0132 | 2.8083 | 0.789932819 | 0.008032155 | 2.577505048 | 0.013137509 | 0.013137509 | 0.005838893 | 0.00583875 |
| 108 | 1070 | 0.004 | 0.0132 | 2.8215 | 0.797989209 | 0.00805639  | 2.59064311  | 0.013138062 | 0.013138062 | 0.005839139 | 0.00583899 |
| 109 | 1080 | 0.004 | 0.0132 | 2.8347 | 0.806069663 | 0.008080455 | 2.603781717 | 0.013138607 | 0.013138607 | 0.005839381 | 0.00583923 |
| 110 | 1090 | 0.004 | 0.0132 | 2.8479 | 0.814174015 | 0.008104351 | 2.616920863 | 0.013139146 | 0.013139146 | 0.00583962  | 0.00583947 |
| 111 | 1100 | 0.004 | 0.0132 | 2.8611 | 0.822302096 | 0.008128081 | 2.63006054  | 0.013139677 | 0.013139677 | 0.005839856 | 0.00583971 |
| 112 | 1110 | 0.004 | 0.0132 | 2.8743 | 0.830453741 | 0.008151645 | 2.643200741 | 0.013140201 | 0.013140201 | 0.005840089 | 0.00583994 |
| 113 | 1120 | 0.004 | 0.0132 | 2.8875 | 0.838628786 | 0.008175045 | 2.656341459 | 0.013140719 | 0.013140719 | 0.005840319 | 0.00584017 |
| 114 | 1130 | 0.004 | 0.0132 | 2.9007 | 0.846827069 | 0.008198283 | 2.669482689 | 0.013141229 | 0.013141229 | 0.005840546 | 0.0058404  |
| 115 | 1140 | 0.004 | 0.0132 | 2.9139 | 0.85504843  | 0.008221361 | 2.682624422 | 0.013141734 | 0.013141734 | 0.00584077  | 0.00584063 |
| 116 | 1150 | 0.004 | 0.0132 | 2.9271 | 0.863292708 | 0.008244278 | 2.695766654 | 0.013142231 | 0.013142231 | 0.005840992 | 0.00584085 |
| 117 | 1160 | 0.004 | 0.0132 | 2.9403 | 0.871559746 | 0.008267038 | 2.708909377 | 0.013142723 | 0.013142723 | 0.00584121  | 0.00584107 |
| 118 | 1170 | 0.004 | 0.0132 | 2.9535 | 0.879849388 | 0.008289642 | 2.722052584 | 0.013143208 | 0.013143208 | 0.005841426 | 0.00584129 |
| 119 | 1180 | 0.004 | 0.0132 | 2.9667 | 0.888161479 | 0.00831209  | 2.735196271 | 0.013143687 | 0.013143687 | 0.005841639 | 0.0058415  |
| 120 | 1190 | 0.004 | 0.0132 | 2.9799 | 0.896495864 | 0.008334385 | 2.748340431 | 0.01314416  | 0.01314416  | 0.005841849 | 0.00584172 |
| 121 | 1200 | 0.004 | 0.0132 | 2.9931 | 0.904852392 | 0.008356528 | 2.761485058 | 0.013144627 | 0.013144627 | 0.005842056 | 0.00584193 |
| 122 | 1210 | 0.004 | 0.0132 | 3.0063 | 0.913230912 | 0.00837852  | 2.774630147 | 0.013145088 | 0.013145088 | 0.005842261 | 0.00584213 |
| 123 | 1220 | 0.004 | 0.0132 | 3.0195 | 0.921631274 | 0.008400362 | 2.78777569  | 0.013145544 | 0.013145544 | 0.005842464 | 0.00584234 |
| 124 | 1230 | 0.004 | 0.0132 | 3.0327 | 0.930053331 | 0.008422057 | 2.800921684 | 0.013145994 | 0.013145994 | 0.005842664 | 0.00584254 |
| 125 | 1240 | 0.004 | 0.0132 | 3.0459 | 0.938496935 | 0.008443604 | 2.814068122 | 0.013146438 | 0.013146438 | 0.005842861 | 0.00584274 |
| 126 | 1250 | 0.004 | 0.0132 | 3.0591 | 0.946961942 | 0.008465007 | 2.827214999 | 0.013146877 | 0.013146877 | 0.005843056 | 0.00584293 |
| 127 | 1260 | 0.004 | 0.0132 | 3.0723 | 0.955448207 | 0.008486265 | 2.840362309 | 0.01314731  | 0.01314731  | 0.005843249 | 0.00584313 |
| 128 | 1270 | 0.004 | 0.0132 | 3.0855 | 0.963955587 | 0.00850738  | 2.853510047 | 0.013147738 | 0.013147738 | 0.005843439 | 0.00584332 |
| 129 | 1280 | 0.004 | 0.0132 | 3.0987 | 0.97248394  | 0.008528354 | 2.866658208 | 0.013148161 | 0.013148161 | 0.005843627 | 0.00584351 |
| 130 | 1290 | 0.004 | 0.0132 | 3.1119 | 0.981033127 | 0.008549187 | 2.879806788 | 0.013148579 | 0.013148579 | 0.005843813 | 0.0058437  |
| 131 | 1300 | 0.004 | 0.0132 | 3.1251 | 0.989603009 | 0.008569881 | 2.89295578  | 0.013148992 | 0.013148992 | 0.005843996 | 0.00584388 |
| 132 | 1310 | 0.004 | 0.0132 | 3.1383 | 0.998193446 | 0.008590438 | 2.906105179 | 0.0131494   | 0.0131494   | 0.005844178 | 0.00584406 |
| 133 | 1320 | 0.004 | 0.0132 | 3.1515 | 1.006804304 | 0.008610858 | 2.919254982 | 0.013149803 | 0.013149803 | 0.005844357 | 0.00584424 |
| 134 | 1330 | 0.004 | 0.0132 | 3.1647 | 1.015435446 | 0.008631142 | 2.932405183 | 0.013150201 | 0.013150201 | 0.005844534 | 0.00584442 |
| 135 | 1340 | 0.004 | 0.0132 | 3.1779 | 1.024086739 | 0.008651293 | 2.945555778 | 0.013150595 | 0.013150595 | 0.005844709 | 0.0058446  |
| 136 | 1350 | 0.004 | 0.0132 | 3.1911 | 1.032758049 | 0.00867131  | 2.958706761 | 0.013150983 | 0.013150983 | 0.005844882 | 0.00584477 |
| 137 | 1360 | 0.004 | 0.0132 | 3.2043 | 1.041449244 | 0.008691195 | 2.971858129 | 0.013151368 | 0.013151368 | 0.005845052 | 0.00584494 |
| 138 | 1370 | 0.004 | 0.0132 | 3.2175 | 1.050160194 | 0.00871095  | 2.985009877 | 0.013151747 | 0.013151747 | 0.005845221 | 0.00584511 |
| 139 | 1380 | 0.004 | 0.0132 | 3.2307 | 1.05889077  | 0.008730575 | 2.998161999 | 0.013152123 | 0.013152123 | 0.005845388 | 0.00584528 |
| 140 | 1390 | 0.004 | 0.0132 | 3.2439 | 1.067640842 | 0.008750072 | 3.011314493 | 0.013152494 | 0.013152494 | 0.005845553 | 0.00584545 |
| 141 | 1400 | 0.004 | 0.0132 | 3.2571 | 1.076410283 | 0.008769442 | 3.024467354 | 0.01315286  | 0.01315286  | 0.005845716 | 0.00584561 |
| 142 | 1410 | 0.004 | 0.0132 | 3.2703 | 1.085198968 | 0.008788685 | 3.037620577 | 0.013153223 | 0.013153223 | 0.005845877 | 0.00584578 |
| 143 | 1420 | 0.003 | 0.0099 | 3.2802 | 1.091803035 | 0.006604067 | 3.047485729 | 0.009865153 | 0.009865153 | 0.004384512 | 0.00519924 |
| 144 | 1430 | 0.003 | 0.0099 | 3.2901 | 1.098417804 | 0.006614769 | 3.057351082 | 0.009865352 | 0.009865352 | 0.004384601 | 0.00447828 |
| 145 | 1440 | 0.003 | 0.0099 | 3.3    | 1.105043222 | 0.006625418 | 3.067216632 | 0.00986555  | 0.00986555  | 0.004384689 | 0.00439542 |

|                                    |            |
|------------------------------------|------------|
| Peak instantaneous flow rate (cfs) | 0.06000124 |
|------------------------------------|------------|



| Roof Analysis for 100-year, 24-hour Event |                 |       |      |        |
|-------------------------------------------|-----------------|-------|------|--------|
| Total Area (ac)                           | 0.0734619       |       |      |        |
| Area (ft <sup>2</sup> )                   | 3200            |       |      |        |
| Pervious CN                               | 74 Pervious S   | 3.51  | 0.2S | 0.702  |
| Impervious CN                             | 98 Impervious S | 0.204 | 0.2S | 0.0408 |
| T <sub>c</sub> (min)                      | 6.3             |       |      |        |
| w                                         | 0.4424779       |       |      |        |
| Perv. Area (ft <sup>2</sup> )             | 0               |       |      |        |
| Imperv. Area (ft <sup>2</sup> )           | 3200            |       |      |        |
| dt (min)                                  | 10              |       |      |        |
| P (25 yr, 24-hr) (in)                     | 4.2             |       |      |        |

|                |                |                                  |                           |                           | Pervious                |                          | Impervious              |                          |                   |                         |                        |
|----------------|----------------|----------------------------------|---------------------------|---------------------------|-------------------------|--------------------------|-------------------------|--------------------------|-------------------|-------------------------|------------------------|
| 1              | 2              | 3                                | 4                         | 5                         | 6                       | 7                        | 8                       | 9                        | 10                | 11                      | 12                     |
| Time Increment | Time (minutes) | Rainfall Distribution (fraction) | Incremental Rainfall (in) | Accumulated Rainfall (in) | Accumulated Runoff (in) | Incremenetal Runoff (in) | Accumulated Runoff (in) | Incremenetal Runoff (in) | Total Runoff (in) | Instant Flow Rate (cfs) | Design flow rate (cfs) |
| 1              | 0              | 0                                | 0                         | 0                         | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 2              | 10             | 0.004                            | 0.0168                    | 0.0168                    | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 3              | 20             | 0.004                            | 0.0168                    | 0.0336                    | 0                       | 0                        | 0                       | 0                        | 0                 | 0                       | 0                      |
| 4              | 30             | 0.004                            | 0.0168                    | 0.0504                    | 0                       | 0                        | 0.000431461             | 0.000431461              | 0.000431461       | 0.00019176              | 8.485E-05              |
| 5              | 40             | 0.004                            | 0.0168                    | 0.0672                    | 0                       | 0                        | 0.003025                | 0.002593539              | 0.002593539       | 0.001152684             | 0.00060465             |
| 6              | 50             | 0.004                            | 0.0168                    | 0.084                     | 0                       | 0                        | 0.007549515             | 0.004524515              | 0.004524515       | 0.002010895             | 0.00146938             |
| 7              | 60             | 0.004                            | 0.0168                    | 0.1008                    | 0                       | 0                        | 0.013636364             | 0.006086849              | 0.006086849       | 0.002705266             | 0.00225584             |
| 8              | 70             | 0.004                            | 0.0168                    | 0.1176                    | 0                       | 0                        | 0.021005128             | 0.007368765              | 0.007368765       | 0.003275006             | 0.00290566             |
| 9              | 80             | 0.004                            | 0.0168                    | 0.1344                    | 0                       | 0                        | 0.02943871              | 0.008433581              | 0.008433581       | 0.003748258             | 0.00344192             |
| 10             | 90             | 0.004                            | 0.0168                    | 0.1512                    | 0                       | 0                        | 0.038766412             | 0.009327703              | 0.009327703       | 0.004145646             | 0.00388885             |
| 11             | 100            | 0.004                            | 0.0168                    | 0.168                     | 0                       | 0                        | 0.048852174             | 0.010085762              | 0.010085762       | 0.004482561             | 0.00426518             |
| 12             | 110            | 0.005                            | 0.021                     | 0.189                     | 0                       | 0                        | 0.062360136             | 0.013507962              | 0.013507962       | 0.006003539             | 0.00513055             |
| 13             | 120            | 0.005                            | 0.021                     | 0.21                      | 0                       | 0                        | 0.076711254             | 0.014351118              | 0.014351118       | 0.006378275             | 0.00606892             |
| 14             | 130            | 0.005                            | 0.021                     | 0.231                     | 0                       | 0                        | 0.091770776             | 0.015059522              | 0.015059522       | 0.006693121             | 0.006482               |
| 15             | 140            | 0.005                            | 0.021                     | 0.252                     | 0                       | 0                        | 0.107431214             | 0.015660438              | 0.015660438       | 0.006960194             | 0.00678701             |
| 16             | 150            | 0.005                            | 0.021                     | 0.273                     | 0                       | 0                        | 0.123605777             | 0.016174563              | 0.016174563       | 0.007188695             | 0.00704138             |
| 17             | 160            | 0.005                            | 0.021                     | 0.294                     | 0                       | 0                        | 0.140223622             | 0.016617845              | 0.016617845       | 0.007385709             | 0.00725892             |
| 18             | 170            | 0.006                            | 0.0252                    | 0.3192                    | 0                       | 0                        | 0.160668657             | 0.020445035              | 0.020445035       | 0.009086682             | 0.00812377             |
| 19             | 180            | 0.006                            | 0.0252                    | 0.3444                    | 0                       | 0                        | 0.181585816             | 0.020917159              | 0.020917159       | 0.009296515             | 0.00906875             |
| 20             | 190            | 0.006                            | 0.0252                    | 0.3696                    | 0                       | 0                        | 0.202908108             | 0.021322293              | 0.021322293       | 0.009476574             | 0.00934998             |
| 21             | 200            | 0.006                            | 0.0252                    | 0.3948                    | 0                       | 0                        | 0.224580645             | 0.021672537              | 0.021672537       | 0.009632239             | 0.00953089             |
| 22             | 210            | 0.006                            | 0.0252                    | 0.42                      | 0                       | 0                        | 0.246558025             | 0.02197738               | 0.02197738        | 0.009767724             | 0.00968053             |
| 23             | 220            | 0.006                            | 0.0252                    | 0.4452                    | 0                       | 0                        | 0.268802367             | 0.022244342              | 0.022244342       | 0.009886374             | 0.00981019             |
| 24             | 230            | 0.007                            | 0.0294                    | 0.4746                    | 0                       | 0                        | 0.295049294             | 0.026246928              | 0.026246928       | 0.011665301             | 0.01066475             |
| 25             | 240            | 0.007                            | 0.0294                    | 0.504                     | 0                       | 0                        | 0.321574101             | 0.026524806              | 0.026524806       | 0.011788803             | 0.01160484             |
| 26             | 250            | 0.007                            | 0.0294                    | 0.5334                    | 0                       | 0                        | 0.348341602             | 0.026767501              | 0.026767501       | 0.011896667             | 0.01181537             |
| 27             | 260            | 0.007                            | 0.0294                    | 0.5628                    | 0                       | 0                        | 0.375322314             | 0.026980712              | 0.026980712       | 0.011991428             | 0.01192924             |
| 28             | 270            | 0.007                            | 0.0294                    | 0.5922                    | 0                       | 0                        | 0.402491342             | 0.027169028              | 0.027169028       | 0.012075124             | 0.01202131             |
| 29             | 280            | 0.007                            | 0.0294                    | 0.6216                    | 0                       | 0                        | 0.429827523             | 0.027336181              | 0.027336181       | 0.012149414             | 0.0121018              |
| 30             | 290            | 0.008                            | 0.0336                    | 0.6552                    | 0                       | 0                        | 0.46125044              | 0.031422917              | 0.031422917       | 0.013965741             | 0.01294762             |
| 31             | 300            | 0.008                            | 0.0336                    | 0.6888                    | 0                       | 0                        | 0.49284507              | 0.031594631              | 0.031594631       | 0.014042058             | 0.01388238             |
| 32             | 310            | 0.008                            | 0.0336                    | 0.7224                    | 0.000117879             | 0.000117879              | 0.52459187              | 0.031746799              | 0.031746799       | 0.014109689             | 0.01405361             |
| 33             | 320            | 0.008                            | 0.0336                    | 0.756                     | 0.000818182             | 0.000700303              | 0.556474151             | 0.031882282              | 0.031882282       | 0.014169903             | 0.01412988             |
| 34             | 330            | 0.008                            | 0.0336                    | 0.7896                    | 0.002133022             | 0.00131484               | 0.588477582             | 0.03200343               | 0.03200343        | 0.014223747             | 0.01418912             |
| 35             | 340            | 0.008                            | 0.0336                    | 0.8232                    | 0.00404534              | 0.001912318              | 0.620589781             | 0.032112199              | 0.032112199       | 0.014272089             | 0.01424115             |
| 36             | 350            | 0.01                             | 0.042                     | 0.8652                    | 0.007250964             | 0.003205623              | 0.660866744             | 0.040276963              | 0.040276963       | 0.017900873             | 0.01587419             |
| 37             | 360            | 0.01                             | 0.042                     | 0.9072                    | 0.011333721             | 0.004082757              | 0.701278924             | 0.040412179              | 0.040412179       | 0.017960969             | 0.01769431             |
| 38             | 370            | 0.01                             | 0.042                     | 0.9492                    | 0.016264197             | 0.004930476              | 0.741811003             | 0.040532079              | 0.040532079       | 0.018014258             | 0.01795387             |
| 39             | 380            | 0.01                             | 0.042                     | 0.9912                    | 0.022014277             | 0.00575008               | 0.782449896             | 0.040638893              | 0.040638893       | 0.01806173              | 0.01802832             |
| 40             | 390            | 0.01                             | 0.042                     | 1.0332                    | 0.028557076             | 0.006542799              | 0.823184353             | 0.040734457              | 0.040734457       | 0.018104203             | 0.01807668             |
| 41             | 400            | 0.01                             | 0.042                     | 1.0752                    | 0.035866873             | 0.007309797              | 0.864004651             | 0.040820298              | 0.040820298       | 0.018142355             | 0.01811792             |
| 42             | 410            | 0.013                            | 0.0546                    | 1.1298                    | 0.04647591              | 0.010609038              | 0.917185615             | 0.053180964              | 0.053180964       | 0.023635984             | 0.02057035             |
| 43             | 420            | 0.013                            | 0.0546                    | 1.1844                    | 0.058288188             | 0.011812277              | 0.970481567             | 0.053295952              | 0.053295952       | 0.02368709              | 0.02330591             |
| 44             | 430            | 0.013                            | 0.0546                    | 1.239                     | 0.071255004             | 0.012966816              | 1.023879076             | 0.053397509              | 0.053397509       | 0.023732226             | 0.02366321             |
| 45             | 440            | 0.018                            | 0.0756                    | 1.3146                    | 0.091029632             | 0.019774628              | 1.09796078              | 0.074081704              | 0.074081704       | 0.032925202             | 0.02779197             |
| 46             | 450            | 0.018                            | 0.0756                    | 1.3902                    | 0.112814835             | 0.021785203              | 1.172190267             | 0.074229487              | 0.074229487       | 0.032990883             | 0.03236372             |
| 47             | 460            | 0.034                            | 0.1428                    | 1.533                     | 0.159078784             | 0.046263949              | 1.312734843             | 0.140544576              | 0.140544576       | 0.062464256             | 0.04596005             |
| 48             | 470            | 0.054                            | 0.2268                    | 1.7598                    | 0.244962748             | 0.085883964              | 1.536641186             | 0.223906343              | 0.223906343       | 0.09951393              | 0.0769592              |
| 49             | 480            | 0.027                            | 0.1134                    | 1.8732                    | 0.293025173             | 0.048062425              | 1.648836064             | 0.112194878              | 0.112194878       | 0.04986439              | 0.07495032             |
| 50             | 490            | 0.018                            | 0.0756                    | 1.9488                    | 0.326797477             | 0.033772304              | 1.723704545             | 0.074868482              | 0.074868482       | 0.033274881             | 0.04540989             |
| 51             | 500            | 0.013                            | 0.0546                    | 2.0034                    | 0.352006061             | 0.025208583              | 1.777807976             | 0.05410343               | 0.05410343        | 0.024045969             | 0.03058735             |
| 52             | 510            | 0.013                            | 0.0546                    | 2.058                     | 0.377874229             | 0.025868169              | 1.831935818             | 0.054127843              | 0.054127843       | 0.024056819             | 0.02480332             |
| 53             | 520            | 0.013                            | 0.0546                    | 2.1126                    | 0.404380027             | 0.026505797              | 1.886086317             | 0.054150498              | 0.054150498       | 0.024066888             | 0.02414715             |
| 54             | 530            | 0.009                            | 0.0378                    | 2.1504                    | 0.423092643             | 0.018712616              | 1.923587552             | 0.037501235              | 0.037501235       | 0.016667216             | 0.02080193             |
| 55             | 540            | 0.009                            | 0.0378                    | 2.1882                    | 0.44209408              | 0.019001437              | 1.961098392             | 0.037510841              | 0.037510841       | 0.016671485             | 0.01714478             |
| 56             | 550            | 0.009                            | 0.0378                    | 2.226                     | 0.461377831             | 0.019283751              | 1.998618383             | 0.03751999               | 0.03751999        | 0.016675551             | 0.01672773             |
| 57             | 560            | 0.009                            | 0.0378                    | 2.2638                    | 0.480937584             | 0.019559754              | 2.036147095             | 0.                       |                   |                         |                        |

|     |      |       |        |        |             |             |             |             |             |             |            |
|-----|------|-------|--------|--------|-------------|-------------|-------------|-------------|-------------|-------------|------------|
| 84  | 830  | 0.006 | 0.0252 | 3.0954 | 0.970349893 | 0.01625319  | 2.863371129 | 0.025100466 | 0.025100466 | 0.011155763 | 0.01115533 |
| 85  | 840  | 0.006 | 0.0252 | 3.1206 | 0.986679142 | 0.016329249 | 2.888473123 | 0.025101994 | 0.025101994 | 0.011156442 | 0.01115601 |
| 86  | 850  | 0.006 | 0.0252 | 3.1458 | 1.003083483 | 0.016404341 | 2.913576609 | 0.025103487 | 0.025103487 | 0.011157105 | 0.01115669 |
| 87  | 860  | 0.006 | 0.0252 | 3.171  | 1.019561967 | 0.016478484 | 2.938681555 | 0.025104946 | 0.025104946 | 0.011157754 | 0.01115734 |
| 88  | 870  | 0.006 | 0.0252 | 3.1962 | 1.03611366  | 0.016551694 | 2.963787926 | 0.025106372 | 0.025106372 | 0.011158387 | 0.01115799 |
| 89  | 880  | 0.006 | 0.0252 | 3.2214 | 1.052737646 | 0.016623985 | 2.988895692 | 0.025107766 | 0.025107766 | 0.011159007 | 0.01115862 |
| 90  | 890  | 0.005 | 0.021  | 3.2424 | 1.066645537 | 0.013907892 | 3.009819873 | 0.020924181 | 0.020924181 | 0.009299636 | 0.01033623 |
| 91  | 900  | 0.005 | 0.021  | 3.2634 | 1.08060249  | 0.013956953 | 3.030744983 | 0.02092511  | 0.02092511  | 0.009300049 | 0.00941907 |
| 92  | 910  | 0.005 | 0.021  | 3.2844 | 1.094607997 | 0.014005506 | 3.051671006 | 0.020926023 | 0.020926023 | 0.009300454 | 0.00931392 |
| 93  | 920  | 0.005 | 0.021  | 3.3054 | 1.108661557 | 0.01405356  | 3.072597924 | 0.020926918 | 0.020926918 | 0.009300853 | 0.00930218 |
| 94  | 930  | 0.005 | 0.021  | 3.3264 | 1.122762676 | 0.014101119 | 3.093525722 | 0.020927798 | 0.020927798 | 0.009301244 | 0.00930118 |
| 95  | 940  | 0.005 | 0.021  | 3.3474 | 1.136910869 | 0.014148192 | 3.114454384 | 0.020928662 | 0.020928662 | 0.009301627 | 0.00930141 |
| 96  | 950  | 0.005 | 0.021  | 3.3684 | 1.151105654 | 0.014194785 | 3.135383894 | 0.02092951  | 0.02092951  | 0.009302004 | 0.00930177 |
| 97  | 960  | 0.005 | 0.021  | 3.3894 | 1.165346558 | 0.014240904 | 3.156314237 | 0.020930343 | 0.020930343 | 0.009302375 | 0.00930214 |
| 98  | 970  | 0.005 | 0.021  | 3.4104 | 1.179633115 | 0.014286556 | 3.1772454   | 0.020931162 | 0.020931162 | 0.009302739 | 0.00930251 |
| 99  | 980  | 0.005 | 0.021  | 3.4314 | 1.193964862 | 0.014331747 | 3.198177366 | 0.020931966 | 0.020931966 | 0.009303036 | 0.00930287 |
| 100 | 990  | 0.005 | 0.021  | 3.4524 | 1.208341346 | 0.014376484 | 3.219110123 | 0.020932757 | 0.020932757 | 0.009303447 | 0.00930323 |
| 101 | 1000 | 0.005 | 0.021  | 3.4734 | 1.222762117 | 0.014420771 | 3.240043656 | 0.020933533 | 0.020933533 | 0.009303793 | 0.00930357 |
| 102 | 1010 | 0.004 | 0.0168 | 3.4902 | 1.234330323 | 0.011568206 | 3.256791033 | 0.016747377 | 0.016747377 | 0.007443279 | 0.00848053 |
| 103 | 1020 | 0.004 | 0.0168 | 3.507  | 1.245926366 | 0.011596043 | 3.273538892 | 0.016747859 | 0.016747859 | 0.007443493 | 0.0075627  |
| 104 | 1030 | 0.004 | 0.0168 | 3.5238 | 1.257550024 | 0.011623658 | 3.290287225 | 0.016748334 | 0.016748334 | 0.007443704 | 0.0074573  |
| 105 | 1040 | 0.004 | 0.0168 | 3.5406 | 1.269201077 | 0.011651054 | 3.307036028 | 0.016748802 | 0.016748802 | 0.007443912 | 0.00744536 |
| 106 | 1050 | 0.004 | 0.0168 | 3.5574 | 1.28087931  | 0.011678233 | 3.323785293 | 0.016749265 | 0.016749265 | 0.007444118 | 0.00744417 |
| 107 | 1060 | 0.004 | 0.0168 | 3.5742 | 1.292584507 | 0.011705197 | 3.340535014 | 0.016749721 | 0.016749721 | 0.00744432  | 0.00744421 |
| 108 | 1070 | 0.004 | 0.0168 | 3.591  | 1.304316456 | 0.011731949 | 3.357285185 | 0.016750171 | 0.016750171 | 0.00744452  | 0.0074444  |
| 109 | 1080 | 0.004 | 0.0168 | 3.6078 | 1.316074946 | 0.011758491 | 3.3740358   | 0.016750615 | 0.016750615 | 0.007444718 | 0.00744459 |
| 110 | 1090 | 0.004 | 0.0168 | 3.6246 | 1.327859771 | 0.011784824 | 3.390786853 | 0.016751053 | 0.016751053 | 0.007444912 | 0.00744479 |
| 111 | 1100 | 0.004 | 0.0168 | 3.6414 | 1.339670723 | 0.011810952 | 3.407538338 | 0.016751485 | 0.016751485 | 0.007445105 | 0.00744498 |
| 112 | 1110 | 0.004 | 0.0168 | 3.6582 | 1.3515076   | 0.011836877 | 3.42429025  | 0.016751912 | 0.016751912 | 0.007445294 | 0.00744517 |
| 113 | 1120 | 0.004 | 0.0168 | 3.675  | 1.363370199 | 0.011862599 | 3.441042582 | 0.016752333 | 0.016752333 | 0.007445481 | 0.00744536 |
| 114 | 1130 | 0.004 | 0.0168 | 3.6918 | 1.375258322 | 0.011888123 | 3.457795331 | 0.016752748 | 0.016752748 | 0.007445666 | 0.00744555 |
| 115 | 1140 | 0.004 | 0.0168 | 3.7086 | 1.387171771 | 0.011913449 | 3.474548489 | 0.016753158 | 0.016753158 | 0.007445848 | 0.00744573 |
| 116 | 1150 | 0.004 | 0.0168 | 3.7254 | 1.39911035  | 0.011938579 | 3.491302052 | 0.016753563 | 0.016753563 | 0.007446028 | 0.00744591 |
| 117 | 1160 | 0.004 | 0.0168 | 3.7422 | 1.411073866 | 0.011963517 | 3.508056015 | 0.016753963 | 0.016753963 | 0.007446206 | 0.00744609 |
| 118 | 1170 | 0.004 | 0.0168 | 3.759  | 1.423062129 | 0.011988262 | 3.524810372 | 0.016754357 | 0.016754357 | 0.007446381 | 0.00744627 |
| 119 | 1180 | 0.004 | 0.0168 | 3.7758 | 1.435074948 | 0.012012819 | 3.541565118 | 0.016754746 | 0.016754746 | 0.007446554 | 0.00744644 |
| 120 | 1190 | 0.004 | 0.0168 | 3.7926 | 1.447112135 | 0.012037188 | 3.558320249 | 0.016755131 | 0.016755131 | 0.007446725 | 0.00744662 |
| 121 | 1200 | 0.004 | 0.0168 | 3.8094 | 1.459173506 | 0.012061371 | 3.575075759 | 0.01675551  | 0.01675551  | 0.007446893 | 0.00744679 |
| 122 | 1210 | 0.004 | 0.0168 | 3.8262 | 1.471258877 | 0.012085371 | 3.591831644 | 0.016755885 | 0.016755885 | 0.00744706  | 0.00744695 |
| 123 | 1220 | 0.004 | 0.0168 | 3.843  | 1.483368065 | 0.012109188 | 3.608587899 | 0.016756255 | 0.016756255 | 0.007447224 | 0.00744712 |
| 124 | 1230 | 0.004 | 0.0168 | 3.8598 | 1.495500891 | 0.012132826 | 3.625344519 | 0.01675662  | 0.01675662  | 0.007447387 | 0.00744728 |
| 125 | 1240 | 0.004 | 0.0168 | 3.8766 | 1.507657176 | 0.012156285 | 3.6421015   | 0.016756981 | 0.016756981 | 0.007447547 | 0.00744745 |
| 126 | 1250 | 0.004 | 0.0168 | 3.8934 | 1.519836745 | 0.012179568 | 3.658858837 | 0.016757337 | 0.016757337 | 0.007447706 | 0.00744761 |
| 127 | 1260 | 0.004 | 0.0168 | 3.9102 | 1.532039421 | 0.012202677 | 3.675616527 | 0.016757689 | 0.016757689 | 0.007447862 | 0.00744776 |
| 128 | 1270 | 0.004 | 0.0168 | 3.927  | 1.544265033 | 0.012225612 | 3.692374564 | 0.016758037 | 0.016758037 | 0.007448016 | 0.00744792 |
| 129 | 1280 | 0.004 | 0.0168 | 3.9438 | 1.55651341  | 0.012248376 | 3.709132944 | 0.01675838  | 0.01675838  | 0.007448169 | 0.00744807 |
| 130 | 1290 | 0.004 | 0.0168 | 3.9606 | 1.568784381 | 0.012270971 | 3.725891663 | 0.016758719 | 0.016758719 | 0.00744832  | 0.00744822 |
| 131 | 1300 | 0.004 | 0.0168 | 3.9774 | 1.581077779 | 0.012293398 | 3.742650717 | 0.016759054 | 0.016759054 | 0.007448469 | 0.00744837 |
| 132 | 1310 | 0.004 | 0.0168 | 3.9942 | 1.593393437 | 0.012315659 | 3.759410102 | 0.016759385 | 0.016759385 | 0.007448616 | 0.00744852 |
| 133 | 1320 | 0.004 | 0.0168 | 4.011  | 1.605731192 | 0.012337755 | 3.776169815 | 0.016759712 | 0.016759712 | 0.007448761 | 0.00744867 |
| 134 | 1330 | 0.004 | 0.0168 | 4.0278 | 1.61809088  | 0.012359688 | 3.79292985  | 0.016760035 | 0.016760035 | 0.007448904 | 0.00744881 |
| 135 | 1340 | 0.004 | 0.0168 | 4.0446 | 1.63047234  | 0.01238146  | 3.809690204 | 0.016760354 | 0.016760354 | 0.007449046 | 0.00744896 |
| 136 | 1350 | 0.004 | 0.0168 | 4.0614 | 1.642875413 | 0.012403072 | 3.826450873 | 0.01676067  | 0.01676067  | 0.007449186 | 0.0074491  |
| 137 | 1360 | 0.004 | 0.0168 | 4.0782 | 1.655299939 | 0.012424526 | 3.843211855 | 0.016760981 | 0.016760981 | 0.007449325 | 0.00744924 |
| 138 | 1370 | 0.004 | 0.0168 | 4.095  | 1.667745763 | 0.012445824 | 3.859973144 | 0.016761289 | 0.016761289 | 0.007449462 | 0.00744938 |
| 139 | 1380 | 0.004 | 0.0168 | 4.1118 | 1.680212729 | 0.012466966 | 3.876734737 | 0.016761593 | 0.016761593 | 0.007449597 | 0.00744951 |
| 140 | 1390 | 0.004 | 0.0168 | 4.1286 | 1.692700683 | 0.012487955 | 3.893496631 | 0.016761894 | 0.016761894 | 0.007449731 | 0.00744965 |
| 141 | 1400 | 0.004 | 0.0168 | 4.1454 | 1.705209475 | 0.012508791 | 3.910258822 | 0.016762191 | 0.016762191 | 0.007449863 | 0.00744978 |
| 142 | 1410 | 0.004 | 0.0168 | 4.1622 | 1.717738952 | 0.012529477 | 3.927021307 | 0.016762485 | 0.016762485 | 0.007449993 | 0.00744991 |
| 143 | 1420 | 0.003 | 0.0126 | 4.1748 | 1.727149545 | 0.009410593 | 3.939593361 | 0.012572054 | 0.012572054 | 0.00558758  | 0.00662591 |
| 144 | 1430 | 0.003 | 0.0126 | 4.1874 | 1.736571627 | 0.009422082 | 3.952165577 | 0.012572216 | 0.012572216 | 0.005587652 | 0.00570707 |
| 145 | 1440 | 0.003 | 0.0126 | 4.2    | 1.746005137 | 0.00943351  | 3.964737954 | 0.012572377 | 0.012572377 | 0.005587723 | 0.00560142 |

|                                    |           |
|------------------------------------|-----------|
| Peak instantaneous flow rate (cfs) | 0.0769592 |
|------------------------------------|-----------|