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FARRIS SHORT PLAT

Lot 2 Improvements

Stormwater Site Plan – Drainage Report

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DATE: April 12, 2023

JOB NO: 2349

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4/12/2023
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DRAINAGE REPORT

Section I - Project Overview

Overview:

The project site is located on the north side of West Stewart, between 23rd St and 26th St SW. The overall project consists of the short platting of 2.84 acres into two lots. The current project consists of the construction of a single family residence on Lot 2 of said short plat. Lot 1 is currently developed with a veterinary clinic and residence and outbuildings. Lot 2 includes some outbuildings and the septic system for Lot 1. Lot 1 is landscaped and Lot 2 is primarily pasture. An existing greenhouse and shed will be removed as part of the proposed improvements. Frontage improvements consisting of roadway widening, curb and gutter, and sidewalk have already been installed per short plat conditions.

To address runoff caused by new hard surfaces from this project, sheet flow dispersion and concentrated flow dispersion will be used for the driveway and roof.

Project Requirements:

Determination of Applicable Minimum Requirements

The storm drainage requirements for this project are the 2014 Stormwater Management Manual for Western Washington.

This phase of the project consists of Lot 2 improvements for single family residence including building and driveway construction. The project is considered new development. The project consists of 5,552 sf of new driveway and 4,274 sf of new roof. This totals 9,826 sf of new hard surfaces. Approximately 22,703 sf or 0.52 acres will be disturbed; of this 1,960 sf is existing pasture to be restored to pasture and therefore is not subject to the minimum requirements. The net area subject to minimum requirements is 20,743 sf or 0.4762 acres. The total area of Lot 2 is 2.37 acres. Since there is greater than 5,000 sf of new plus replaced hard surfaces, all Minimum Requirements apply to the new and replaced hard surfaces and converted vegetation areas, per Figure 2.4.1 below.

1,227 sf of the new hard surface is minor gravel widening of the existing driveway with a maximum width of 6.7 feet. This area is minimal and will have no material impact on the current drainage pattern from that portion of the driveway. Therefore, no BMP's are applied to the widened gravel driveway.

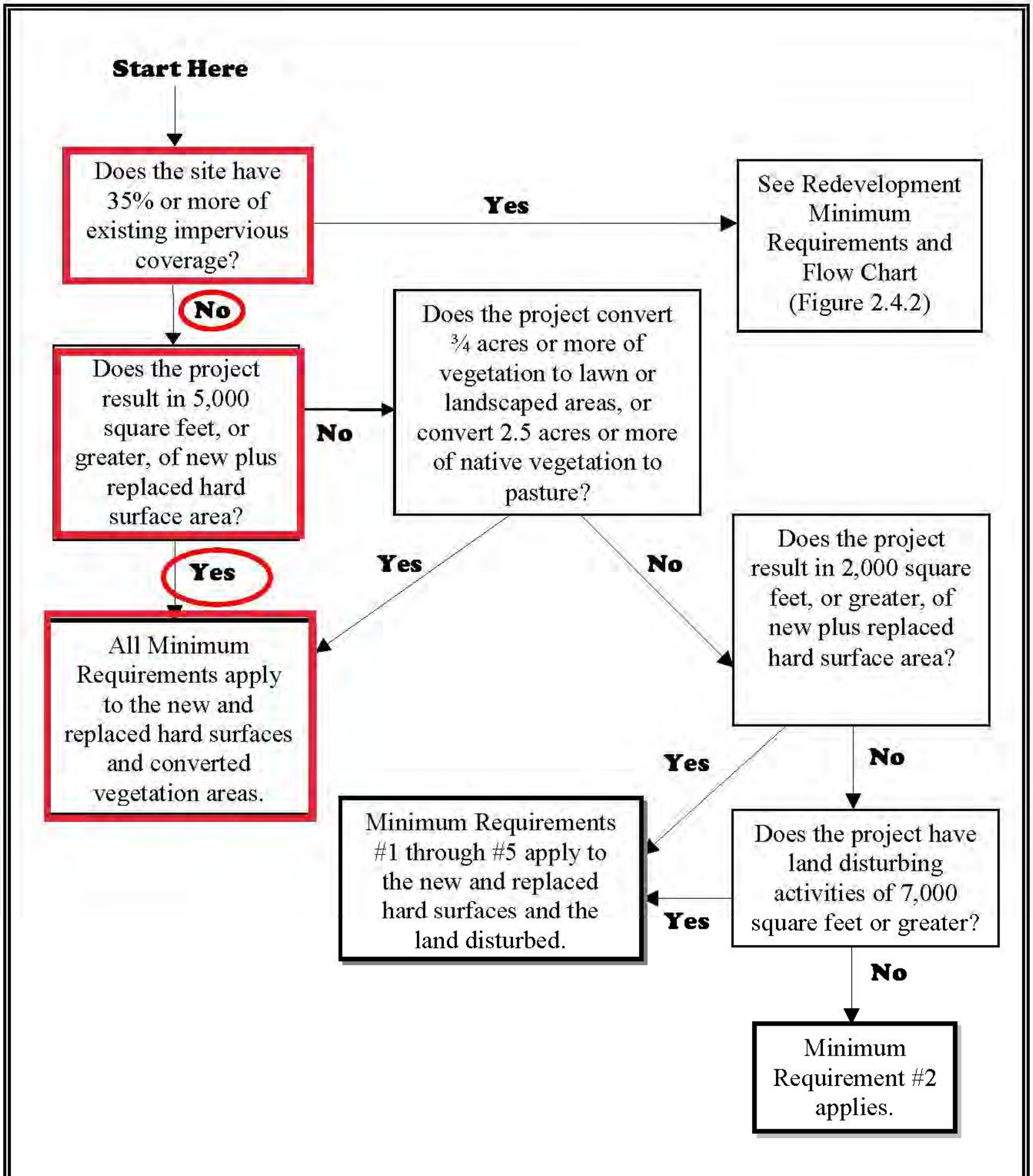

Figure 2.4.1 – Flow Chart for Determining Requirements for New Development

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Discussion of Minimum Requirements

Minimum Requirement #1: Preparation of Stormwater Site Plans

The Stormwater Site Plan consists of a report and construction plans. This report and the Lot 2 Site Development plans satisfy Minimum Requirement #1.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

An SWPPP has been prepared consisting of Section 5 of this report and the ESC portion of the construction plans to satisfy this requirement.

Minimum Requirement #3: Source Control of Pollution

The proposed used of the site is single family residential. Per Section IV-2.1, implementation of source control BMPs are not required for this use.

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

Currently, drainage from the site generally sheet flows from east to west. The use of sheet flow dispersion and concentrated flow dispersion will preserve the natural drainage system and outfall.

Minimum Requirement #5: On-site Stormwater Management

Because the project site is within the UGA on a parcel less than 5 acres, the project may either meet the Low Impact Development Performance Standard, or use List #2. The applicant chooses to use List #2. BMPs for each surface type are considered and the first feasible BMP in the list is selected.

<u>Lawn and Landscaped Areas</u>:

- All lawn and landscaped areas will meet the requirements of BMP T5.13, Post Construction Soil Quality and Depth with notes on the plans to this effect.

<u>Roofs:</u>

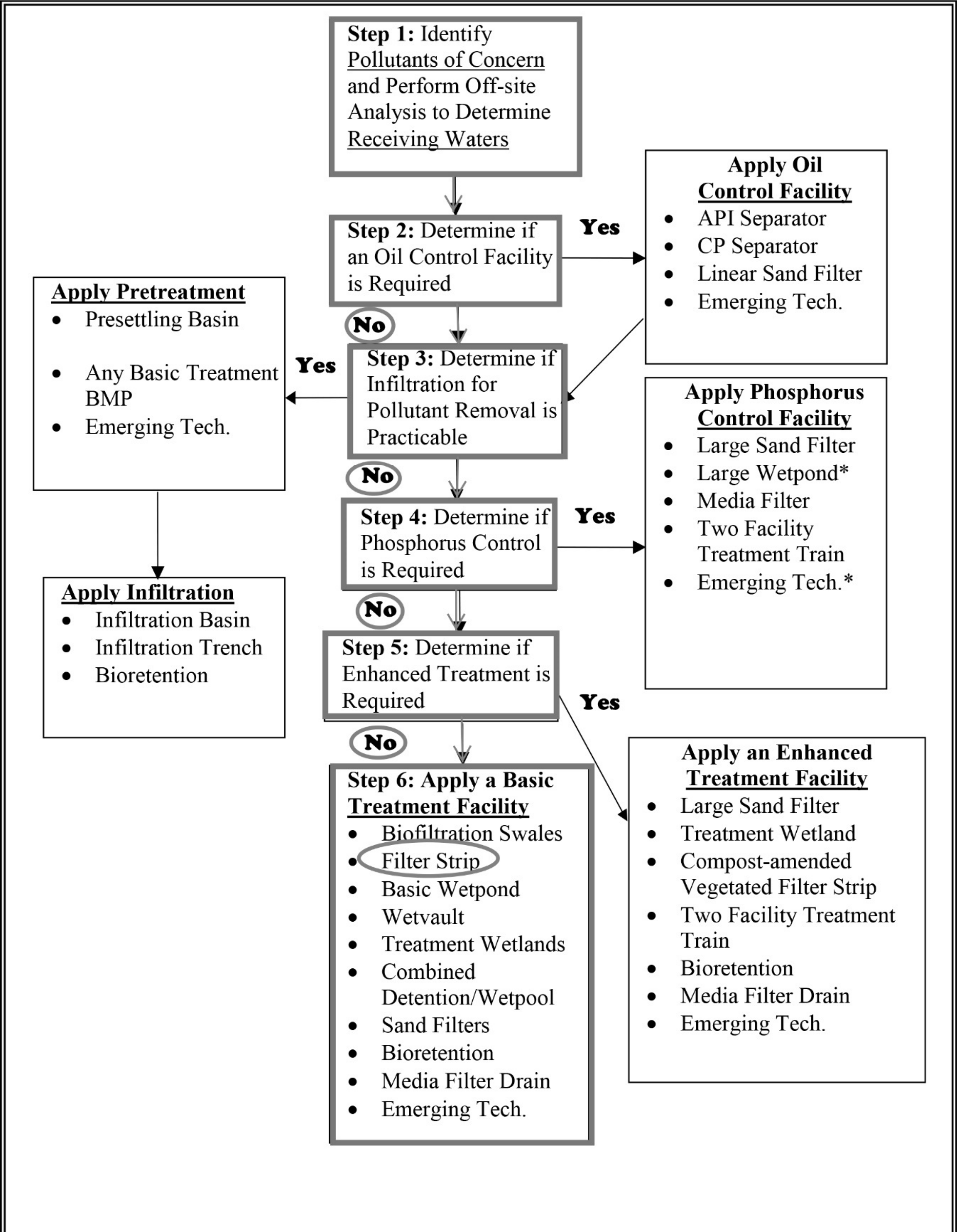
1. BMP T5.30: Full Dispersion is not feasible due to lack of native vegetation on the site. BMP T5.10A: Downspout Full Infiltration – infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
2. Bioretention is infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
3. BMP T5.10B: Downspout Dispersion is feasible; a dispersion trench and splashblocks will be used for roof runoff.

<u>Other Hard Surfaces:</u>

1. BMP T5.30: Full Dispersion – infeasible due to lack of native vegetation on the site.
2. BMP T5.15: Permeable pavement is infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
3. Bioretention is infeasible due to high groundwater and low infiltration rates per the soils analysis found in Appendix B.
4. BMP T5.12: Sheet Flow Dispersion and BMP T5.11: Concentrated Flow Dispersion are feasible and will be used for driveway runoff.

Minimum Requirement #6: Runoff Treatment

The project includes 5,552 square feet of new driveway. Since the total new pollution generating impervious surface (PGIS) is greater than 5,000 sf, treatment of runoff is required. As a single-family residence development, basic treatment is required. A basic filter strip will be used to provide treatment of runoff from the driveway.



*When **Phosphorous Control and Enhanced** treatment are required, the Large Wetpond and certain types of emerging technologies will not meet both types of treatment requirements. A different or an additional treatment facility will be required to meet Enhanced treatment.

Figure 2.1.1 – Treatment Facility Selection Flow Chart

Minimum Requirement #7: Flow Control

The total new plus replaced hard surface area for the project is 9,826 square feet. There are no native vegetation areas being converted. The resulting increase in peak flow for the 100-year event is less than 0.15 cfs, as determined in Section IV of this report. Since the effective impervious area for the project is less than 10,000 square feet, no native vegetation is being converted, and the increase in the 100-year runoff rate is less than 0.15 cfs, flow control is not required.

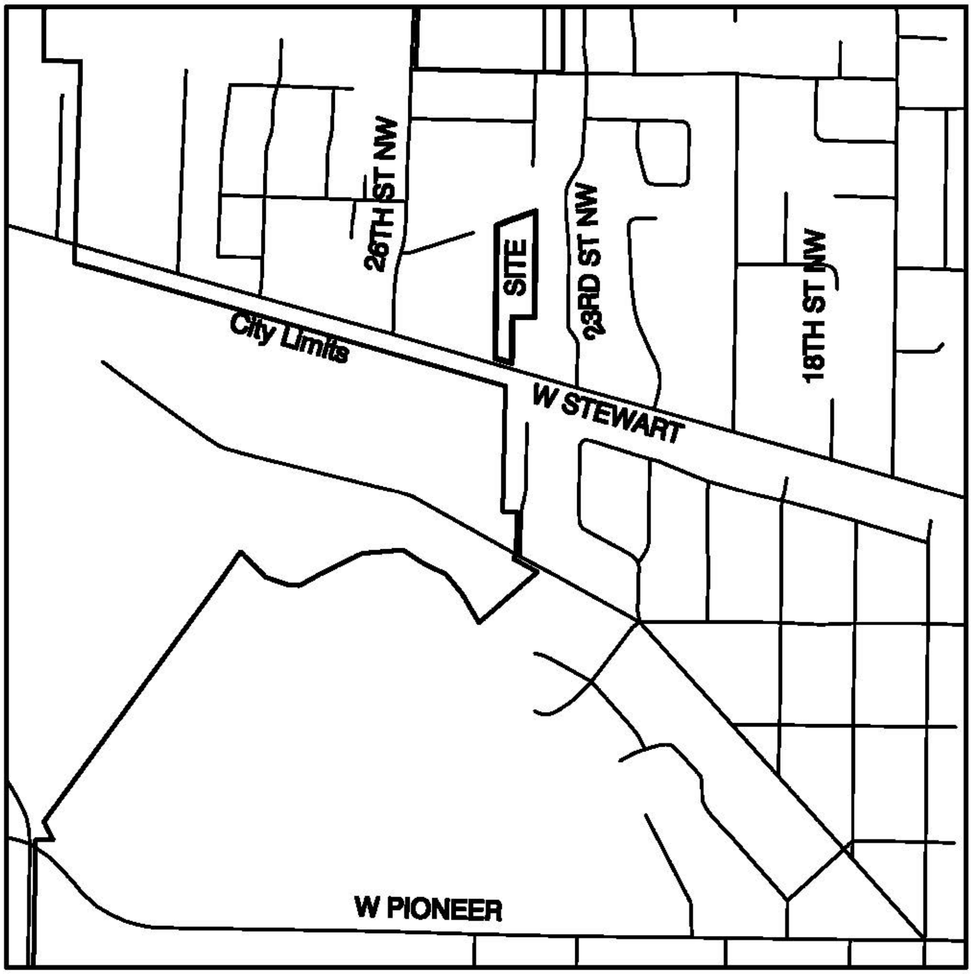
Minimum Requirement #8: Wetlands Protection

There are no known wetlands on or adjacent to the project. The proposed improvements will infiltrate runoff to the maximum extent feasible, and will not alter the natural drainage system, thus meeting this requirement.

Minimum Requirement #9: Operation and Maintenance

The stormwater facilities required for this project that require a maintenance plan are: vegetated filter strip, dispersion trench, and conveyance system. An O&M plan is included with this submittal as required for building permit approval to address this requirement.

Figure 1. Site Location:



Section II - Existing Conditions Summary

Topography:

In existing conditions project area is generally flat. The vicinity generally slopes down to the west, with an average slope of less than 1%.

Ground Cover:

An existing driveway runs along the majority of the proposed driveway route. The reminder of the site is primarily pasture with an existing greenhouse and shed which will be removed/demolished.

Drainage:

Drainage at the project site generally sheet flows to the west per the topography described above.

Soils:

The NRCS Soil Survey of Pierce County indicates the soils along the area of driveway construction are Briscot loam (6A) and in the area of proposed house and raingarden are Sultan silt loam. Briscot soils are classified as hydrologic group D, Sultan soils are classified as hydrologic group C. A geotechnical report was prepared for the site by Migizi Group and can be found in Appendix B. The soils were found to be silty fine sand to sandy silt over mottled silt. Groundwater, or indicators thereof, were found at a depth of 2.5 to 3.5 feet. Groundwater monitoring and infiltration testing was then conducted with results presented in a report by Migizi dated 9/28/21, also in Appendix B. This report found groundwater as shallow as the surface and no measured infiltration occurred. Therefore, infiltration of runoff on the site is deemed infeasible.

Floodplain

The project site is not located within a flood zone per FEMA data. Per Pierce County's flood studies, there is an AH zone approximately 1,500 feet to the northeast with a static flood elevation of 30. The lowest grade in the vicinity of the proposed improvements is 33, well above the closest flood zone.

Section III – Off-Site Analysis

Upstream

Based on the topography of the area, the only upstream area tributary to the site is the approximately 30 feet of back yard areas along the east property line.

Downstream

Any runoff from the site will travel as sheet flow to the west across the west property line and continue as sheet flow for approximately 520 feet across pasture to 26th St NW. There is no defined drainage course at this location, but drainage will run along the grass shoulder or pavement edge t the north for about 100 feet before crossing 10th Ave Ct NW in a 12-inch culvert that discharges into a roadside ditch continuing north. This ditch flows north with a 12-inch culvert driveway crossing at one point, for approximately 525 feet before entering a 12-inch culvert with unknown discharge location. GIS mapping shows this culvert as about 108 feet long. There is an approximately 160 foot gap before another existing closed conveyance system starts, flowing north.

Problems

There are no known drainage problems along this downstream route.

Section IV – Permanent Stormwater Control Plan

Existing Site Hydrology

In existing conditions, any runoff sheet flows offsite to the west as described above. For the hydrologic analysis, the drainage area is the area within grading limits subject to minimum requirements: 20,743 sf and is delineated for existing land cover as follows:

PRE-DEVELOPED	sf	acre
SAT, Forest, Flat	20743	0.4762

For the WWHM analysis, 15 minute time steps are use and the site is within the 42-inch, east rainfall zone. The basin is connected to POC 1 for flow comparison. Additional basins are connected to POC 2 and 3 in order to obtain correct treatment flow analysis in developed conditions. Those two basins are irrelevant in the pre-developed scenario. The resulting peak runoff rates are:

```
      Flow Frequency
 Flow(cfs)  0501 15m
2 Year   =    0.0072
5 Year   =    0.0242
10 Year  =    0.0444
25 Year  =    0.0831
50 Year  =    0.1233
100 Year =    0.1744
```

See Appendix A for full WWHM analysis.

Developed Site Hydrology

In developed conditions, a portion of the roof and driveway will be routed to dispersion trenches with 25 feet of flowpath, so are modeled as 50/50 impervious/lawn, and a portion of roof will be routed to splashblocks with 50 foot flowpath so are modeled as lawn. The minor gravel driveway widening is modeled as driveway. The following table summarizes the effective surface area types:

		Model as			
	Area	Lawn		Impervious	
Impervious Area Type	sf	sf	ac	sf	ac
Roof to Dispersion Trench	3097	1549	0.0355	1549	0.0355
Roof to Splashblock	1178	1178	0.0270	0	0.0000
sub-total	4275	2727	0.0626	1549	0.0355
Driveway to Sheet Flow	1742	871	0.0200	871	0.0200
Driveway to Dispersion Trench	2582	1291	0.0296	1291	0.0296
Driveway Direct Discharge	1227	0	0.0000	1227	0.0282
sub-total	5551	2162	0.0496	3389	0.0778
Total	9826	4889	0.1122	4938	0.1133

The resulting drainage basin for flow comparison, POC 1 is:

DEVELOPED	sf	acre
SAT, Lawn, Flat	15806	0.3628
Driveway, Flat	3389	0.0778
Roof	1549	0.0355
Total Impervious	4938	0.1133
Total Area	20743	0.4762

The resulting peak runoff rates are:

```
     Flow Frequency
 Flow(cfs)  0801 15m
2 Year   =    0.0485
5 Year   =    0.0692
10 Year  =    0.0847
25 Year  =    0.1064
50 Year  =    0.1241
100 Year =    0.1432
```

In developed conditions there is a decrease in the peak 100-year flow of 0.03 cfs. Since there is less than a 0.15 cfs increase, MR #7 does not apply.

Stormwater Management

To address MR #5, On-Site Stormwater Management BMP's in the form of dispersion trenches, splashblocks, and sheet flow dispersion with vegetated filter strip will be used.

The total roof area is 4,275 sf. 3,097 sf of roof area will be routed to a dispersion trench. The required trench length is 10 feet per 700 sf of impervious area. Therefore, the required trench length for the roof is is 44 feet. The dispersion trench is setback 25 feet from the property line to provide a minimum 25 foot vegetated flowpath. The remaining 1,178 sf of roof is routed to two splashblocks. For the splashblocks, a maximum of 700 sf of roof area is allowed per splashblocks. The building location is such that the 50 foot vegetated flowpath requirement is easily met onsite.

The total driveway area is 5,551 sf. 2,582 sf of driveway area will be routed to a dispersion trench. The required trench length is 10 feet per 700 sf of impervious area. Therefore, the required trench length for the and for the driveway is 37 feet. 1,227 sf of driveway is minor driveway widening which will be allowed to direct discharge. The remaining 1,742 sf of driveway will use sheet flow dispersion. Sheet flow dispersion will be through a vegetated filter strip for which 10 feet of width is required for up to 20 feet of driveway width, with an additional 10 feet of width required for each additional 20 feet of driveway or fraction thereof. The vegetated filter strip width varies, per the plans, based on the tributary driveway width, ranging from 10 to 20 feet wide.

Runoff Treatment – Basic Filter Strip

To provide treatment of runoff from the driveway, a basic filter strip will be used. This will be the same area as the vegetated filter strip required to meet MR #5. The filter strip is sized for the driveway flow tributary to it. POC 2 is used within the WWHM analysis to size the filter strip where sheet flow is used, POC 3 is used to size the filter strip where the dispersion trench is used. The basin areas with resulting treatment flow rates and 100-year flow rates are:

	Area		Treat Flow	Q100
Treatment Areas	ac	POC	cfs	cfs
Driveway to Sheet Flow	0.0400	2	0.0062	0.0363
Driveway to Dispersion Trench	0.0593	3	0.0092	0.0538

Manning's Equation is used to confirm flow characteristics and sizing of the filter strip. For treatment, the flow depth must be less than 1-inch, the velocity less than 0.5 fps, and the residence time 9 minutes. Due to the shallow depth of flow relative to the vegetation height, a high Manning's coefficient of 0.35 is used.. The slope of the filter strip is assumed to be 0.5%. Due to the shallow depth of flow relative to vegetation depth, a Manning's n value of 0.35 is used. Flows are distributed along the length of filter strip "T". The following table shows Manning's Equation Analysis:

Filter Strip Analysis					flow depth						
Q	Q	T	slope	n	y	y	Hyd. Rad.	Area	V	T	Min. L
	cfs	feet	ft/ft		ft	in	ft	sf	fps	minutes	ft
Treatment Analysis											
Driveway to Sheet Flow	0.0062	89	0.005	0.35	0.0057	0.0684	0.0057	0.5073	0.0122	9	6.6
Driveway to Dispersion Trench	0.0092	37	0.005	0.35	0.0125	0.1500	0.0125	0.4625	0.0199	9	10.7
Stability Analysis											
Driveway to Sheet Flow	0.0364	89	0.005	0.35	0.0170	0.2040	0.0170	1.5130	0.0241		
Driveway to Dispersion Trench	0.0538	37	0.005	0.35	0.0372	0.4464	0.0371	1.3763	0.0391		

The analysis shows that 7 feet of length and 11 feet of flowpath length are required for the sheet flow dispersion and dispersion trench, respectively. A minimum of 10 feet and 25 feet are provided, respectively. The analysis also shows that for the 100-yeare event, velocities and depth of flow are minimal and vegetation is adequate to prevent scouring of the flowpath.

Conveyance System Analysis and Design

The conveyance systems for this project are for the 3,097 sf of roof area and 2,582 sf of driveway area routed to the dispersion trenches. The analysis above shows that the driveway 100-year peak runoff is only 0.0538. The Manning's Equation analysis below shows that a 4-inch pipe at 0.50% has a full-flow capacity of 0.135 cfs. Therefore, a minimum of 4-inch pipe at 0.5% is adequate to convey the design flows for this project.

Pipe Dia	n	S	depth	Hyd. Rad.	Q	V
in		ft/ft	ft	ft	cfs	fps
4	0.013	0.005	0.333	0.083	0.135	1.542

Section V – Construction Stormwater Pollution Prevention Plan

Following are the 12 elements of the SWPPP. Where specific BMP's are prescribed, they are explained as shown on the engineering drawings for the project. Alternate BMP's may be acceptable in lieu of, or as a supplement to the prescribed BMP's. Where identified, alternate BMP's are listed and requirements included. Note that the project is of limited scope and is expected to be completed in one week.

Element #1 – Mark Clearing Limits

The site is already cleared for agricultural and residential use. Therefore no BMPs are necessary for marking of clearing limits.

Element #2 – Establish Construction Access

Construction access or activities occurring on unpaved areas shall be minimized, yet where necessary, access points shall be stabilized to minimize the tracking of sediment onto public roads, and wheel washing, street sweeping, and street cleaning shall be employed to prevent sediment from entering state waters. All wash wastewater shall be controlled on site. The existing paved driveway approach and gravel driveway are adequate to meet construction access requirements. If, during construction, it is determined that additional measures are necessary, the following alternative BMP should be used:

- Stabilized Construction Entrance (C105)

Element #3 – Control Flow Rates

Due to the limited scope of work, no BMPs to control flow rates are required.

Element #4 – Install Sediment Controls

All stormwater runoff from disturbed areas shall pass through an appropriate sediment removal BMP before leaving the construction site or prior to being discharged to an infiltration facility. The specific BMPs to be used for controlling sediment on this project include:

- Silt Fence (C233)

Element #5 – Stabilize Soils

Exposed and unworked soils shall be stabilized with the application of effective BMPs to prevent erosion throughout the life of the project. The specific BMPs for soil stabilization that shall be used on this project include:

- Temporary and Permanent Seeding (C120)
- Mulching (C121)

No soils shall remain exposed and unworked for more than 7 days during the dry season (May 1 to September 30) and 2 days during the wet season (October 1 to April 30). Regardless of the time of year, all soils shall be stabilized at the end of the shift before a holiday or weekend if needed based on weather forecasts.

In general, cut and fill slopes will be stabilized as soon as possible and soil stockpiles will be temporarily covered with plastic sheeting. All stockpiled soils shall be stabilized from erosion, protected with sediment trapping measures, and where possible, be located away from storm drain inlets, waterways, and drainage channels.

Alternate BMP’s:

- Plastic Covering (C123)
- Sodding (C124)
- Topsoiling (C125)

Element #6 – Protect Slopes

The slopes within the clearing limits/area to be disturbed are nearly flat. Additional protection is not needed.

Element #7 – Protect Drain Inlets

All storm drain inlets and culverts made operable during construction shall be protected to prevent unfiltered or untreated water from entering the drainage conveyance system. However, the first priority is to keep all access roads clean of sediment and keep street wash water separate from entering storm drains until treatment can be provided. Storm Drain Inlet Protection (BMP C220) will be implemented for all drainage inlets and culverts that could potentially be impacted by sediment-laden runoff on and near the project site. The following inlet protection measures will be applied on this project:

- Storm Drain Inlet Protection (C220)

Element #8 – Stabilize Channels and Outlets

Where site runoff is to be conveyed in channels, or discharged to a stream or some other natural drainage point, efforts will be taken to prevent downstream erosion. No surface channels or outlets are proposed for this project.

Element #9 – Control Pollutants

All pollutants, including waste materials and demolition debris, that occur onsite shall be handled and disposed of in a manner that does not cause contamination of stormwater. Good housekeeping and preventative measures will be taken to ensure that the site will be kept clean, well organized, and free of debris. If required, BMPs to be implemented to control specific sources of pollutants are discussed below.

Vehicles, construction equipment, and/or petroleum product storage/dispensing:

- All vehicles, equipment, and petroleum product storage/dispensing areas will be inspected regularly to detect any leaks or spills, and to identify maintenance needs to prevent leaks or spills.
- On-site fueling tanks and petroleum product storage containers shall include secondary containment.
- Spill prevention measures, such as drip pans, will be used when conducting maintenance and repair of vehicles or equipment.
- In order to perform emergency repairs on site, temporary plastic will be placed beneath and, if raining, over the vehicle.
- Contaminated surfaces shall be cleaned immediately following any discharge or spill incident.

Specific construction related BMP's to be used include:

- Material Delivery, Storage and Containment (C153)

Element #10 – Control Dewatering

Due to the shallow depth of groundwater, dewatering may be required for the storm pipe installation. The water from all de-watering systems for trenches, vaults and foundations may be disposed of in one of the following manners:

(1) Foundation, vault, and trench de-watering water which have similar characteristics to stormwater runoff at the site shall be discharged into a controlled conveyance system prior to discharge to a sediment trap or sediment pond.

(2) Clean, non-turbid de-watering water, such as well-point ground water, can be discharged to systems tributary to or directly into surface waters of the state, provided the de-watering flow does not cause erosion or flooding of receiving waters. Clean de-watering water should not be routed through stormwater sediment ponds. Other disposal options for clean, non-turbid de-watering water may include:

(a) Infiltration;

(b) Transportation off-site in a vehicle (such as a vacuum flush truck) for legal disposal in a manner that does not pollute state waters;

(c) On-site chemical treatment or other suitable treatment technologies approved by the department and Washington State Department of Ecology;

(d) Sanitary sewer discharge with local sewer district approval, if there is no other option; and

(e) Use of a sedimentation bag with outfall to a ditch or swale for small volumes of localized de-watering water.

Element #11 – Maintain BMPs

All temporary and permanent erosion and sediment control BMPs shall be maintained and repaired as needed to assure continued performance of their intended function. Maintenance and repair shall be conducted in accordance with each particular BMP's specifications. Visual monitoring of the BMPs will be conducted at least once every calendar week and within 24 hours of any rainfall event (typically around 0.5" in 24-hour period) that causes a discharge from the site. If the site becomes inactive, and is temporarily stabilized, the inspection frequency may be reduced to once every month, during the dry season

All temporary erosion and sediment control BMPs shall be removed within 30 days after the final site stabilization is achieved or after the temporary BMPs are no longer needed. The need for TESC measures continuance or removal shall be determined by the designated site CESC lead person with concurrence of the City inspector. Trapped sediment shall be removed or stabilized on site. Disturbed soil resulting from removal of BMPs or vegetation shall be permanently stabilized.

Element #12 – Manage the Project

Erosion and sediment control BMPs for this project have been designed based on the following principles:

- Design the project to fit the existing topography, soils, and drainage patterns.
- Emphasize erosion control rather than sediment control.
- Minimize the extent and duration of the area exposed.
- Keep runoff velocities low.
- Retain sediment on site.
- Thoroughly monitor site and maintain all ESC measures. A Certified Erosion and Sedimentation Control Lead (CESCL) person shall be assigned to the project and will file regular and special inspection reports with the City.
- Schedule major earthwork during the dry season.

In addition, project management will incorporate the key components listed below:
As this project site is located west of the Cascade Mountain Crest, the project will be managed according to the following key project components:

Phasing of Construction

- The construction project is being phased to the extent practicable in order to prevent soil erosion, and, to the maximum extent possible, the transport of sediment from the site during construction.
- Revegetation of exposed areas and maintenance of that vegetation shall be an integral part of the clearing activities during each phase of construction, per the Scheduling BMP (C 162).

Seasonal Work Limitations

- From October 1 through April 30, clearing, grading, and other soil disturbing activities shall only be permitted if shown to the satisfaction of the local permitting authority that silt-laden runoff will be prevented from leaving the site through a combination of the following:
    - ☐ Site conditions including existing vegetative coverage, slope, soil type, and proximity to receiving waters; and
    - ☐ Limitations on activities and the extent of disturbed areas; and
    - ☐ Proposed erosion and sediment control measures.
- Based on the information provided and/or local weather conditions, the local permitting authority may expand or restrict the seasonal limitation on site disturbance.
- The following activities are exempt from the seasonal clearing and grading limitations:
    - ☐ Routine maintenance and necessary repair of erosion and sediment control BMPs;
    - ☐ Routine maintenance of public facilities or existing utility structures that do not expose the soil or result in the removal of the vegetative cover to soil; and
    - ☐ Activities where there is 100 percent infiltration of surface water runoff within the site in approved and installed erosion and sediment control facilities.

Coordination with Utilities and Other Jurisdictions

- Care has been taken to coordinate with utilities, other construction projects, and the local jurisdiction in preparing this SWPPP and scheduling the construction work.

Inspection and Monitoring

- All BMPs shall be inspected, maintained, and repaired as needed to assure continued performance of their intended function. Site inspections shall be conducted by a person who is knowledgeable in the principles and practices of erosion and sediment control. This person has the necessary skills to:
    - ☐ Assess the site conditions and construction activities that could impact the quality of stormwater, and
    - ☐ Assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
- A Certified Erosion and Sediment Control Lead shall be on-site or on-call at all times.
- Whenever inspection and/or monitoring reveals that the BMPs identified in this SWPPP are inadequate, due to the actual discharge of or potential to discharge a significant amount of any pollutant, appropriate BMPs or design changes shall be implemented as soon as possible.

Maintaining an Updated Construction SWPPP

- This SWPPP shall be retained on-site or within reasonable access to the site.
- The SWPPP shall be modified whenever there is a change in the design, construction, operation, or maintenance at the construction site that has, or could have, a significant effect on the discharge of pollutants to waters of the state.
- The SWPPP shall be modified if, during inspections or investigations conducted by the owner/operator, or the applicable local or state regulatory authority, it is determined that the SWPPP is ineffective in eliminating or significantly minimizing pollutants in stormwater discharges from the site. The SWPPP shall be modified as necessary to include additional or modified BMPs designed to correct problems identified. Revisions to the SWPPP shall be completed within seven (7) days following the inspection.

Specific management related BMP’s to be used include:

- Certified Erosion and Sediment Control Lead (C160)
- Scheduling (C162)

Section VI – Special Reports and Studies

There are no special reports or studies required for the project.

A Geotechnical Report has been prepared and can be found in Appendix B.

Section VII – Other Permits

A building permit will be required for construction of the residence.

A septic permit from TPCHD will be required.

Section VIII – Operation and Maintenance Manual

An Operations and Maintenance Manual is required for the dispersion trench, vegetated flowpath, and conveyance system. The O&M Manual has been prepared as a separate document.

Section IX – Bond Quantities Worksheet

Any required bond amounts will be calculated when required for permit issuance.

APPENDIX A

WWHM Analysis

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	Farris SP Lot 2 041223
Site Name:	Farris SP Lot 2
Site Address:	
City:	
Report Date:	4/13/2023
Gage:	42 IN EAST
Data Start:	10/01/1901
Data End:	09/30/2059
Timestep:	15 Minute
Precip Scale:	1.000
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Pasture, Flat	0.4762
Pervious Total	0.4762
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.4762

Element Flows To:

Surface	Interflow	Groundwater

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Pasture, Flat	0.04
Pervious Total	0.04
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.04

Element Flows To:

Surface	Interflow	Groundwater

Basin 3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Pasture, Flat	0.0593
Pervious Total	0.0593
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.0593

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
SAT, Lawn, Flat	0.3628
Pervious Total	0.3628
Impervious Land Use	acre
ROOF TOPS FLAT	0.0355
DRIVEWAYS FLAT	0.0778
Impervious Total	0.1133
Basin Total	0.4761

Element Flows To:

Surface	Interflow	Groundwater

Basin 2

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
DRIVEWAYS FLAT	0.04
Impervious Total	0.04
Basin Total	0.04

Element Flows To:

Surface	Interflow	Groundwater

Basin 3

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
Pervious Total	0
Impervious Land Use	acre
DRIVEWAYS FLAT	0.0593
Impervious Total	0.0593
Basin Total	0.0593

Element Flows To:

Surface	Interflow	Groundwater

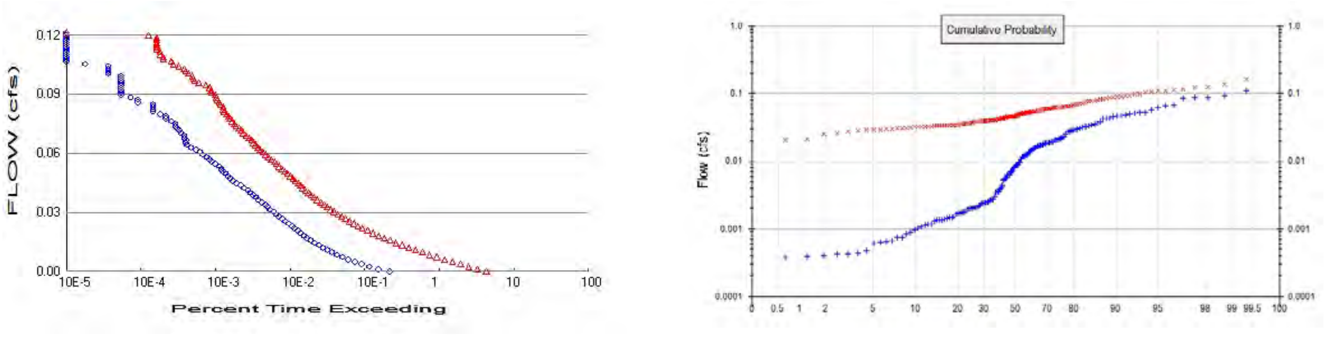
Routing Elements

Predeveloped Routing

Mitigated Routing

Analysis Results

POC 1



+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1

Total Pervious Area:	0.4762
Total Impervious Area:	0

Mitigated Landuse Totals for POC #1

Total Pervious Area:	0.3628
Total Impervious Area:	0.1133

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.007177
5 year	0.024179
10 year	0.044385
25 year	0.083114
50 year	0.12327
100 year	0.174435

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.048455
5 year	0.069229
10 year	0.084742
25 year	0.106421
50 year	0.124132
100 year	0.143226

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1902	0.021	0.049
1903	0.001	0.054
1904	0.002	0.062
1905	0.002	0.028
1906	0.000	0.031
1907	0.004	0.041
1908	0.006	0.036
1909	0.005	0.045
1910	0.053	0.091
1911	0.014	0.045

1912	0.110	0.164
1913	0.030	0.057
1914	0.001	0.138
1915	0.003	0.031
1916	0.008	0.052
1917	0.001	0.021
1918	0.018	0.042
1919	0.002	0.029
1920	0.006	0.044
1921	0.009	0.044
1922	0.012	0.053
1923	0.022	0.054
1924	0.001	0.059
1925	0.001	0.025
1926	0.006	0.049
1927	0.010	0.042
1928	0.002	0.033
1929	0.043	0.079
1930	0.015	0.061
1931	0.009	0.034
1932	0.003	0.033
1933	0.017	0.039
1934	0.088	0.113
1935	0.012	0.032
1936	0.017	0.039
1937	0.013	0.052
1938	0.016	0.040
1939	0.000	0.034
1940	0.006	0.062
1941	0.003	0.063
1942	0.007	0.046
1943	0.001	0.046
1944	0.018	0.066
1945	0.008	0.050
1946	0.008	0.063
1947	0.001	0.030
1948	0.002	0.042
1949	0.019	0.064
1950	0.000	0.037
1951	0.011	0.055
1952	0.052	0.127
1953	0.088	0.108
1954	0.002	0.036
1955	0.001	0.032
1956	0.001	0.029
1957	0.013	0.039
1958	0.092	0.110
1959	0.047	0.086
1960	0.004	0.034
1961	0.025	0.094
1962	0.007	0.040
1963	0.001	0.030
1964	0.002	0.090
1965	0.063	0.093
1966	0.001	0.033
1967	0.001	0.046
1968	0.012	0.038
1969	0.002	0.035

1970	0.033	0.069
1971	0.043	0.079
1972	0.028	0.123
1973	0.046	0.074
1974	0.016	0.063
1975	0.007	0.082
1976	0.035	0.060
1977	0.002	0.026
1978	0.058	0.098
1979	0.002	0.046
1980	0.017	0.046
1981	0.012	0.043
1982	0.002	0.034
1983	0.021	0.054
1984	0.002	0.046
1985	0.004	0.054
1986	0.003	0.028
1987	0.007	0.047
1988	0.016	0.041
1989	0.002	0.030
1990	0.004	0.039
1991	0.022	0.048
1992	0.029	0.060
1993	0.028	0.062
1994	0.033	0.072
1995	0.001	0.029
1996	0.047	0.078
1997	0.012	0.037
1998	0.019	0.056
1999	0.000	0.046
2000	0.003	0.039
2001	0.001	0.033
2002	0.019	0.065
2003	0.004	0.033
2004	0.037	0.059
2005	0.067	0.116
2006	0.019	0.045
2007	0.005	0.050
2008	0.006	0.046
2009	0.002	0.031
2010	0.001	0.040
2011	0.001	0.040
2012	0.002	0.039
2013	0.002	0.037
2014	0.001	0.037
2015	0.017	0.072
2016	0.000	0.035
2017	0.035	0.061
2018	0.084	0.099
2019	0.038	0.067
2020	0.013	0.051
2021	0.030	0.064
2022	0.001	0.063
2023	0.021	0.078
2024	0.052	0.110
2025	0.007	0.041
2026	0.032	0.061
2027	0.003	0.049

2028	0.000	0.020
2029	0.019	0.053
2030	0.049	0.088
2031	0.002	0.020
2032	0.001	0.035
2033	0.001	0.043
2034	0.004	0.034
2035	0.003	0.046
2036	0.027	0.052
2037	0.000	0.045
2038	0.048	0.084
2039	0.000	0.087
2040	0.001	0.034
2041	0.002	0.043
2042	0.023	0.054
2043	0.032	0.065
2044	0.043	0.071
2045	0.029	0.058
2046	0.021	0.049
2047	0.003	0.041
2048	0.002	0.034
2049	0.013	0.051
2050	0.002	0.041
2051	0.018	0.053
2052	0.009	0.040
2053	0.015	0.035
2054	0.016	0.080
2055	0.001	0.041
2056	0.001	0.054
2057	0.010	0.033
2058	0.011	0.051
2059	0.068	0.104

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Predeveloped**	**Mitigated**
1	0.1096	0.1636
2	0.0922	0.1379
3	0.0884	0.1270
4	0.0883	0.1229
5	0.0843	0.1156
6	0.0679	0.1130
7	0.0666	0.1105
8	0.0626	0.1104
9	0.0576	0.1084
10	0.0534	0.1035
11	0.0524	0.0990
12	0.0516	0.0980
13	0.0491	0.0939
14	0.0482	0.0933
15	0.0475	0.0909
16	0.0474	0.0901
17	0.0460	0.0879
18	0.0435	0.0870
19	0.0434	0.0856
20	0.0433	0.0839
21	0.0383	0.0824
22	0.0368	0.0803

23	0.0349	0.0790
24	0.0346	0.0786
25	0.0330	0.0783
26	0.0328	0.0783
27	0.0324	0.0738
28	0.0317	0.0720
29	0.0305	0.0719
30	0.0300	0.0707
31	0.0288	0.0694
32	0.0287	0.0672
33	0.0280	0.0661
34	0.0275	0.0655
35	0.0272	0.0646
36	0.0252	0.0641
37	0.0233	0.0639
38	0.0223	0.0632
39	0.0220	0.0629
40	0.0210	0.0629
41	0.0207	0.0627
42	0.0207	0.0624
43	0.0207	0.0622
44	0.0195	0.0619
45	0.0192	0.0613
46	0.0191	0.0611
47	0.0190	0.0607
48	0.0189	0.0596
49	0.0184	0.0595
50	0.0182	0.0594
51	0.0180	0.0586
52	0.0174	0.0577
53	0.0172	0.0569
54	0.0168	0.0558
55	0.0168	0.0554
56	0.0162	0.0544
57	0.0162	0.0543
58	0.0161	0.0543
59	0.0156	0.0542
60	0.0150	0.0539
61	0.0149	0.0537
62	0.0144	0.0534
63	0.0134	0.0533
64	0.0134	0.0530
65	0.0130	0.0524
66	0.0125	0.0521
67	0.0124	0.0520
68	0.0121	0.0514
69	0.0118	0.0514
70	0.0117	0.0506
71	0.0116	0.0502
72	0.0108	0.0498
73	0.0107	0.0494
74	0.0097	0.0494
75	0.0095	0.0492
76	0.0089	0.0485
77	0.0088	0.0481
78	0.0088	0.0473
79	0.0085	0.0463
80	0.0084	0.0463

81	0.0081	0.0461
82	0.0073	0.0459
83	0.0072	0.0457
84	0.0070	0.0457
85	0.0069	0.0456
86	0.0067	0.0456
87	0.0062	0.0455
88	0.0062	0.0454
89	0.0062	0.0451
90	0.0056	0.0448
91	0.0056	0.0446
92	0.0055	0.0441
93	0.0053	0.0436
94	0.0045	0.0428
95	0.0042	0.0427
96	0.0040	0.0427
97	0.0039	0.0422
98	0.0036	0.0418
99	0.0035	0.0417
100	0.0035	0.0414
101	0.0034	0.0414
102	0.0030	0.0413
103	0.0028	0.0410
104	0.0027	0.0410
105	0.0027	0.0409
106	0.0026	0.0405
107	0.0025	0.0404
108	0.0025	0.0401
109	0.0025	0.0399
110	0.0024	0.0398
111	0.0024	0.0395
112	0.0024	0.0392
113	0.0023	0.0390
114	0.0022	0.0390
115	0.0021	0.0389
116	0.0021	0.0387
117	0.0021	0.0384
118	0.0020	0.0374
119	0.0020	0.0369
120	0.0020	0.0368
121	0.0019	0.0367
122	0.0018	0.0360
123	0.0017	0.0359
124	0.0017	0.0353
125	0.0017	0.0352
126	0.0017	0.0348
127	0.0016	0.0346
128	0.0015	0.0344
129	0.0015	0.0340
130	0.0015	0.0340
131	0.0014	0.0339
132	0.0014	0.0338
133	0.0014	0.0337
134	0.0013	0.0336
135	0.0013	0.0332
136	0.0013	0.0330
137	0.0012	0.0328
138	0.0012	0.0328

139	0.0012	0.0328
140	0.0011	0.0327
141	0.0010	0.0324
142	0.0010	0.0324
143	0.0009	0.0315
144	0.0008	0.0310
145	0.0007	0.0306
146	0.0007	0.0303
147	0.0007	0.0298
148	0.0007	0.0297
149	0.0006	0.0293
150	0.0006	0.0292
151	0.0005	0.0289
152	0.0004	0.0279
153	0.0004	0.0278
154	0.0004	0.0259
155	0.0004	0.0255
156	0.0004	0.0212
157	0.0004	0.0204
158	0.0003	0.0199

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0036	11845	237613	2006	Fail
0.0048	8476	178889	2110	Fail
0.0060	6399	137227	2144	Fail
0.0072	5042	106480	2111	Fail
0.0084	4099	83212	2030	Fail
0.0096	3343	65262	1952	Fail
0.0108	2807	51523	1835	Fail
0.0121	2337	41080	1757	Fail
0.0133	2017	32897	1630	Fail
0.0145	1747	26576	1521	Fail
0.0157	1520	21601	1421	Fail
0.0169	1347	17723	1315	Fail
0.0181	1186	14620	1232	Fail
0.0193	1041	12088	1161	Fail
0.0205	931	10066	1081	Fail
0.0217	847	8465	999	Fail
0.0229	768	7119	926	Fail
0.0241	695	6066	872	Fail
0.0253	630	5188	823	Fail
0.0266	585	4491	767	Fail
0.0278	531	3945	742	Fail
0.0290	479	3445	719	Fail
0.0302	432	3038	703	Fail
0.0314	391	2702	691	Fail
0.0326	357	2416	676	Fail
0.0338	334	2152	644	Fail
0.0350	299	1926	644	Fail
0.0362	275	1729	628	Fail
0.0374	255	1588	622	Fail
0.0386	232	1418	611	Fail
0.0399	207	1280	618	Fail
0.0411	193	1146	593	Fail
0.0423	176	1051	597	Fail
0.0435	162	969	598	Fail
0.0447	150	886	590	Fail
0.0459	135	813	602	Fail
0.0471	120	758	631	Fail
0.0483	105	703	669	Fail
0.0495	94	649	690	Fail
0.0507	87	604	694	Fail
0.0519	81	558	688	Fail
0.0532	76	511	672	Fail
0.0544	69	464	672	Fail
0.0556	66	427	646	Fail
0.0568	62	393	633	Fail
0.0580	55	362	658	Fail
0.0592	49	341	695	Fail
0.0604	46	309	671	Fail
0.0616	42	282	671	Fail
0.0628	37	260	702	Fail
0.0640	34	238	700	Fail
0.0652	30	217	723	Fail
0.0665	26	205	788	Fail
0.0677	23	191	830	Fail

0.0689	22	180	818	Fail
0.0701	22	169	768	Fail
0.0713	21	155	738	Fail
0.0725	21	143	680	Fail
0.0737	19	132	694	Fail
0.0749	18	122	677	Fail
0.0761	17	114	670	Fail
0.0773	16	104	650	Fail
0.0785	16	99	618	Fail
0.0797	14	92	657	Fail
0.0810	12	87	725	Fail
0.0822	12	83	691	Fail
0.0834	10	77	770	Fail
0.0846	8	73	912	Fail
0.0858	8	70	875	Fail
0.0870	8	70	875	Fail
0.0882	8	64	800	Fail
0.0894	5	62	1240	Fail
0.0906	5	59	1180	Fail
0.0918	4	57	1425	Fail
0.0930	3	55	1833	Fail
0.0943	3	49	1633	Fail
0.0955	3	48	1600	Fail
0.0967	3	46	1533	Fail
0.0979	3	41	1366	Fail
0.0991	3	33	1100	Fail
0.1003	3	29	966	Fail
0.1015	3	28	933	Fail
0.1027	3	27	900	Fail
0.1039	2	24	1200	Fail
0.1051	2	22	1100	Fail
0.1063	2	21	1050	Fail
0.1076	2	18	900	Fail
0.1088	1	15	1500	Fail
0.1100	0	14	n/a	Fail
0.1112	0	11	n/a	Fail
0.1124	0	11	n/a	Fail
0.1136	0	10	n/a	Fail
0.1148	0	10	n/a	Fail
0.1160	0	9	n/a	Fail
0.1172	0	9	n/a	Fail
0.1184	0	9	n/a	Fail
0.1196	0	9	n/a	Fail
0.1209	0	9	n/a	Fail
0.1221	0	9	n/a	Fail
0.1233	0	7	n/a	Fail

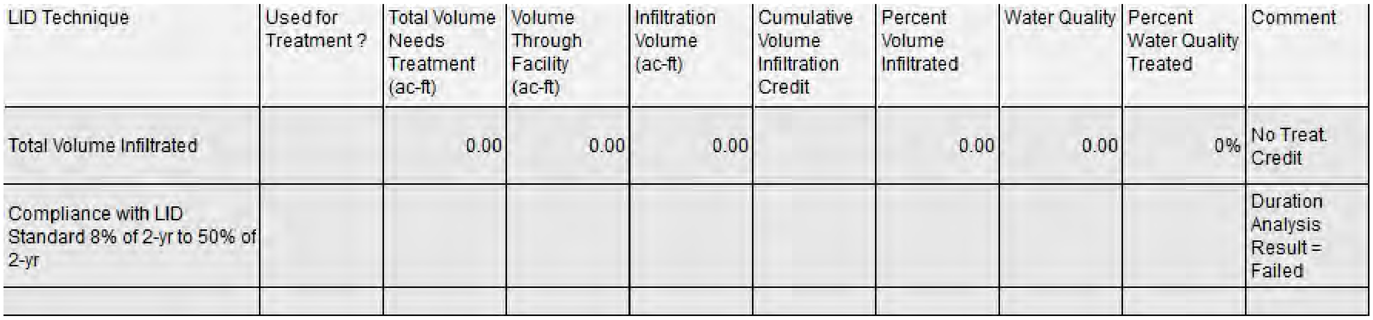
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #1

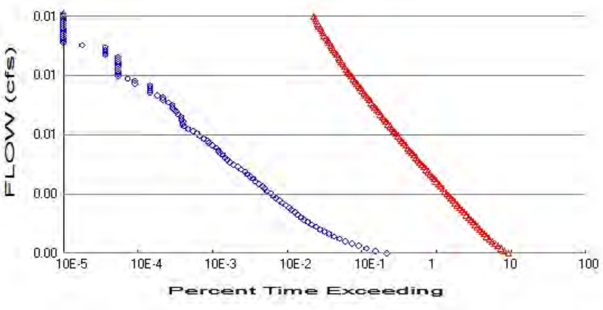
On-line facility volume:	0 acre-feet
On-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.
Off-line facility target flow:	0 cfs.
Adjusted for 15 min:	0 cfs.

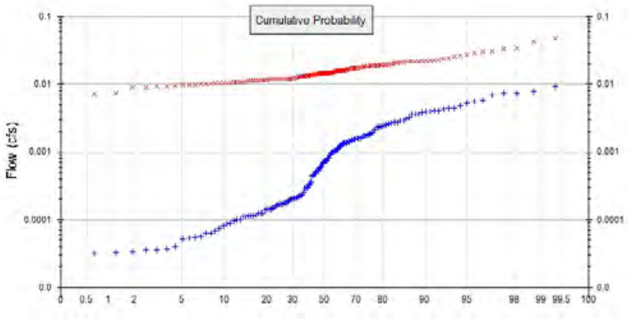
LID Report



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

POC 2





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2	
Total Pervious Area:	0.04
Total Impervious Area:	0

Mitigated Landuse Totals for POC #2	
Total Pervious Area:	0
Total Impervious Area:	0.04

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.000603
5 year	0.002031
10 year	0.003728
25 year	0.006981
50 year	0.010354
100 year	0.014652

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.014649
5 year	0.019613
10 year	0.023214
25 year	0.028135
50 year	0.032079
100 year	0.036268

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1902	0.002	0.017
1903	0.000	0.019
1904	0.000	0.022
1905	0.000	0.010
1906	0.000	0.011
1907	0.000	0.015
1908	0.001	0.012
1909	0.000	0.015
1910	0.004	0.014
1911	0.001	0.016
1912	0.009	0.026

1913	0.003	0.012
1914	0.000	0.049
1915	0.000	0.010
1916	0.001	0.018
1917	0.000	0.007
1918	0.002	0.015
1919	0.000	0.009
1920	0.001	0.012
1921	0.001	0.010
1922	0.001	0.016
1923	0.002	0.011
1924	0.000	0.021
1925	0.000	0.009
1926	0.000	0.017
1927	0.001	0.015
1928	0.000	0.010
1929	0.004	0.021
1930	0.001	0.022
1931	0.001	0.011
1932	0.000	0.011
1933	0.001	0.011
1934	0.007	0.018
1935	0.001	0.010
1936	0.001	0.014
1937	0.001	0.018
1938	0.001	0.010
1939	0.000	0.012
1940	0.000	0.022
1941	0.000	0.022
1942	0.001	0.016
1943	0.000	0.016
1944	0.002	0.023
1945	0.001	0.018
1946	0.001	0.014
1947	0.000	0.011
1948	0.000	0.015
1949	0.002	0.023
1950	0.000	0.013
1951	0.001	0.020
1952	0.004	0.022
1953	0.007	0.020
1954	0.000	0.012
1955	0.000	0.011
1956	0.000	0.010
1957	0.001	0.012
1958	0.008	0.015
1959	0.004	0.015
1960	0.000	0.012
1961	0.002	0.033
1962	0.001	0.014
1963	0.000	0.010
1964	0.000	0.031
1965	0.005	0.014
1966	0.000	0.012
1967	0.000	0.016
1968	0.001	0.014
1969	0.000	0.012
1970	0.003	0.014

1971	0.004	0.013
1972	0.002	0.043
1973	0.004	0.026
1974	0.001	0.019
1975	0.001	0.019
1976	0.003	0.021
1977	0.000	0.009
1978	0.005	0.015
1979	0.000	0.016
1980	0.001	0.016
1981	0.001	0.015
1982	0.000	0.012
1983	0.002	0.016
1984	0.000	0.016
1985	0.000	0.018
1986	0.000	0.009
1987	0.001	0.017
1988	0.001	0.010
1989	0.000	0.010
1990	0.000	0.012
1991	0.002	0.017
1992	0.002	0.017
1993	0.002	0.019
1994	0.003	0.013
1995	0.000	0.010
1996	0.004	0.014
1997	0.001	0.012
1998	0.002	0.014
1999	0.000	0.016
2000	0.000	0.014
2001	0.000	0.012
2002	0.002	0.020
2003	0.000	0.012
2004	0.003	0.018
2005	0.006	0.034
2006	0.002	0.016
2007	0.000	0.018
2008	0.001	0.015
2009	0.000	0.011
2010	0.000	0.014
2011	0.000	0.014
2012	0.000	0.014
2013	0.000	0.013
2014	0.000	0.013
2015	0.001	0.022
2016	0.000	0.012
2017	0.003	0.021
2018	0.007	0.013
2019	0.003	0.019
2020	0.001	0.016
2021	0.003	0.013
2022	0.000	0.022
2023	0.002	0.028
2024	0.004	0.029
2025	0.001	0.014
2026	0.003	0.019
2027	0.000	0.017
2028	0.000	0.007

2029	0.002	0.011
2030	0.004	0.024
2031	0.000	0.007
2032	0.000	0.012
2033	0.000	0.015
2034	0.000	0.012
2035	0.000	0.014
2036	0.002	0.012
2037	0.000	0.016
2038	0.004	0.015
2039	0.000	0.031
2040	0.000	0.012
2041	0.000	0.015
2042	0.002	0.017
2043	0.003	0.019
2044	0.004	0.013
2045	0.002	0.011
2046	0.002	0.012
2047	0.000	0.015
2048	0.000	0.012
2049	0.001	0.018
2050	0.000	0.013
2051	0.002	0.019
2052	0.001	0.014
2053	0.001	0.012
2054	0.001	0.024
2055	0.000	0.014
2056	0.000	0.019
2057	0.001	0.009
2058	0.001	0.018
2059	0.006	0.022

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	**Predeveloped**	**Mitigated**
1	0.0092	0.0487
2	0.0077	0.0433
3	0.0074	0.0343
4	0.0074	0.0331
5	0.0071	0.0307
6	0.0057	0.0307
7	0.0056	0.0293
8	0.0053	0.0276
9	0.0048	0.0262
10	0.0045	0.0260
11	0.0044	0.0241
12	0.0043	0.0239
13	0.0041	0.0233
14	0.0041	0.0226
15	0.0040	0.0222
16	0.0040	0.0221
17	0.0039	0.0221
18	0.0037	0.0220
19	0.0036	0.0217
20	0.0036	0.0217
21	0.0032	0.0217
22	0.0031	0.0216
23	0.0029	0.0214

24	0.0029	0.0210
25	0.0028	0.0209
26	0.0028	0.0207
27	0.0027	0.0202
28	0.0027	0.0200
29	0.0026	0.0196
30	0.0025	0.0194
31	0.0024	0.0192
32	0.0024	0.0192
33	0.0023	0.0191
34	0.0023	0.0190
35	0.0023	0.0190
36	0.0021	0.0189
37	0.0020	0.0187
38	0.0019	0.0186
39	0.0019	0.0184
40	0.0018	0.0184
41	0.0017	0.0183
42	0.0017	0.0183
43	0.0017	0.0181
44	0.0016	0.0178
45	0.0016	0.0177
46	0.0016	0.0176
47	0.0016	0.0176
48	0.0016	0.0174
49	0.0015	0.0174
50	0.0015	0.0173
51	0.0015	0.0171
52	0.0015	0.0170
53	0.0014	0.0170
54	0.0014	0.0167
55	0.0014	0.0163
56	0.0014	0.0162
57	0.0014	0.0161
58	0.0014	0.0161
59	0.0013	0.0161
60	0.0013	0.0161
61	0.0013	0.0161
62	0.0012	0.0160
63	0.0011	0.0159
64	0.0011	0.0159
65	0.0011	0.0158
66	0.0011	0.0156
67	0.0010	0.0156
68	0.0010	0.0151
69	0.0010	0.0151
70	0.0010	0.0151
71	0.0010	0.0151
72	0.0009	0.0149
73	0.0009	0.0148
74	0.0008	0.0148
75	0.0008	0.0147
76	0.0007	0.0147
77	0.0007	0.0147
78	0.0007	0.0146
79	0.0007	0.0146
80	0.0007	0.0146
81	0.0007	0.0146

82	0.0006	0.0145
83	0.0006	0.0145
84	0.0006	0.0144
85	0.0006	0.0143
86	0.0006	0.0142
87	0.0005	0.0142
88	0.0005	0.0141
89	0.0005	0.0141
90	0.0005	0.0140
91	0.0005	0.0139
92	0.0005	0.0138
93	0.0004	0.0138
94	0.0004	0.0137
95	0.0004	0.0137
96	0.0003	0.0137
97	0.0003	0.0135
98	0.0003	0.0135
99	0.0003	0.0135
100	0.0003	0.0132
101	0.0003	0.0132
102	0.0002	0.0132
103	0.0002	0.0131
104	0.0002	0.0130
105	0.0002	0.0130
106	0.0002	0.0129
107	0.0002	0.0128
108	0.0002	0.0124
109	0.0002	0.0123
110	0.0002	0.0121
111	0.0002	0.0121
112	0.0002	0.0120
113	0.0002	0.0120
114	0.0002	0.0120
115	0.0002	0.0120
116	0.0002	0.0120
117	0.0002	0.0119
118	0.0002	0.0119
119	0.0002	0.0119
120	0.0002	0.0119
121	0.0002	0.0119
122	0.0002	0.0118
123	0.0001	0.0118
124	0.0001	0.0118
125	0.0001	0.0118
126	0.0001	0.0117
127	0.0001	0.0116
128	0.0001	0.0115
129	0.0001	0.0115
130	0.0001	0.0114
131	0.0001	0.0114
132	0.0001	0.0113
133	0.0001	0.0112
134	0.0001	0.0112
135	0.0001	0.0111
136	0.0001	0.0107
137	0.0001	0.0107
138	0.0001	0.0107
139	0.0001	0.0106

140	0.0001	0.0105
141	0.0001	0.0105
142	0.0001	0.0104
143	0.0001	0.0104
144	0.0001	0.0103
145	0.0001	0.0102
146	0.0001	0.0101
147	0.0001	0.0100
148	0.0001	0.0099
149	0.0001	0.0098
150	0.0001	0.0097
151	0.0000	0.0094
152	0.0000	0.0092
153	0.0000	0.0092
154	0.0000	0.0090
155	0.0000	0.0089
156	0.0000	0.0075
157	0.0000	0.0072
158	0.0000	0.0070

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0003	11867	512345	4317	Fail
0.0004	8476	451127	5322	Fail
0.0005	6404	404812	6321	Fail
0.0006	5042	366475	7268	Fail
0.0007	4103	334731	8158	Fail
0.0008	3344	306920	9178	Fail
0.0009	2811	283042	10069	Fail
0.0010	2338	261934	11203	Fail
0.0011	2017	242932	12044	Fail
0.0012	1747	225758	12922	Fail
0.0013	1520	210024	13817	Fail
0.0014	1347	195564	14518	Fail
0.0015	1187	182545	15378	Fail
0.0016	1041	170357	16364	Fail
0.0017	931	159055	17084	Fail
0.0018	847	148585	17542	Fail
0.0019	768	138779	18070	Fail
0.0020	695	129693	18660	Fail
0.0021	630	121327	19258	Fail
0.0022	585	113461	19395	Fail
0.0023	530	106092	20017	Fail
0.0024	479	99333	20737	Fail
0.0025	432	93018	21531	Fail
0.0026	391	87145	22287	Fail
0.0027	357	81550	22843	Fail
0.0028	334	76287	22840	Fail
0.0029	299	71633	23957	Fail
0.0030	275	67146	24416	Fail
0.0031	255	63101	24745	Fail
0.0032	232	59057	25455	Fail
0.0033	207	55306	26717	Fail
0.0034	193	51855	26867	Fail
0.0036	176	48575	27599	Fail
0.0037	162	45584	28138	Fail
0.0038	150	42764	28509	Fail
0.0039	135	40127	29723	Fail
0.0040	120	37672	31393	Fail
0.0041	105	35351	33667	Fail
0.0042	94	33157	35273	Fail
0.0043	87	31174	35832	Fail
0.0044	81	29290	36160	Fail
0.0045	76	27473	36148	Fail
0.0046	69	25795	37384	Fail
0.0047	66	24243	36731	Fail
0.0048	62	22808	36787	Fail
0.0049	55	21462	39021	Fail
0.0050	49	20216	41257	Fail
0.0051	47	19025	40478	Fail
0.0052	42	17917	42659	Fail
0.0053	37	16914	45713	Fail
0.0054	34	15878	46700	Fail
0.0055	30	14958	49860	Fail
0.0056	26	14055	54057	Fail
0.0057	23	13219	57473	Fail

0.0058	22	12465	56659	Fail
0.0059	22	11745	53386	Fail
0.0060	21	11080	52761	Fail
0.0061	21	10454	49780	Fail
0.0062	19	9861	51900	Fail
0.0063	18	9324	51800	Fail
0.0064	17	8792	51717	Fail
0.0065	16	8305	51906	Fail
0.0066	16	7850	49062	Fail
0.0067	14	7390	52785	Fail
0.0068	12	6997	58308	Fail
0.0069	12	6615	55125	Fail
0.0070	10	6260	62600	Fail
0.0071	8	5917	73962	Fail
0.0072	8	5573	69662	Fail
0.0073	8	5268	65850	Fail
0.0074	8	5011	62637	Fail
0.0075	5	4761	95220	Fail
0.0076	5	4483	89660	Fail
0.0077	4	4231	105775	Fail
0.0078	3	4000	133333	Fail
0.0079	3	3808	126933	Fail
0.0080	3	3620	120666	Fail
0.0081	3	3420	114000	Fail
0.0082	3	3238	107933	Fail
0.0083	3	3096	103200	Fail
0.0084	3	2946	98200	Fail
0.0085	3	2813	93766	Fail
0.0086	3	2681	89366	Fail
0.0087	2	2567	128350	Fail
0.0088	2	2429	121450	Fail
0.0089	2	2318	115900	Fail
0.0090	2	2209	110450	Fail
0.0091	1	2104	210400	Fail
0.0092	0	2013	n/a	Fail
0.0093	0	1937	n/a	Fail
0.0094	0	1842	n/a	Fail
0.0095	0	1755	n/a	Fail
0.0096	0	1682	n/a	Fail
0.0097	0	1609	n/a	Fail
0.0098	0	1535	n/a	Fail
0.0099	0	1468	n/a	Fail
0.0100	0	1426	n/a	Fail
0.0102	0	1355	n/a	Fail
0.0103	0	1310	n/a	Fail
0.0104	0	1254	n/a	Fail

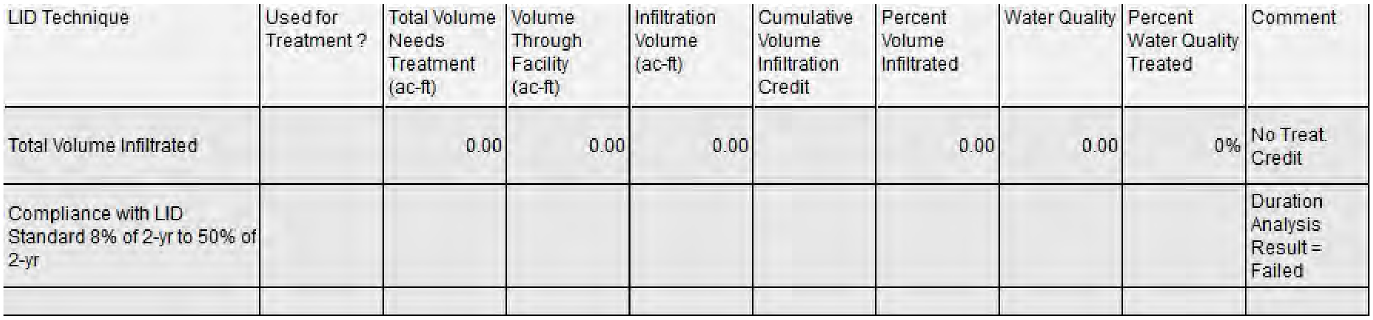
The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #2

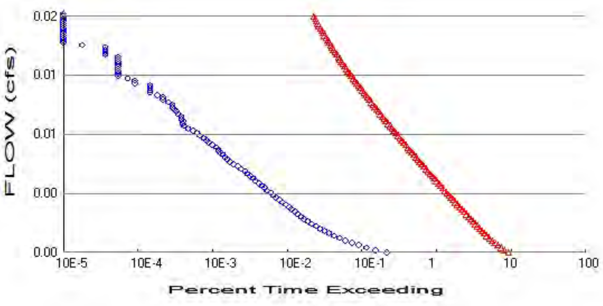
On-line facility volume:	0.0044 acre-feet
On-line facility target flow:	0.0062 cfs.
Adjusted for 15 min:	0.0062 cfs.
Off-line facility target flow:	0.0036 cfs.
Adjusted for 15 min:	0.0036 cfs.

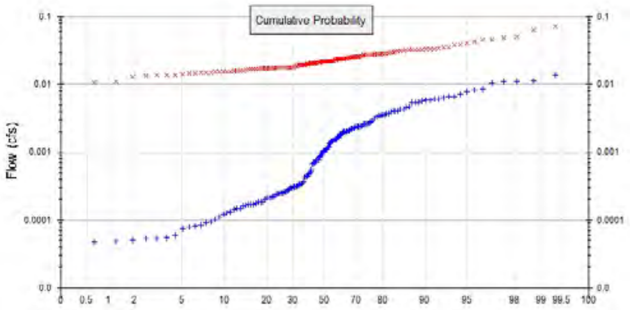
LID Report



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

POC 3





+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #3

Total Pervious Area:	0.0593
Total Impervious Area:	0

Mitigated Landuse Totals for POC #3

Total Pervious Area:	0
Total Impervious Area:	0.0593

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #3

Return Period	**Flow(cfs)**
2 year	0.000894
5 year	0.003011
10 year	0.005527
25 year	0.01035
50 year	0.015351
100 year	0.021722

Flow Frequency Return Periods for Mitigated. POC #3

Return Period	**Flow(cfs)**
2 year	0.021717
5 year	0.029077
10 year	0.034415
25 year	0.04171
50 year	0.047557
100 year	0.053768

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #3

Year	**Predeveloped**	**Mitigated**
1902	0.003	0.026
1903	0.000	0.028
1904	0.000	0.032
1905	0.000	0.014
1906	0.000	0.016
1907	0.001	0.022
1908	0.001	0.018
1909	0.001	0.022
1910	0.007	0.021
1911	0.002	0.024
1912	0.014	0.039

1913	0.004	0.017
1914	0.000	0.072
1915	0.000	0.015
1916	0.001	0.027
1917	0.000	0.011
1918	0.002	0.022
1919	0.000	0.014
1920	0.001	0.018
1921	0.001	0.015
1922	0.001	0.024
1923	0.003	0.017
1924	0.000	0.031
1925	0.000	0.013
1926	0.001	0.025
1927	0.001	0.022
1928	0.000	0.016
1929	0.005	0.031
1930	0.002	0.032
1931	0.001	0.016
1932	0.000	0.017
1933	0.002	0.017
1934	0.011	0.027
1935	0.001	0.015
1936	0.002	0.020
1937	0.002	0.027
1938	0.002	0.015
1939	0.000	0.018
1940	0.001	0.033
1941	0.000	0.033
1942	0.001	0.024
1943	0.000	0.024
1944	0.002	0.035
1945	0.001	0.026
1946	0.001	0.020
1947	0.000	0.016
1948	0.000	0.022
1949	0.002	0.034
1950	0.000	0.020
1951	0.001	0.029
1952	0.007	0.032
1953	0.011	0.030
1954	0.000	0.018
1955	0.000	0.017
1956	0.000	0.015
1957	0.002	0.018
1958	0.011	0.022
1959	0.006	0.022
1960	0.000	0.018
1961	0.003	0.049
1962	0.001	0.021
1963	0.000	0.016
1964	0.000	0.046
1965	0.008	0.020
1966	0.000	0.017
1967	0.000	0.024
1968	0.001	0.020
1969	0.000	0.018
1970	0.004	0.020

1971	0.005	0.020
1972	0.003	0.064
1973	0.006	0.039
1974	0.002	0.028
1975	0.001	0.029
1976	0.004	0.031
1977	0.000	0.013
1978	0.007	0.022
1979	0.000	0.024
1980	0.002	0.023
1981	0.002	0.022
1982	0.000	0.018
1983	0.003	0.024
1984	0.000	0.024
1985	0.000	0.027
1986	0.000	0.014
1987	0.001	0.025
1988	0.002	0.014
1989	0.000	0.015
1990	0.001	0.018
1991	0.003	0.025
1992	0.004	0.025
1993	0.003	0.028
1994	0.004	0.019
1995	0.000	0.015
1996	0.006	0.020
1997	0.002	0.018
1998	0.002	0.021
1999	0.000	0.024
2000	0.000	0.020
2001	0.000	0.017
2002	0.002	0.030
2003	0.000	0.017
2004	0.005	0.026
2005	0.008	0.051
2006	0.002	0.023
2007	0.001	0.026
2008	0.001	0.022
2009	0.000	0.016
2010	0.000	0.021
2011	0.000	0.021
2012	0.000	0.021
2013	0.000	0.019
2014	0.000	0.019
2015	0.002	0.032
2016	0.000	0.018
2017	0.004	0.032
2018	0.010	0.019
2019	0.005	0.028
2020	0.002	0.023
2021	0.004	0.019
2022	0.000	0.033
2023	0.003	0.041
2024	0.006	0.043
2025	0.001	0.021
2026	0.004	0.028
2027	0.000	0.026
2028	0.000	0.010

2029	0.002	0.017
2030	0.006	0.035
2031	0.000	0.011
2032	0.000	0.018
2033	0.000	0.022
2034	0.000	0.018
2035	0.000	0.021
2036	0.003	0.018
2037	0.000	0.024
2038	0.006	0.022
2039	0.000	0.046
2040	0.000	0.018
2041	0.000	0.022
2042	0.003	0.026
2043	0.004	0.029
2044	0.005	0.020
2045	0.004	0.016
2046	0.003	0.018
2047	0.000	0.022
2048	0.000	0.018
2049	0.002	0.026
2050	0.000	0.020
2051	0.002	0.028
2052	0.001	0.021
2053	0.002	0.018
2054	0.002	0.036
2055	0.000	0.021
2056	0.000	0.028
2057	0.001	0.014
2058	0.001	0.027
2059	0.008	0.033

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #3

Rank	**Predeveloped**	**Mitigated**
1	0.0137	0.0721
2	0.0115	0.0643
3	0.0110	0.0509
4	0.0110	0.0491
5	0.0105	0.0455
6	0.0084	0.0455
7	0.0083	0.0434
8	0.0078	0.0410
9	0.0072	0.0388
10	0.0066	0.0386
11	0.0065	0.0357
12	0.0064	0.0354
13	0.0061	0.0346
14	0.0060	0.0335
15	0.0059	0.0329
16	0.0059	0.0328
17	0.0057	0.0328
18	0.0054	0.0327
19	0.0054	0.0322
20	0.0054	0.0321
21	0.0048	0.0321
22	0.0046	0.0321
23	0.0043	0.0317

24	0.0043	0.0311
25	0.0041	0.0310
26	0.0041	0.0306
27	0.0040	0.0300
28	0.0039	0.0297
29	0.0038	0.0290
30	0.0037	0.0287
31	0.0036	0.0285
32	0.0036	0.0285
33	0.0035	0.0284
34	0.0034	0.0282
35	0.0034	0.0282
36	0.0031	0.0281
37	0.0029	0.0277
38	0.0028	0.0276
39	0.0027	0.0273
40	0.0026	0.0272
41	0.0026	0.0272
42	0.0026	0.0271
43	0.0026	0.0269
44	0.0024	0.0264
45	0.0024	0.0262
46	0.0024	0.0261
47	0.0024	0.0260
48	0.0024	0.0258
49	0.0023	0.0257
50	0.0023	0.0257
51	0.0022	0.0254
52	0.0022	0.0252
53	0.0021	0.0251
54	0.0021	0.0247
55	0.0021	0.0242
56	0.0020	0.0240
57	0.0020	0.0239
58	0.0020	0.0239
59	0.0019	0.0239
60	0.0019	0.0238
61	0.0019	0.0238
62	0.0018	0.0237
63	0.0017	0.0236
64	0.0017	0.0235
65	0.0016	0.0234
66	0.0016	0.0232
67	0.0015	0.0231
68	0.0015	0.0224
69	0.0015	0.0224
70	0.0015	0.0223
71	0.0014	0.0223
72	0.0013	0.0221
73	0.0013	0.0220
74	0.0012	0.0219
75	0.0012	0.0219
76	0.0011	0.0218
77	0.0011	0.0217
78	0.0011	0.0217
79	0.0011	0.0217
80	0.0010	0.0216
81	0.0010	0.0216

82	0.0009	0.0215
83	0.0009	0.0215
84	0.0009	0.0214
85	0.0009	0.0212
86	0.0008	0.0211
87	0.0008	0.0210
88	0.0008	0.0209
89	0.0008	0.0209
90	0.0007	0.0208
91	0.0007	0.0206
92	0.0007	0.0205
93	0.0007	0.0204
94	0.0006	0.0204
95	0.0005	0.0203
96	0.0005	0.0203
97	0.0005	0.0201
98	0.0004	0.0201
99	0.0004	0.0200
100	0.0004	0.0196
101	0.0004	0.0196
102	0.0004	0.0195
103	0.0003	0.0194
104	0.0003	0.0193
105	0.0003	0.0192
106	0.0003	0.0192
107	0.0003	0.0189
108	0.0003	0.0184
109	0.0003	0.0182
110	0.0003	0.0180
111	0.0003	0.0180
112	0.0003	0.0178
113	0.0003	0.0178
114	0.0003	0.0178
115	0.0003	0.0178
116	0.0003	0.0178
117	0.0003	0.0177
118	0.0002	0.0177
119	0.0002	0.0177
120	0.0002	0.0176
121	0.0002	0.0176
122	0.0002	0.0176
123	0.0002	0.0175
124	0.0002	0.0175
125	0.0002	0.0175
126	0.0002	0.0173
127	0.0002	0.0172
128	0.0002	0.0171
129	0.0002	0.0171
130	0.0002	0.0169
131	0.0002	0.0169
132	0.0002	0.0168
133	0.0002	0.0166
134	0.0002	0.0166
135	0.0002	0.0164
136	0.0002	0.0159
137	0.0001	0.0159
138	0.0001	0.0158
139	0.0001	0.0158

140	0.0001	0.0155
141	0.0001	0.0155
142	0.0001	0.0155
143	0.0001	0.0154
144	0.0001	0.0153
145	0.0001	0.0151
146	0.0001	0.0149
147	0.0001	0.0148
148	0.0001	0.0147
149	0.0001	0.0145
150	0.0001	0.0144
151	0.0001	0.0140
152	0.0001	0.0136
153	0.0001	0.0136
154	0.0001	0.0133
155	0.0001	0.0132
156	0.0000	0.0111
157	0.0000	0.0106
158	0.0000	0.0103

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0004	11839	512013	4324	Fail
0.0006	8482	451294	5320	Fail
0.0007	6393	404591	6328	Fail
0.0009	5045	366586	7266	Fail
0.0010	4099	334564	8162	Fail
0.0012	3344	306975	9179	Fail
0.0014	2807	282876	10077	Fail
0.0015	2339	261934	11198	Fail
0.0017	2013	242821	12062	Fail
0.0018	1747	225813	12925	Fail
0.0020	1520	209913	13810	Fail
0.0021	1347	195453	14510	Fail
0.0023	1186	182434	15382	Fail
0.0024	1038	170302	16406	Fail
0.0026	931	159055	17084	Fail
0.0027	847	148529	17535	Fail
0.0029	768	138779	18070	Fail
0.0030	695	129693	18660	Fail
0.0032	630	121327	19258	Fail
0.0033	585	113405	19385	Fail
0.0035	531	106148	19990	Fail
0.0036	479	99333	20737	Fail
0.0038	432	93018	21531	Fail
0.0039	391	87145	22287	Fail
0.0041	357	81494	22827	Fail
0.0042	334	76287	22840	Fail
0.0044	299	71578	23939	Fail
0.0045	275	67201	24436	Fail
0.0047	254	63046	24821	Fail
0.0048	232	59112	25479	Fail
0.0050	207	55284	26707	Fail
0.0051	193	51855	26867	Fail
0.0053	176	48548	27584	Fail
0.0054	162	45567	28127	Fail
0.0056	150	42736	28490	Fail
0.0057	135	40110	29711	Fail
0.0059	120	37656	31379	Fail
0.0060	105	35335	33652	Fail
0.0062	94	33157	35273	Fail
0.0063	87	31157	35812	Fail
0.0065	81	29296	36167	Fail
0.0066	76	27462	36134	Fail
0.0068	69	25795	37384	Fail
0.0069	66	24232	36715	Fail
0.0071	62	22797	36769	Fail
0.0072	55	21457	39012	Fail
0.0074	49	20210	41244	Fail
0.0075	46	19013	41332	Fail
0.0077	42	17911	42645	Fail
0.0078	37	16903	45683	Fail
0.0080	34	15867	46667	Fail
0.0081	30	14958	49860	Fail
0.0083	26	14050	54038	Fail
0.0084	23	13219	57473	Fail

0.0086	22	12460	56636	Fail
0.0087	22	11734	53336	Fail
0.0089	21	11080	52761	Fail
0.0090	21	10449	49757	Fail
0.0092	19	9861	51900	Fail
0.0093	18	9313	51738	Fail
0.0095	17	8787	51688	Fail
0.0096	16	8299	51868	Fail
0.0098	16	7850	49062	Fail
0.0099	14	7390	52785	Fail
0.0101	12	6997	58308	Fail
0.0102	12	6620	55166	Fail
0.0104	10	6260	62600	Fail
0.0105	8	5917	73962	Fail
0.0107	8	5584	69800	Fail
0.0108	8	5271	65887	Fail
0.0110	8	5013	62662	Fail
0.0111	5	4764	95280	Fail
0.0113	5	4502	90040	Fail
0.0114	4	4238	105950	Fail
0.0116	3	4009	133633	Fail
0.0117	3	3822	127400	Fail
0.0119	3	3624	120800	Fail
0.0120	3	3433	114433	Fail
0.0122	3	3250	108333	Fail
0.0123	3	3095	103166	Fail
0.0125	3	2944	98133	Fail
0.0126	3	2813	93766	Fail
0.0128	3	2681	89366	Fail
0.0129	2	2567	128350	Fail
0.0131	2	2430	121500	Fail
0.0132	2	2318	115900	Fail
0.0134	2	2209	110450	Fail
0.0135	1	2106	210600	Fail
0.0137	0	2014	n/a	Fail
0.0138	0	1939	n/a	Fail
0.0140	0	1845	n/a	Fail
0.0141	0	1759	n/a	Fail
0.0143	0	1689	n/a	Fail
0.0144	0	1613	n/a	Fail
0.0146	0	1538	n/a	Fail
0.0147	0	1469	n/a	Fail
0.0149	0	1424	n/a	Fail
0.0150	0	1358	n/a	Fail
0.0152	0	1310	n/a	Fail
0.0154	0	1254	n/a	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

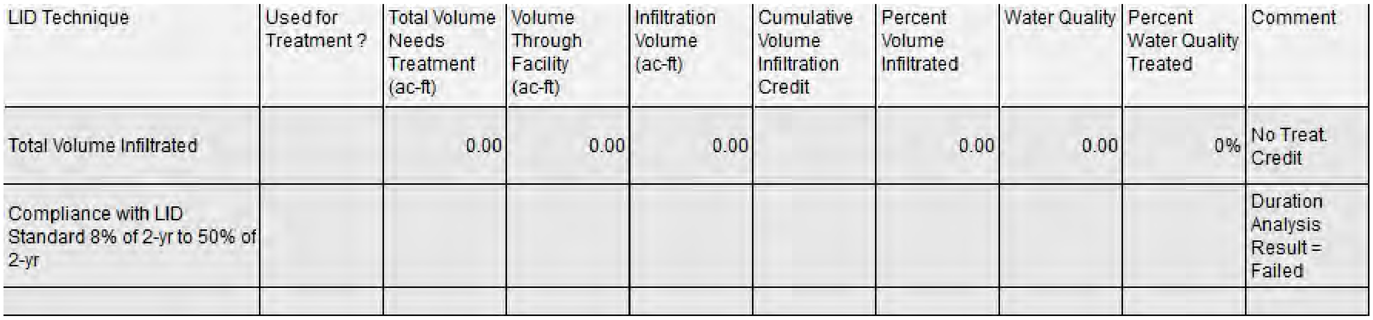
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality

Water Quality BMP Flow and Volume for POC #3

On-line facility volume:	0.0065 acre-feet
On-line facility target flow:	0.0092 cfs.
Adjusted for 15 min:	0.0092 cfs.
Off-line facility target flow:	0.0054 cfs.
Adjusted for 15 min:	0.0054 cfs.

LID Report



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

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

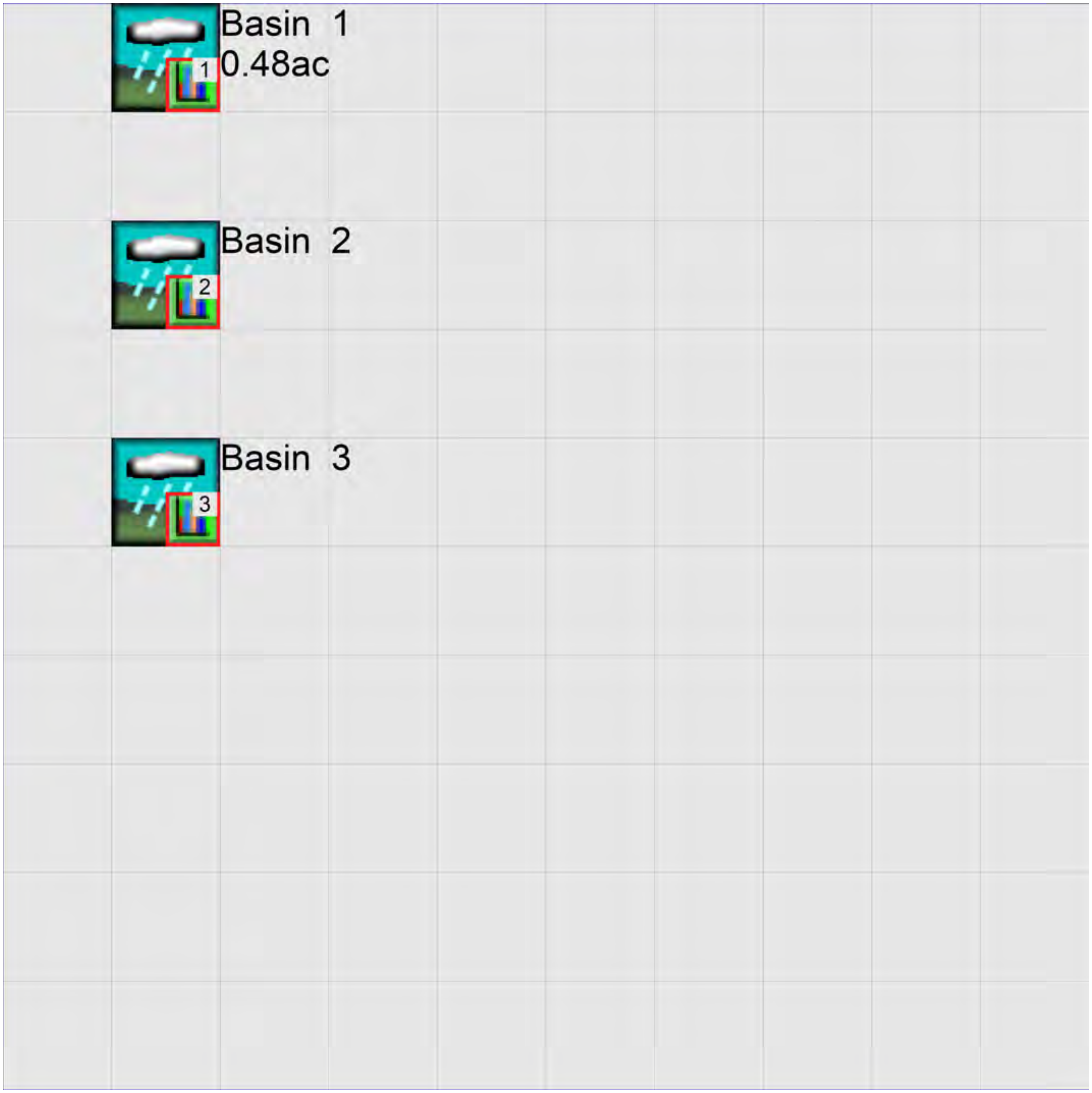
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

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

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                             ***
WDM        26   Farris SP Lot 2 041223.wdm
MESSU      25   PreFarris SP Lot 2 041223.MES
           27   PreFarris SP Lot 2 041223.L61
           28   PreFarris SP Lot 2 041223.L62
           30   POCFarris SP Lot 2 0412231.dat
           31   POCFarris SP Lot 2 0412232.dat
           32   POCFarris SP Lot 2 0412233.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      22
      COPY       501
      COPY       502
      COPY       503
      DISPLY       1
      DISPLY       2
      DISPLY       3
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                   1    2   30    9
    2        Basin  2                    MAX                   1    2   31    9
    3        Basin  3                    MAX                   1    2   32    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                         User  t-series Engl Metr ***
                                         in  out           ***
   22     SAT, Pasture, Flat      1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************* Active Sections *****************************
```

```
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   22         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   22         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   22         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   22               0         4       1.8       100     0.001       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   22               0         0        10         2         0         0       0.5
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   22           0.15         3       0.5         1       0.7       0.6
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   22               0         0         0         0       4.2         1         0
  END PWAT-STATE1

END PERLND

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

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

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

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

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

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  22                      0.4762     COPY   501     12
PERLND  22                      0.4762     COPY   501     13
Basin  2***
PERLND  22                        0.04     COPY   502     12
PERLND  22                        0.04     COPY   502     13
Basin  3***
PERLND  22                      0.0593     COPY   503     12
PERLND  22                      0.0593     COPY   503     13

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

NETWORK
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   #        <Name> # #<-factor->strg <Name>   #   #        <Name> # #  ***
COPY   501 OUTPUT MEAN   1 1   48.4        DISPLY   1     INPUT  TIMSER 1
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1



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

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

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

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

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

  HYDR-PARM2
    # -  #    FTABNO       LEN     DELTH     STCOR        KS      DB50       ***
  <------><--------><--------><--------><--------><--------><-------->       ***
  END HYDR-PARM2
```

```
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                             ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
          *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><--->
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

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

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    501 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     48.4      WDM    503 FLOW     ENGL      REPL
END EXT TARGETS

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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

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

FILES
<File>  <Un#>   <-----------File Name------------------------------>***
<-ID->                                                              ***
WDM        26   Farris SP Lot 2 041223.wdm
MESSU      25   MitFarris SP Lot 2 041223.MES
           27   MitFarris SP Lot 2 041223.L61
           28   MitFarris SP Lot 2 041223.L62
           30   POCFarris SP Lot 2 0412231.dat
           31   POCFarris SP Lot 2 0412232.dat
           32   POCFarris SP Lot 2 0412233.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      25
      IMPLND       4
      IMPLND       5
      COPY       501
      COPY       502
      COPY       503
      DISPLY       1
      DISPLY       2
      DISPLY       3
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                    MAX                    1    2   30    9
    2        Basin  2                    MAX                    1    2   31    9
    3        Basin  3                    MAX                    1    2   32    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         1    1
  503         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                           in  out           ***
   25     SAT, Lawn, Flat         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***
```

```
  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   25         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ***************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   25         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   25         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   25             0         4         1       100     0.001       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   25             0         0        10         2         0         0      0.35
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                               ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   25           0.1         3       0.5         1       0.7       0.4
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
              ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   25             0         0         0         0       4.2         1         0
  END PWAT-STATE1

END PERLND

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

  ACTIVITY
    <PLS > ************* Active Sections *****************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    4         0    0    1    0    0    0
    5         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
```

```
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
    5         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    4            400      0.01       0.1       0.1
    5            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4              0         0
    5              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4              0         0
    5              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
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PERLND  25                      0.3628     COPY   501     13
IMPLND   4                      0.0355     COPY   501     15
IMPLND   5                      0.0778     COPY   501     15
Basin  2***
IMPLND   5                        0.04     COPY   502     15
Basin  3***
IMPLND   5                      0.0593     COPY   503     15

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

NETWORK
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COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     INPUT  TIMSER 1
COPY   503 OUTPUT MEAN   1 1   48.4        DISPLY   3     INPUT  TIMSER 1



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END NETWORK

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

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

```
  PRINT-INFO
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    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
  END PRINT-INFO

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
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WDM      2 PREC     ENGL    1              IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    1              PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    1              IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
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COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
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COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
COPY     3 OUTPUT MEAN   1 1     48.4      WDM    703 FLOW     ENGL      REPL
COPY   503 OUTPUT MEAN   1 1     48.4      WDM    803 FLOW     ENGL      REPL
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  END MASS-LINK   12

  MASS-LINK       13
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  END MASS-LINK   13

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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APPENDIX B

Geotechnical Reports

Geotechnical Engineering Report

P/N 0420203068

2401 West Stewart
Puyallup, Washington
Short Plat No. P-15-0024

April 21, 2016

prepared for:

Farris Vet Clinic
Attention: Richard Farris
2401 West Stewart
Puyallup, Washington 98371

prepared by:

Migizi Group, Inc.
PO Box 44840
Tacoma, Washington 98448
(253) 537-9400

MGI Project P475-T15

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April 21, 2016

Farris Vet Clinic
2401 West Stewart
Puyallup, WA 98371

Attention: Richard Farris

Subject: **Geotechnical Engineering Report**
Residential Development
2401 West Stewart
Puyallup, WA 98371
P/N 0420203068
Short Plat No. P-15-0024

MGI Project P475-T15

Dear Mr. Farris:

Migizi Group, Inc. (MGI) is pleased to submit this report describing the results of our geotechnical engineering evaluation of the proposed residential development in Puyallup, Washington.

This report has been prepared for the exclusive use of Farris Vet Clinic, and their consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The project site consists of an irregularly shaped, 2.84 acre parcel located on the north side of West Stewart Street in Puyallup, Washington, as shown on the enclosed Topographic and Location Map (Figure 1). The parcel is orientated lengthwise from north to south, spanning approximately 692 feet along this orientation, and contains a maximum width of ± 185 feet. A short-plat of the property has recently taken place, dividing the parcel into two lots. Lot 1 is roughly rectangular shaped, and encompasses a 67 by 322 foot area towards the southwest corner of the project site. Farris Vet Clinic, associated parking facilities, and the large shed building directly to the north are all contained within Lot 1. The remaining 2.37 acres of the project area, including the long gravel driveway, are incorporated into Lot 2. Outside of the aforementioned gravel driveway, and an existing greenhouse, Lot 2 is largely undeveloped and occupied by an open, grassy field.

Development plans involve the construction of a new single family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on March 8, 2016. Our exploration and evaluation program comprised the following elements:

- Surface reconnaissance of the site;
- Four test pit explorations (designated TP-1 through TP-4), advanced on March 8, 2016;
- Two grain-size analyses performed on samples collected from our test pit explorations; and
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate functional locations and termination depths of our subsurface exploration, and Figure 2 depicts their approximate relative location. The following sections describe the procedures used for excavation of the test pit.

TABLE 1
APPROXIMATE LOCATION AND DEPTH OF EXPLORATION

Exploration	Functional Location	Termination Depth (feet)
TP-1	South of proposed residential site, immediately northwest of existing greenhouse	5
TP-2	West side of proposed residential site	6
TP-3	East side of proposed residential site	6
TP-4	Southwest of existing greenhouse, northeast of existing shed building	6

The specific number and location of our exploration was selected in relation to the existing site features, under the constraints of surface access, underground utility conflicts, and budget considerations.

It should be realized that the exploration performed and utilized for this evaluation reveals subsurface conditions only at discrete locations across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

2.1 Test Pit Procedures

Our exploratory test pit was excavated with a Deer 310E backhoe operated by the property owner. An engineering geologist from our firm observed the test pit excavation, collected soil samples, and logged the subsurface conditions.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in our test pits, based on our field classifications. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of the in-situ soils by means of the excavation characteristics and the stability of the test pit sidewalls. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of the explorations are included as Figures A-2 through A-5.

3.0 SITE CONDITIONS

The following sections present our observations, measurements, findings, and interpretations regarding, surface, soil, groundwater, and infiltration conditions.

3.1 Surface Conditions

The subject property is located towards the west end of the city limits of Puyallup, Washington. Immediately to the east is more densely populated residential areas, whereas to the west are more sparsely populated agricultural sites. The project area is located between the Puyallup River (to the north) and Clarks Creek (to the south). As previously indicated, the project site consists of a 2.84 acre tax parcel which has recently been short-platted. Lot 1, located towards the southwest corner of the project area, is occupied by the Farris Vet Clinic, associated parking facilities, and a large shed building north of the clinic. Access to the clinic is gained through a gravel driveway which hugs the eastern site boundary, extending north from West Stewart Ave. Lot 2 contains the gravel driveway and portions of the property east and north of the large shed building. The southeast corner of Lot 2 contains an existing greenhouse, and is littered with miscellaneous debris. The remainder of Lot 2 is undeveloped and occupied by an open, grass field. Vegetation on site is largely comprised of tall grasses in the vicinity of Lot 2, and younger cedar along the western, eastern, and northern margins of the site. Scattered brush is encountered throughout the property, and within designated landscaping areas within Lot 1. The subject property is relatively level, with minimal grade change observed over its extent.

No hydrologic features were observed on site, such as seeps, springs, ponds and streams, though scattered ponding was observed within tire ruts along the south side of the Lot 2.

3.2 Soil Conditions

We observed subsurface conditions through the advancement of 4 test pit explorations adjacent to proposed improvements. Test pit explorations TP-1 through TP-3 were performed adjacent to the proposed residential site; south, west, and east of the proposed footprint, respectively. Test pit exploration TP-4 was advanced north of the existing parking facilities, along the proposed alignment of the expanded driveway. In general, our test pit explorations encountered relatively similar subsurface conditions; typically consisting of alluvial deposits associated with the flood plains of the nearby Puyallup River. Underlying a surface mantle of sod and topsoil, we encountered a thin horizon of silty fine sand to sandy silt, typically less than 1 foot in overall thickness. Beneath this stratum, we observed mottled, saturated silt with intermittent lenses or layers of fine sand or silty sand. This stratum was continuous through the termination of all of our subsurface explorations, a maximum depth of 6 feet. Deeper subsurface explorations were not feasible for this project given shallow groundwater and severe caving conditions. An exception to the above described soil sequence was observed in test pit exploration TP-4, with a small fill proponent being encountered towards the top of the exploration, and the upper stratum, free of mottling, was slightly thicker. All soils encountered in our subsurface explorations were in a loose/soft to very loose/soft in situ condition.

The National Cooperative Soil Survey (NCSS) for Pierce County, Washington, classifies soils within the northern half of the property as 42A-Sultan silt loam, and soils within the southern half of the property as 6A-Briscot loam. Each soil group reportedly formed in alluvial flood plain deposits, and is texturally comprised of sand, loam, silt loam and clay loam. Our subsurface explorations generally correspond with the site classification developed by the NCSS.

The enclosed exploration logs (Appendix A) provide a detailed description of the soil strata encountered in our subsurface explorations.

3.3 Groundwater Conditions

We encountered shallow groundwater seepage in all of our test pit explorations, typically observed at a depth of 2½ to 3½ feet below existing grade. Given the fact that our test pit explorations were performed towards the latter end of one of the wettest winters in the recent history of Western Washington, it is our opinion that the observed seepage is representative of seasonally high levels. Given the fact that groundwater was encountered a foot deeper in test pit exploration TP-4, which was the southernmost of our test pit explorations, we anticipate that there will be a general trend of increasing depth to groundwater towards the north to south across the project area. Actual groundwater levels will fluctuate with localized precipitation and geology.

3.4 Infiltration Conditions and Infiltration Rate

Based on our field observations and grain size analyses (presented in Table 2, below), it's evident that native soils consist of slowly permeable silty sand to sandy silt at or near surface elevations, grading to mottled silt with depth, which extended through the termination of our subsurface explorations. Given the relatively shallow depth to groundwater, the only feasible stratum to utilize for infiltration would be the lower of the two soil groups described above, which was found to have a relative fines content (percent silt/clay) that ranges from 79 to 90 percent.

The results of our soil grain size analyses are presented below, and the attached Soil Gradation Graphs (Appendix B) display the grain-size distribution of the samples tested.

TABLE 2
LABORATORY TEST RESULTS FOR NON-ORGANIC ONSITE SOILS

Soil Sample, Depth	% Coarse Gravel	% Fine Gravel	% Coarse Sand	% Medium Sand	% Fine Sand	% Fines	D_{10}
TP-2, S-2, 1.5 feet	0	0	0.2	4.1	5.4	90.2	--
TP-4, S-2, 4 feet	0	0	0	1.7	19.0	79.2	--

Drainage Design Considerations

Given the fine-grained nature of site soils, and the presence of extremely shallow groundwater, it is our opinion that standard retention facilities associated with the full or limited infiltration of stormwater produced by residential construction (i.e. trenches, drywells…) are not feasible for this project. Given such, it is our opinion that roof-runoff produced by the proposed residence should be managed through the introduction of raingardens, a dispersion system, or a combination of the two.

As indicated earlier, the improved driveway will be constructed utilizing pervious pavement. In our opinion, adequate separation from groundwater is present to make this system feasible within the project area.

We determined an infiltration rate for the pervious subgrade by comparing the results of our sieve analyses from test pit explorations TP-2 and TP-4 with Table 3.7, in Volume III of the *2005 DOE Stormwater Management Manual for Western Washington*, located on page 3-76. The alluvial silt stratum, with its intermittent lens and/or layers of silty sand, generally corresponds with a loam U.S.D.A. soil classification. As such, our recommended long-term infiltration rate for the pervious subgrade, using the native fine-grained soils as the infiltrative unit, is 0.13 inches per hour.

Treatment Considerations

As part of our evaluation, we also submitted a sample of native soils for testing to determine the organic content, and cation exchange capacity (CEC) of soils that will underlie proposed pervious pavements. The following table illustrates the results of the laboratory analyses:

TABLE 3
LABORATORY TEST RESULTS FOR TREATMENT CAPACITY OF ONSITE SOILS

Soil Sample, Depth	Organic Content (%)	Cation Exchange Capacity (CEC)(meq/100g)
TP-4, S-1, 18 inches	5.4	10.1

The civil engineer in charge should evaluate the above results to determine if native soils are adequate for treatment. Laboratory results prepared by Krazan & Associates, Inc. and AgSource Laboratories are attached as Appendix C.

3.5 Seismic Conditions

Based on our analysis of subsurface exploration logs and our review of published geologic maps, we interpret the onsite soil conditions to generally correspond with site class E, as defined by Table 30.2-1 in *ASCE 7*, per the 2012 *International Building Code (IBC)*.

Using 2012 IBC information on the USGS Design Summary Report website, Risk Category I/II/III seismic parameters for the site are as follows:

S_s = 1.261 g	S_{MS} = 1.135 g	S_{DS} = 0.757 g
S_1 = 0.487 g	S_{M1} = 1.168 g	S_{D1} = 0.778 g

Using the 2012 IBC information, MCE_R Response Spectrum Graph on the USGS Design Summary Report website, Risk Category I/II/III, S_a at a period of 0.2 seconds is 1.135 g and S_a at a period of 1.0 seconds is 1.168 g.

The Design Response Spectrum Graph from the same website, using the same IBC information and Risk Category, S_a at a period of 0.2 seconds is 0.757 g and S_a at a period of 1.0 seconds is 0.778 g.

<u>3.6 Liquefaction Potential</u>

Liquefaction is a sudden increase in pore water pressure and a sudden loss of soil shear strength caused by shear strains, as could result from an earthquake. Research has shown that saturated, loose, fine to medium sands with a fines (silt and clay) content less than about 20 percent are most susceptible to liquefaction. As described in the Soil Conditions section of this report, native soils are comprised of poorly consolidated alluvial deposits. Given the high relative fines content observed in much of the native soils, some measure of resistance to liquefaction is present, but the potential for liquefaction during a large-scale seismic event should still be considered high in the project area. Recommended subgrade preparation techniques highlighted in Section 4.2 of this report will help mitigate some, but not all of the risk for seismically induced post-construction settlement.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Development plans involve the construction of a new single family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement. We offer these recommendations:

- <u>Feasibility</u>: Based on our field explorations, research and analyses, the proposed structure appears feasible from a geotechnical standpoint.
- <u>Foundation Options</u>: Due to the soft soils underlying the site, over-excavation of spread footing subgrades, to a depth of 3 feet, and the construction of structural fill bearing pads will be necessary for foundation support of the new structure. Given the fact that the over-excavation will likely extend below the water table, we recommend that the bottom 12 inches of the bearing pads consist of 2-4 inch quarry spalls driven into the subgrade using a hoe pack. Recommendations for Spread Footings are provided in Section 4.2.
- <u>Floor Options</u>: Floor sections should bear on medium dense or denser native soils or on properly compacted structural fill that extends down to medium dense or denser native soil. We recommend over-excavation of slab-on-grade floor subgrades to a

minimum depth of 2 feet, then placement of properly compacted structural fill as a floor subbase. If floor construction occurs during wet conditions, it is likely that a geotextile fabric, placed between the structural fill floor subbase and native soils, will be necessary. Recommendations for slab-on-grade floors are included in Section 4.3. Fill underlying floor slabs should be compacted to 95 percent (ASTM:D-1557).

- Infiltration Conditions: Given the fine-grained nature of site soils, and the shallow depth to groundwater, we do not interpret standard full or limited infiltration as being feasible to manage roof-runoff from the proposed residence. Given such, it is our opinion that roof-runoff produced by the proposed residence should be managed through the introduction of raingardens, a dispersion system, or a combination of the two. Pervious pavements utilized in the improved driveway system should be designed utilizing an infiltration rate of **0.13 inches/hour** for native subgrade materials.

The following sections of this report present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, slab-on-grade floors, asphalt pavement, and structural fill. The Washington State Department of Transportation (WSDOT) Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

4.1 Site Preparation

Preparation of the project site should involve erosion control, temporary drainage, clearing, stripping, excavations, cutting, subgrade compaction, and filling.

Erosion Control: Before new construction begins, an appropriate erosion control system should be installed. This system should collect and filter all surface water runoff through silt fencing. We anticipate a system of berms and drainage ditches around construction areas will provide an adequate collection system. Silt fencing fabric should meet the requirements of WSDOT Standard Specification 9-33.2 Table 3. In addition, silt fencing should embed a minimum of 6 inches below existing grade. An erosion control system requires occasional observation and maintenance. Specifically, holes in the filter and areas where the filter has shifted above ground surface should be replaced or repaired as soon as they are identified.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Based on our current understanding of the construction plans, surface and subsurface conditions, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, sod, topsoil, and root-rich soil should be stripped from the site. Our subsurface exploration indicates that the organic horizon can reach thicknesses of up to 8 inches. Stripping is best performed during a period of dry weather.

<u>Site Excavations</u>: Based on our exploration, we expect that site excavations to encountered loose/soft silty alluvial soils, which can be readily excavated using standard excavation equipment.

<u>Dewatering</u>: Our explorations encountered groundwater seepage at a depth of 2½ to 3½ feet below existing grade. For shallow excavations, we anticipate that an internal system of ditches, sump holes, and pumps will be adequate to temporarily dewater excavations. For deeper excavations, those performed well below the water table, we anticipate that well points, or other expensive dewatering techniques will need to be employed to adequately dewater excavations.

<u>Temporary Cut Slopes</u>: All temporary soil slopes associated with site cutting or excavations should be adequately inclined to prevent sloughing and collapse. Temporary cut slopes in site soils should be no steeper than 1½H:1V, and should conform to Washington Industrial Safety and Health Act (WISHA) regulations.

<u>Subgrade Compaction</u>: Exposed subgrades for the foundation of the proposed residence should be compacted to a firm, unyielding state before new concrete or fill soils are placed. Any localized zones of looser granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be overexcavated and replaced with a suitable structural fill material.

<u>Site Filling</u>: Our conclusions regarding the reuse of onsite soils and our comments regarding wet-weather filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the Structural Fill section of this report. Specifically, building pad fill soil should be compacted to a uniform density of at least 95 percent (based on ASTM:D-1557).

<u>Onsite Soils</u>: We offer the following evaluation of these onsite soils in relation to potential use as structural fill:

- *<u>Surficial Organic Soil and Organic-Rich Fill Soils</u>*: Where encountered, surficial organic soils, like duff, topsoil, root-rich soil, and organic-rich fill soils are *not* suitable for use as structural fill under any circumstances, due to high organic content. Consequently, this material can be used only for non-structural purposes, such as in landscaping areas.
- *<u>Alluvial Silt</u>*: Underlying a surface mantle of sod and topsoil, we encountered mottled, silty soils to a depth of 7 feet below existing grade. These soils are extremely moisture sensitive and will be difficult, if not impossible to reuse during wet weather conditions. If reuse is planned, care should be taken while stockpiling in order to avoid saturation/over-saturation of the material, and moisture conditioning should be expected.

- Alluvial Silty Sand: Underlying the silt stratum discussed in the above section, we encountered fine silty sand, which was continuous to the termination depth of our subsurface exploration; 12 feet below existing grade. This material type contains a relative fines content (percent silt/clay) of upwards of 38 percent, and is moderately to severely moisture sensitive. This material type will be difficult to reuse in wet weather conditions, particularly given the fact that it was encountered in a saturated in-situ condition.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to reduce long-term raveling, sloughing, and erosion. We generally recommend that no permanent slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes (such as 2½H:1V) would further reduce long-term erosion and facilitate revegetation.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

4.2 Spread Footings

In our opinion, conventional spread footings will provide adequate support for the residences if the subgrades are properly prepared. Due to the soft soils underlying the site, over-excavation of spread footing subgrades, to a depth of 3 feet, and the construction of structural fill bearing pads will be necessary for foundation support of the new structure.

Footing Depths and Widths: For frost and erosion protection, the bases of all exterior footings should bear at least 18 inches below adjacent outside grades, whereas the bases of interior footings need bear only 12 inches below the surrounding slab surface level. To reduce post-construction settlements, continuous (wall) and isolated (column) footings should be at least 16 and 24 inches wide, respectively.

Bearing Subgrades: Structural fill bearing pads, 3 feet thick and compacted to a density of at least 95 percent (based on ASTM:D-1557), should underlie spread footings on this site. Given the fact that the over-excavation will likely extend below the water table, we recommend that the bottom 12 inches of the bearing pads consist of 2-4 inch quarry spalls driven into the subgrade using a hoe pack.

In general, before footing concrete is placed, any localized zones of loose soils exposed across the footing subgrades should be compacted to a firm, unyielding condition, and any localized zones of soft, organic, or debris-laden soils should be overexcavated and replaced with suitable structural fill.

Lateral Overexcavations: Because foundation stresses are transferred outward as well as downward into the bearing soils, all structural fill placed under footings, should extend horizontally outward from the edge of each footing. This horizontal distance should be equal to the depth of placed fill. Therefore, placed fill that extends 3 feet below the footing base should also extend 3 feet outward from the footing edges.

Subgrade Observation: All footing subgrades should consist of firm, unyielding, native soils, or structural fill materials that have been compacted to a density of at least 95 percent (based on ASTM:D-1557). Footings should never be cast atop loose, soft, or frozen soil, slough, debris, existing uncontrolled fill, or surfaces covered by standing water.

Bearing Pressures: In our opinion, for static loading, footings that bear on properly prepared, structural fill bearing pads 3 feet thick can be designed for a preliminary allowable soil bearing pressure of 1,500 psf. A one-third increase in allowable soil bearing capacity may be used for short-term loads created by seismic or wind related activities.

Footing Settlements: Assuming that structural fill soils are compacted to a medium dense or denser state, we estimate that total post-construction settlements of properly designed footings bearing on properly prepared subgrades will not exceed 1 inch. Differential settlements for comparably loaded elements may approach one-half of the actual total settlement over horizontal distances of approximately 50 feet.

Footing Backfill: To provide erosion protection and lateral load resistance, we recommend that all footing excavations be backfilled on both sides of the footings and stemwalls after the concrete has cured. Either imported structural fill or non-organic onsite soils can be used for this purpose, contingent on suitable moisture content at the time of placement. Regardless of soil type, all footing backfill soil should be compacted to a density of at least 90 percent (based on ASTM:D-1557).

Lateral Resistance: Footings that have been properly backfilled as recommended above will resist lateral movements by means of passive earth pressure and base friction. We recommend using an allowable passive earth pressure of 225 psf and an allowable base friction coefficient of 0.35 for site soils.

4.3 Slab-On-Grade Floors

In our opinion, soil-supported slab-on-grade floors can be used if the subgrades are properly prepared. We offer the following comments and recommendations concerning slab-on-grade floors.

Floor Subbase: We recommend over-excavation of slab-on-grade floor subgrades to a minimum depth of 2 feet, then placement of properly compacted structural fill as a floor subbase. If floor construction occurs during wet conditions, it is likely that a geotextile fabric, placed between the structural fill floor subbase and native soils, will be necessary.

All subbase fill should be compacted to a density of at least 95 percent (based on ASTM:D-1557).

Capillary Break and Vapor Barrier: To retard the upward wicking of moisture beneath the floor slab, we recommend that a capillary break be placed over the subgrade. Ideally, this capillary break would consist of a 4-inch-thick layer of pea gravel or other clean, uniform, well-rounded gravel, such as "Gravel Backfill for Drains" per WSDOT Standard Specification 9-03.12(4), but clean angular gravel can be used if it adequately prevents capillary wicking. In addition, a layer of plastic sheeting (such as Crosstuff, Visqueen, or Moistop) should be placed over the capillary break to serve as a vapor barrier. During subsequent casting of the concrete slab, the contractor should exercise care to avoid puncturing this vapor barrier.

Vertical Deflections: Due to elastic compression of subgrades, soil-supported slab-on-grade floors can deflect downwards when vertical loads are applied. In our opinion, a subgrade reaction modulus of 250 pounds per cubic inch can be used to estimate such deflections.

4.4 Drainage Systems

In our opinion, structures should be provided with permanent drainage systems to reduce the risk of future moisture problems. We offer the following recommendations and comments for drainage design and construction purposes.

Perimeter Drains: We recommend that buildings be encircled with a perimeter drain system to collect seepage water. This drain should consist of a 4-inch-diameter perforated pipe within an envelope of pea gravel or washed rock, extending at least 6 inches on all sides of the pipe, and the gravel envelope should be wrapped with filter fabric to reduce the migration of fines from the surrounding soils. Ideally, the drain invert would be installed no more than 8 inches above the base of the perimeter footings.

Subfloor Drains: We recommend that subfloor drains be included beneath the new building. These subfloor drains should consist of 4-inch-diameter perforated pipes surrounded by at least 6 inches of pea gravel and enveloped with filter fabric. A pattern of parallel pipes spaced no more than 20 feet apart and having inverts located about 12 inches below the capillary break layer would be appropriate, in our opinion.

Discharge Considerations: If possible, all perimeter drains should discharge to a sewer system or other suitable location by gravity flow. Check valves should be installed along any drainpipes that discharge to a sewer system, to prevent sewage backflow into the drain system. If gravity flow is not feasible, a pump system is recommended to discharge any water that enters the drainage system.

Runoff Water: Roof-runoff and surface-runoff water should *not* discharge into the perimeter drain system. Instead, these sources should discharge into separate tightline pipes and be routed away from the building to a storm drain or other appropriate location.

Grading and Capping: Final site grades should slope downward away from the buildings so that runoff water will flow by gravity to suitable collection points, rather than ponding near the building. Ideally, the area surrounding the building would be capped with concrete, asphalt, or low-permeability (silty) soils to minimize or preclude surface-water infiltration.

4.5 Pervious Pavement

We understand that pervious pavement will be utilized in the construction of the improved driveway system. Site grading will consist of removal of sufficient sod and underlying soil to install a thick coarse gravel reservoir along with a slightly finer gravel pavement base course under the area to receive porous paving. The actual thickness of these elements will be determined by the design engineer; however, a minimum of one foot of separation needs to be maintained between from the bottom of the gravel reservoir and seasonally high groundwater levels. We offer the following comments and recommendations for pavement construction.

Subgrade Preparation: The existing subgrade under all pervious pavements must remain in an uncompacted condition to facilitate water infiltration. Traffic from construction equipment and vehicles should be limited to the extent practical prior to placement of the pavement section. Control erosion and avoid introducing sediment from surrounding land uses onto permeable pavements. Do not allow muddy construction equipment on the base material or pavement. Any concentrated areas of fines accumulation due to ponding may be removed to a maximum depth of 6 inches. If desired, these areas may be re-leveled using clean sand. Materials meeting the requirements for “Sand Drainage Blanket” in section 9-03.13(1) of the WSDOT Standard Specifications may be used for this purpose.

We recommend placement of a nonwoven filter fabric such as Mirafi 160N or equal over the prepared subgrade prior to construction of the pervious pavement section.

Maintenance Considerations: Do not allow sediment laden runoff onto permeable pavements. Pavements fouled with sediments or no longer passing an initial infiltration test must be cleaned using procedures from the local stormwater manual or the manufacturer’s procedures.

Construction Observation: We recommend that an MGI representative be retained to observe and document the placement of each course before any overlying layer is placed.

4.6 Structural Fill

The term "structural fill" refers to any material placed under foundations, retaining walls, slab-on-grade floors, sidewalks, pavements, and other structures. Our comments, conclusions, and recommendations concerning structural fill are presented in the following paragraphs.

Materials: Typical structural fill materials include clean sand, gravel, pea gravel, washed rock, crushed rock, well-graded mixtures of sand and gravel (commonly called "gravel borrow" or "pit-run"), and miscellaneous mixtures of silt, sand, and gravel. Recycled asphalt, concrete, and glass, which are derived from pulverizing the parent materials, are also potentially useful as structural fill in certain applications. Soils used for structural fill should not contain any organic matter or debris, nor any individual particles greater than about 6 inches in diameter.

Fill Placement: Clean sand, gravel, crushed rock, soil mixtures, and recycled materials should be placed in horizontal lifts not exceeding 8 inches in loose thickness, and each lift should be thoroughly compacted with a mechanical compactor.

Compaction Criteria: Using the Modified Proctor test (ASTM:D-1557) as a standard, we recommend that structural fill used for various onsite applications be compacted to the following minimum densities:

Fill Application	Minimum Compaction
Footing subgrade and bearing pad	95 percent
Foundation and subgrade wall backfill	90 percent
Slab-on-grade floor subgrade and subbase	95 percent

Subgrade Observation and Compaction Testing: Regardless of material or location, all structural fill should be placed over firm, unyielding subgrades prepared in accordance with the Site Preparation section of this report. The condition of all subgrades should be observed by geotechnical personnel before filling or construction begins. Also, fill soil compaction should be verified by means of in-place density tests performed during fill placement so that adequacy of soil compaction efforts may be evaluated as earthwork progresses.

Soil Moisture Considerations: The suitability of soils used for structural fill depends primarily on their grain-size distribution and moisture content when they are placed. As the "fines" content (that soil fraction passing the U.S. No. 200 Sieve) increases, soils become more sensitive to small changes in moisture content. Soils containing more than about 5 percent fines (by weight) cannot be consistently compacted to a firm, unyielding condition when the moisture content is more than 2 percentage points above or below optimum. For fill placement during wet-weather site work, we recommend using "clean" fill, which refers to soils that have a fines content of 5 percent or less (by weight) based on the soil fraction passing the U.S. No. 4 Sieve.

5.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Subsequently, we recommend that MGI be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design;
- Prepare a letter summarizing all review comments (if required);
- Check all completed subgrades for footings and slab-on-grade floors before concrete is poured, in order to verify their bearing capacity; and
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required).

6.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we observed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. MGI is available to provide geotechnical monitoring of soils throughout construction.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

MIGIZI GROUP, INC.

Jessica Bizah for ZLL.

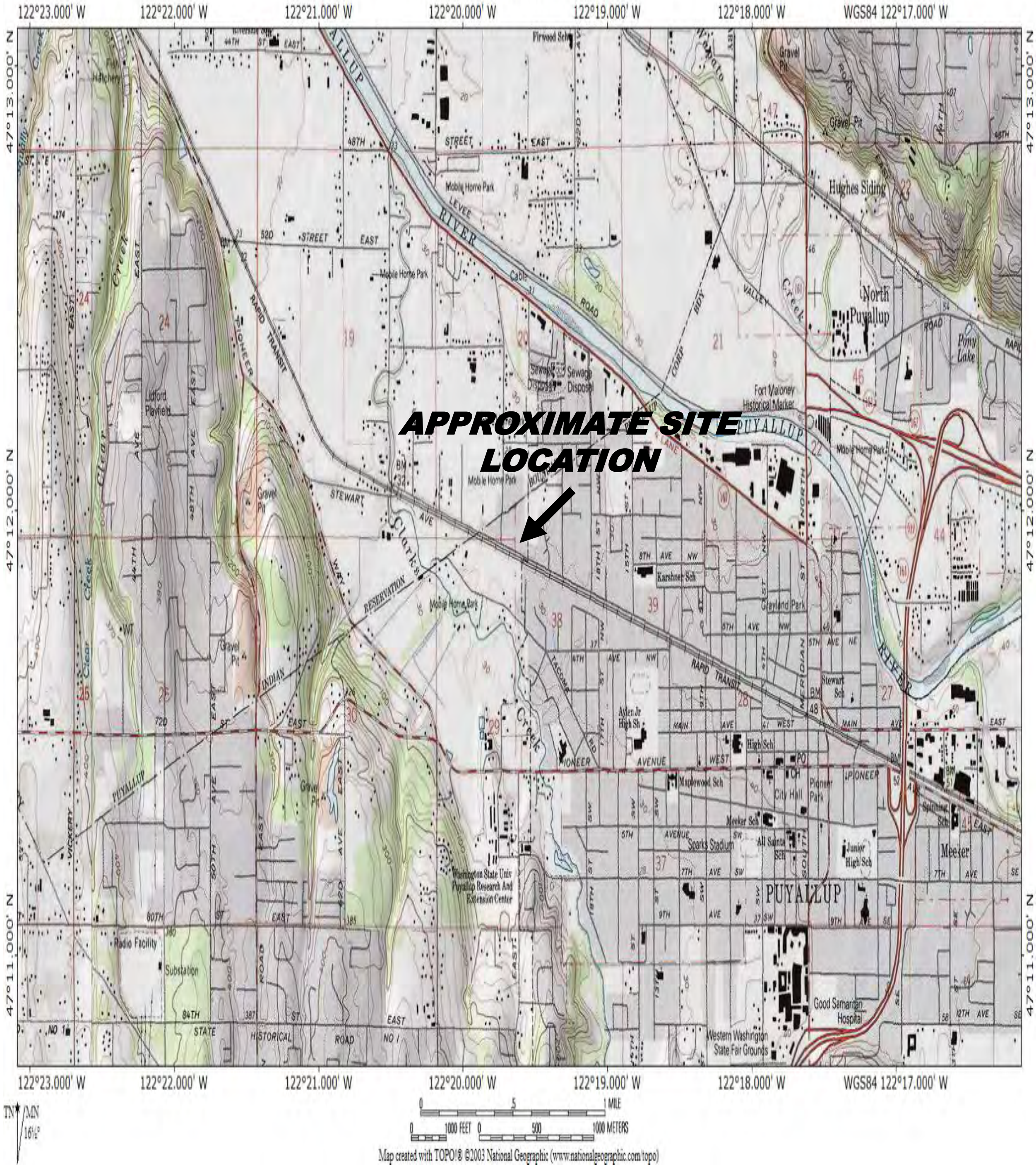
Zach L. Logan
Staff Geologist

James E. Brigham 20540

04-21-16

James E. Brigham, P.E.
Principal Engineer

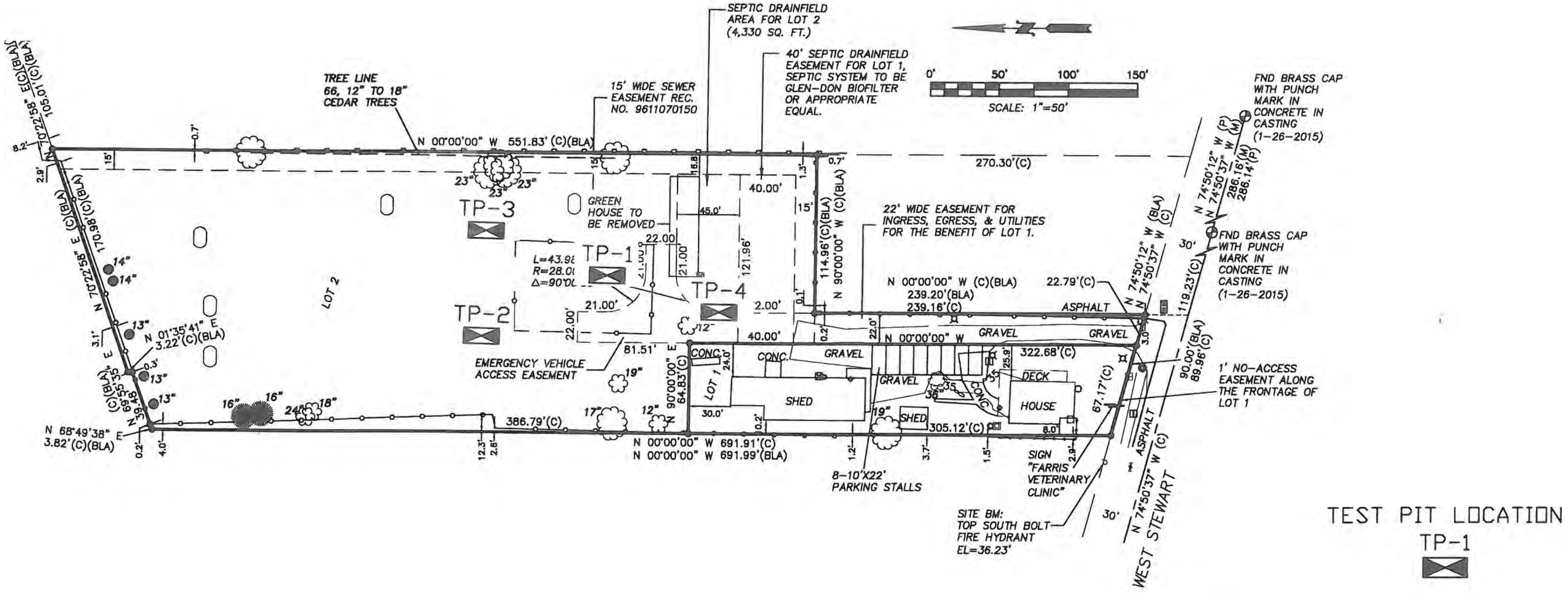
TOPO! map printed on 03/09/16 from "Untitled.tpo"



APPROXIMATE SITE LOCATION

Map created with TOPO!® ©2003 National Geographic (www.nationalgeographic.com/topo)

Migizi Group, Inc. **P.O. Box 44840** **Tacoma, WA 98448**	2401 West Stewart Avenue Puyallup, Washington 98371 Topographic and Location Map	**FIGURE 1** **P475-T15**



NOTE:
BOUNDARY AND TOPOGRAPHY ARE BASED ON MAPPING PROVIDED TO MIGIZI OBSERVATIONS MADE IN THE FIELD. THE INFORMATION SHOWN DOES NOT CONSTITUTE A FIELD SURVEY BY MIGIZI.

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253-537-9401 fax
www.migizigroup.com

PROJECT: 2401 W Stewart St
Puyallup, Washington

SHEET TITLE: Site and Exploration Plan

DESIGNER: CRL	JOB NO. P475-T15
DRAWN BY: CRL	SCALE: As Shown
CHECKED BY: JEB	FIGURE: 2
DATE: Mar. 29, 2016	FILE: Fig2.dwg

APPENDIX A
SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

LOG OF TEST PIT

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

⧗	Modified California	RV	R-Value
⊠	Split Spoon	SA	Sieve Analysis
■	Pushed Shelby Tube	SW	Swell Test
◧	Auger Cuttings	TC	Cyclic Triaxial
✋	Grab Sample	TX	Unconsolidated Undrained Triaxial
■	Sample Attempt with No Recovery	TV	Torvane Shear
CA	Chemical Analysis	UC	Unconfined Compression
CN	Consolidation	(1.2)	(Shear Strength, ksf)
CP	Compaction	WA	Wash Analysis
DS	Direct Shear	(20)	(with % Passing No. 200 Sieve)
PM	Permeability	▽	Water Level at Time of Drilling
PP	Pocket Penetrometer	▼	Water Level after Drilling(with date measured)

SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

Figure A-1

MIGIZI GROUP

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Tacoma, WA 98448
Telephone: 253-537-9400
Fax: 253-537-9401

TEST PIT NUMBER TP-1

PAGE 1 OF 1
Figure A-2

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
▽ **AT TIME OF EXCAVATION** 3.00 ft Moderate seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0.0				0.5	Sod and Topsoil
	GB S-1	SM		1.0	(SM) Brown silty fine sand (very loose, moist) (Alluvial Deposits)
2.5	GB S-2	ML		4.0	(ML) Gray mottled silt (very soft, moist) (Alluvial Deposits) Grades to wet at 2 feet ▽
5.0	GB S-3	SM		5.0	(SM) Gray/brown mottled silty fine sand (very loose, wet) (Alluvial Deposits)

Severe caving observed from 0 to 5 feet
Moderate groundwater seepage observed at 3 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 5.0 feet.

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Fax: 253-537-9401

TEST PIT NUMBER TP-2

PAGE 1 OF 1
Figure A-3

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
▽ **AT TIME OF EXCAVATION** 2.50 ft Moderate seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0.0			0.6	Sod and Topsoil
	GB S-1 GB S-2	ML	1.3	(ML) Brown sandy silt (very soft, moist) (Alluvial Deposits)
2.5		ML	4.0	(ML) Gray mottled silt (very soft, wet) (Alluvial Deposits) ▽
5.0		SM	6.0	(SM) Gray/brown mottled silty fine sand (very loose, wet) (Alluvial Deposits) Buried logs encountered at 4 to 5.5 feet

Severe caving observed from 1.5 to 6 feet
Moderate groundwater seepage observed at 2.5 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 6.0 feet.

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Fax: 253-537-9401

TEST PIT NUMBER TP-3

Figure A-4

CLIENT Farris Vet Clinic

PROJECT NAME 2401 W Stewart Geotech Report

PROJECT NUMBER P475-T15

PROJECT LOCATION Puyallup, Washington

DATE STARTED 3/8/16 **COMPLETED** 3/8/16

GROUND ELEVATION **TEST PIT SIZE**

EXCAVATION CONTRACTOR Owner-Operator

GROUND WATER LEVELS:

EXCAVATION METHOD Rubber Tracked Excavator

∇ **AT TIME OF EXCAVATION** 2.50 ft Moderate seepage

LOGGED BY ZLL **CHECKED BY** JEB

AT END OF EXCAVATION ---

NOTES

AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0.0	GB S-1			0.7	Sod and Topsoil
		SM		1.2	(SM) Brown fine silty sand (very loose, moist) (Alluvial Deposits)
		ML		6.0	(ML) Gray/brown mottled silt (very soft, wet) (Alluvial Deposits)
2.5					∇
5.0					

Severe caving observed from 3 to 6 feet
Moderate groundwater seepage observed at 2.5 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 6.0 feet.

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Fax: 253-537-9401

TEST PIT NUMBER TP-4

PAGE 1 OF 1
Figure A-5

CLIENT Farris Vet Clinic
PROJECT NAME 2401 W Stewart Geotech Report
PROJECT NUMBER P475-T15
PROJECT LOCATION Puyallup, Washington
DATE STARTED 3/8/16 **COMPLETED** 3/8/16
GROUND ELEVATION **TEST PIT SIZE**
EXCAVATION CONTRACTOR Owner-Operator
GROUND WATER LEVELS:
EXCAVATION METHOD Rubber Tracked Excavator
▽ **AT TIME OF EXCAVATION** 3.50 ft Slow seepage
LOGGED BY ZLL **CHECKED BY** JEB
AT END OF EXCAVATION ---
NOTES
AFTER EXCAVATION ---

DEPTH (ft)	SAMPLE TYPE NUMBER	U.S.C.S.	GRAPHIC LOG		MATERIAL DESCRIPTION
0.0		SM	▨	1.0	(SM) Brown silty sand with gravel, crushed rock, and brick debris (medium dense, moist) (Fill)
2.5	GB S-1	SM		3.0	(SM) Brown fine silty sand (loose, moist) (Alluvial Deposits)
5.0	GB S-2	ML		6.0	(ML) Gray/brown mottled silt (soft, wet) (Alluvial Deposits) ▽

No caving observed
Slow groundwater seepage observed at 3.5 feet

The depths on the test pit logs are based on an average of measurements across the test pit and should be considered accurate to 0.5 foot.

Bottom of test pit at 6.0 feet.

APPENDIX B
LABORATORY TESTING RESULTS

Particle Size Analysis Summary Data

Job Name: 2401 W Stewart Ave Puyallup
Job Number: P475-T15
Tested By: ZLL
Date: 3/8/16
Boring #: TP-2
Sample #: 2
Depth: 1.5 feet

Moisture Content (%)	37.8%

Sieve Size	**Percent Passing (%)**
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	99.8
No. 20 (.850-mm)	98.0
No. 40 (.425-mm)	95.6
No. 60 (.250-mm)	93.9
No. 100 (.150-mm)	92.4
No. 200 (.075-mm)	90.2

Size Fraction	**Percent By Weight**
Coarse Gravel	
Fine Gravel	
Coarse Sand	0.2
Medium Sand	4.1
Fine Sand	5.4
Fines	90.2
Total	100.0

LL ____________
PI ____________

D10 ____________
D30 ____________
D60 ____________

Cc ____________
Cu ____________

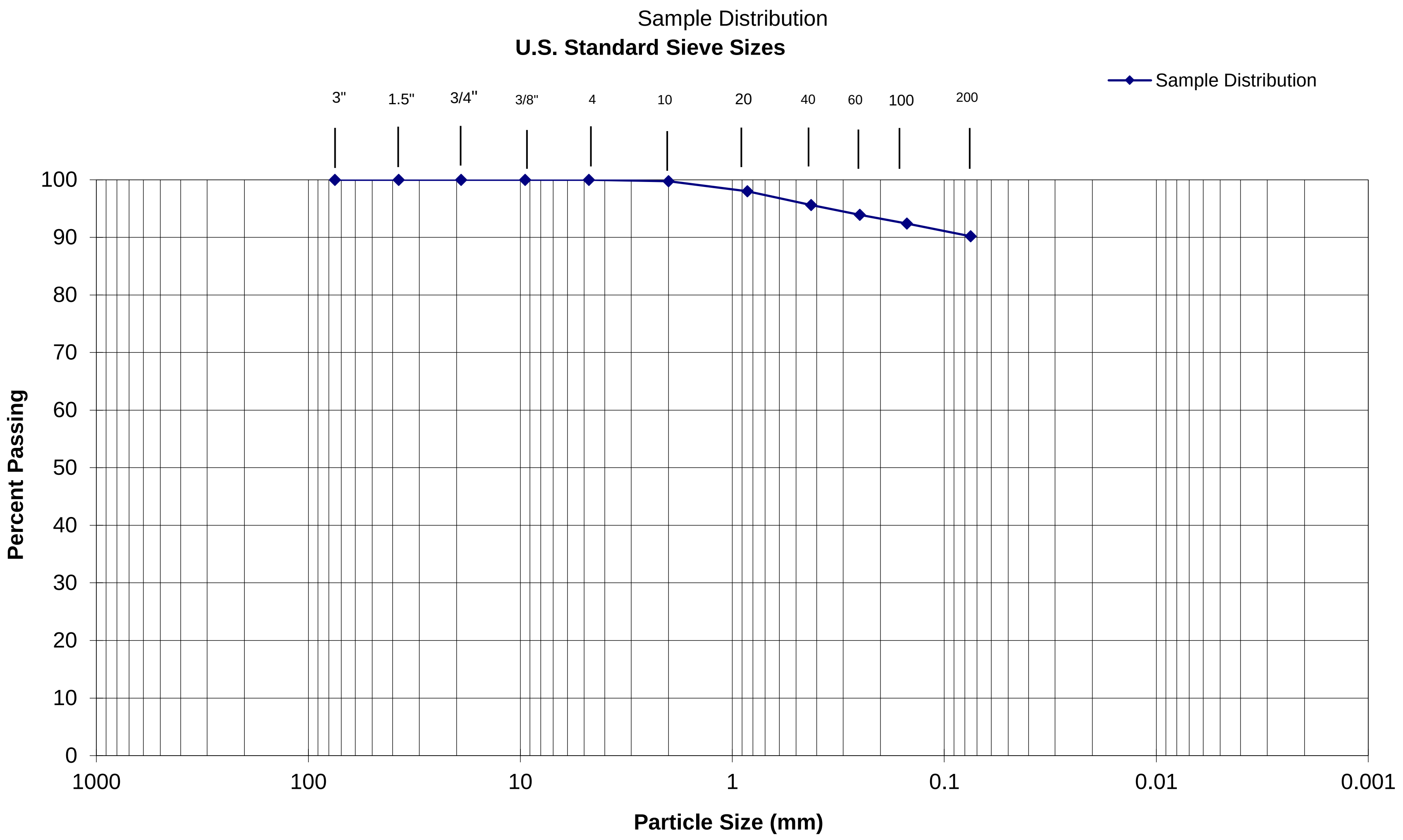
ASTM Classification

Group Name Grayish-brown silt
Symbol (ML) (very soft, wet)

MIGIZI GROUP

Figure B-1

Soil Classification Data Sheet



MIGIZI GROUP

Sample Distribution	Job Name: 2401 W Stewart Ave Puyallup	Sample #: 2
	Job Number: P475-T15	Date: 3/8/16
Figure: B-2	Tested By: ZLL	Depth: 1.5 feet
	Exploration #: TP-2	

Particle Size Analysis Summary Data

Job Name: 2401 W Stewart Ave Puyallup
Job Number: P475-T15
Tested By: ZLL
Date: 3/8/16
Boring #: TP-4
Sample #: 2
Depth: 4 feet

Moisture Content (%)	37.2%

Sieve Size	Percent Passing (%)
3.0 in. (75.0)	100.0
1.5 in. (37.5)	100.0
3/4 in. (19.0)	100.0
3/8 in. (9.5-mm)	100.0
No. 4 (4.75-mm)	100.0
No. 10 (2.00-mm)	100.0
No. 20 (.850-mm)	99.3
No. 40 (.425-mm)	98.2
No. 60 (.250-mm)	97.5
No. 100 (.150-mm)	95.7
No. 200 (.075-mm)	79.2

Size Fraction	Percent By Weight
Coarse Gravel	
Fine Gravel	
Coarse Sand	0.0
Medium Sand	1.7
Fine Sand	19.0
Fines	79.2
Total	100.0

LL ________
PI ________

D10 ________
D30 ________
D60 ________

Cc ________
Cu ________

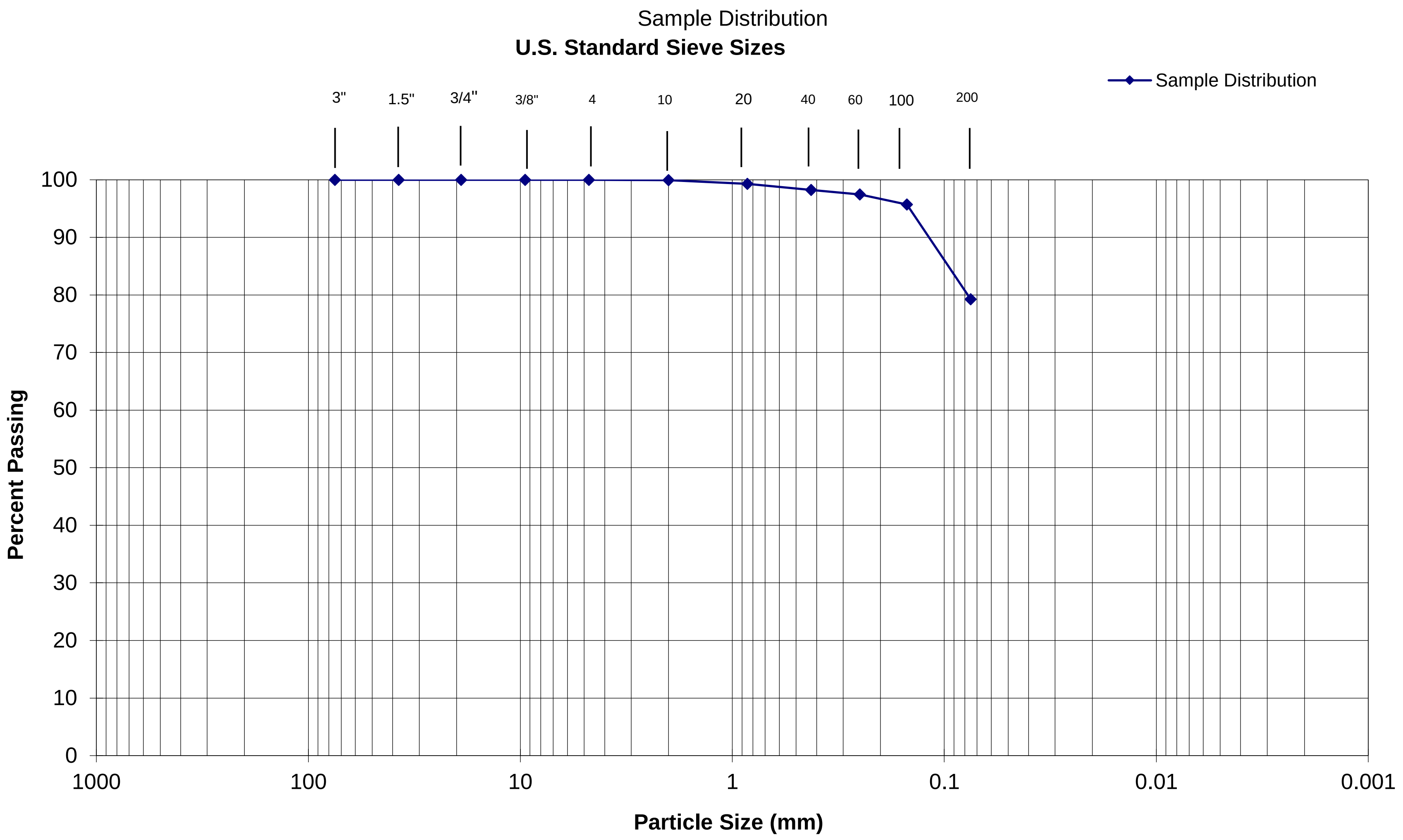
ASTM Classification

Group Name Grayish-brown silt with sand
Symbol (ML) (med. stiff, wet)

MIGIZI GROUP

Figure B-3

Soil Classification Data Sheet



MIGIZI GROUP	**Sample Distribution**	Job Name:	2401 W Stewart Ave Puyallup	Sample #:	2
		Job Number:	P475-T15	Date:	3/8/16
	Figure: B-4	Tested By:	ZLL	Depth:	4 feet
		Exploration #:	TP-4		

APPENDIX C
KRAZAN & ASSOCIATES, INC. AND AGSOURCE LABORATORIES RESULTS

Krazan & ASSOCIATES, INC.

GEOTECHNICAL ENGINEERING • ENVIRONMENTAL ENGINEERING
CONSTRUCTION TESTING & INSPECTION

April 1, 2016

KA Project No: 066-16081
Page 1 of 1

Zach Logan
Migizi Group,Inc.
201 160th St. S.
Spanaway WA 98387

RE: Organic Content & Cat-Ion Exchange
Ferris Vet Clinic P475-T15

Dear Mr. Logan,

In accordance with your request and authorization, we have performed laboratory testing and analysis of a silty sand per A.S.T.M. standard D2974. Please the table below for a summary of our test results.

Sample ID	**Material Description**	**Organic Content (ASTM D2974**	**Cat-Ion Exchance Capacity**
16L150	Silty sand	5.4%	10.1 ~~ppm~~ meq/100g

If you have any questions or need any additional information, please do not hesitate to contact our office at (253) 939-2500.

Respectfully submitted,
KRAZAN & ASSOCIATES, INC

Michael Thomas
Laboratory Manager
Krazan and Associates, Inc.
Phone: (253) 939-2500
Email: Mikethomas@krazan.com

Attached:
Agsource Laboratories Soil Analysis of Cat-Ion Exchange Capacity

AgSource Laboratories
A Subsidiary of Cooperative Resources International

323 Sixth Street
Umatilla, OR 97882
Tel:541-922-4894
umatilla@agsource.com

Soil Analysis

Submitted By: **UMK23345**
KRAZAN & ASSOCIATES, INC. - PUYALLUP
922 VALLEY AVENUE NW, SUITE 101
PUYALLUP, WA 98391

Submitted For:
FERRIS VET CLINIC P475-T15

Laboratory Sample #
AU48434

Date Received
24-Mar-2016

Date Reported
25-Mar-2016

Information Sheet #
S9830

REPORT OF ANALYTICAL RESULTS

Client Sample Identification	Analysis	Result
TP-4 SAMPLE 1		
	Actual CEC	10.1 ~~ppm~~ meq/100g

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APPENDIX B

MIGIZI GROUP, INC.

PO Box 44840
Tacoma, Washington 98448

PHONE (253) 537-9400
FAX (253) 537-9401

September 28, 2021

Danny Foster
2345 W Stewart St
Puyallup, Washington 98371

Subject: Draft **Infiltration Report**
Residential Development
2345 W Stewart St
Puyallup, Washington 98371
Parcel No. 0420207029

MGI Project P2271-T20

Dear Mr. Foster:

Migizi Group, Inc. (MGI) is pleased to submit this report describing the results of our infiltration evaluation of the development of your residential parcel in Puyallup, Washington. The purpose of this evaluation is to supplement the original *Geotechnical Engineering Report* prepared for this project by the undersigned, dated April 21, 2016.

This report has been prepared for the exclusive use of Danny Foster, and his consultants, for specific application to this project, in accordance with generally accepted geotechnical engineering practice.

1.0 SITE AND PROJECT DESCRIPTION

The parent property of the project site consisted of an irregularly shaped, 2.84-acre parcel located on the north side of West Stewart Street in Puyallup, Washington, as shown on the enclosed Topographic and Location Map (Figure 1). The parcel was orientated lengthwise from north to south, spanning approximately 692 feet along this orientation, and contains a maximum width of ± 185 feet. A short plat of the property has recently taken place, dividing the parcel into two lots. Lot 1 is roughly rectangular shaped and encompasses a 67 by 322-foot area towards the southwest corner of the project site. Farris Vet Clinic, associated parking facilities, and the large, shed building directly to the north are all contained within Lot 1. The remaining 2.37 acres of the project area, including the long gravel driveway, are incorporated into Lot 2. Outside of the aforementioned gravel driveway, and an existing greenhouse, Lot 2 is largely undeveloped and occupied by an open, grassy field.

Development plans involve the construction of a new single-family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement.

2.0 EXPLORATORY METHODS

We explored surface and subsurface conditions at the project site on December 31, 2020, and performed regular groundwater monitoring visits between December 31, 2020, thru April 30, 2021. Our exploration and evaluation program included the following elements:

- Surface reconnaissance of the site,
- Two test pit explorations (designated TP-1 & TP-2) conducted onsite, advanced on December 31, 2020,
- Two Small-Scale Pilot Infiltration Tests along the alignment of the proposed infiltration trench and pervious pavements,
- Installation of five, 6-foot monitoring wells along the course of the pervious driveway and proposed infiltration trench, with regular groundwater monitoring measurements taken between December 31, 2020, thru April 30, 2021,
- Review of the original *Geotechnical Engineering Report* for this project, prepared by the undersigned, dated April 21, 2016, and
- A review of published geologic and seismologic maps and literature.

Table 1 summarizes the approximate functional locations and termination depths of our subsurface explorations, and Figure 2 depicts their approximate relative locations. The following sections describe the procedures used for excavation of the test pits.

TABLE 1
APPROXIMATE LOCATIONS AND DEPTHS OF EXPLORATIONS

Exploration	Functional Location	Termination Depth (feet)
TP-1	North end of proposed infiltration trench, along north side of existing residence	6½
TP-2	Southwest of the southwest corner of the proposed residential site	9

The specific numbers and locations of our explorations were selected in relation to the existing site features, under the constraints of surface access, underground utility conflicts, and budget considerations.

It should be realized that the explorations performed and used for this evaluation reveal subsurface conditions only at a discrete location across the project site and that actual conditions in other areas could vary. Furthermore, the nature and extent of any such variations would not become evident until additional explorations are performed or until construction activities have begun. If significant variations are observed at that time, we may need to modify our conclusions and recommendations contained in this report to reflect the actual site conditions.

2.1 Test Pit Procedures

Our exploratory test pits were excavated with a rubber-tracked mini-excavator operated by an excavation contractor under subcontract to MGI. An engineering geologist from our firm observed the test pit excavations, collected soil samples, and logged the subsurface conditions.

The enclosed test pit logs indicate the vertical sequence of soils and materials encountered in our test pits, based on our field classifications. Where a soil contact was observed to be gradational or undulating, our logs indicate the average contact depth. We estimated the relative density and consistency of the in-situ soils by means of the excavation characteristics and the stability of the test pit sidewalls. Our logs also indicate the approximate depths of any sidewall caving or groundwater seepage observed in the test pits. The soils were classified visually in general accordance with the system described in Figure A-1, which includes a key to the exploration logs. Summary logs of our explorations are included as Figures A-2 and A-3.

2.2 Infiltration Test Procedures

In-situ field infiltration testing was performed for determination of a Design Infiltration Rate in general accordance with the Small-Scale PIT procedures, as described in Section III-3.3.6 of the *2014 Stormwater Management Manual for Western Washington*, as adopted by the City of Puyallup. The first step of this test procedure was to identify a suitable soil stratum for stormwater retention and once completed, perform an excavation within this soil group with a minimum surface area of 12 square feet (sf). After the excavation was completed, a vertical measuring rod marked in half-inch increments was installed towards the center of the test area. Water was then introduced into the test area, being conveyed through a 4-inch corrugated pipe to a splash block at the bottom of the excavation. After 12 inches of water was developed at the bottom of the excavation, the test surface was saturated prior to testing. After the saturation period was completed, a steady-state flow rate was developed to maintain 12 inches of head at the bottom of the test surface. This steady-state rate was maintained for 1 hour. After completion of the steady-state period, water was no longer introduced into the excavation and infiltration of the existing water was allowed. We recorded the falling head rate for 1 hour for comparison with the steady-state rate.

3.0 SITE CONDITIONS

The following sections present our observations, measurements, findings, and interpretations regarding surface, soil, groundwater, infiltration and seismic conditions and liquefaction potential.

3.1 Surface Conditions

The subject property is located towards the west end of the city limits of Puyallup, Washington. Immediately to the east is more densely populated residential areas, whereas to the west are more sparsely populated agricultural sites. The project area is located between the Puyallup River (to the north) and Clarks Creek (to the south). As previously indicated, the project site consists of a 2.84-acre tax parcel which has recently been short-platted. Lot 1, located towards the southwest corner of the project area, is occupied by the Farris Vet Clinic, associated parking facilities, and a large, shed building north of the clinic. Access to the clinic is gained through a gravel driveway which hugs the eastern site boundary, extending north from West Stewart Ave. Lot 2 contains the gravel driveway and portions of the property east and north of the large, shed building. The southeast corner of Lot 2 contains an existing greenhouse and is littered with miscellaneous debris. The remainder of Lot 2 is undeveloped and occupied by an open, grass field.

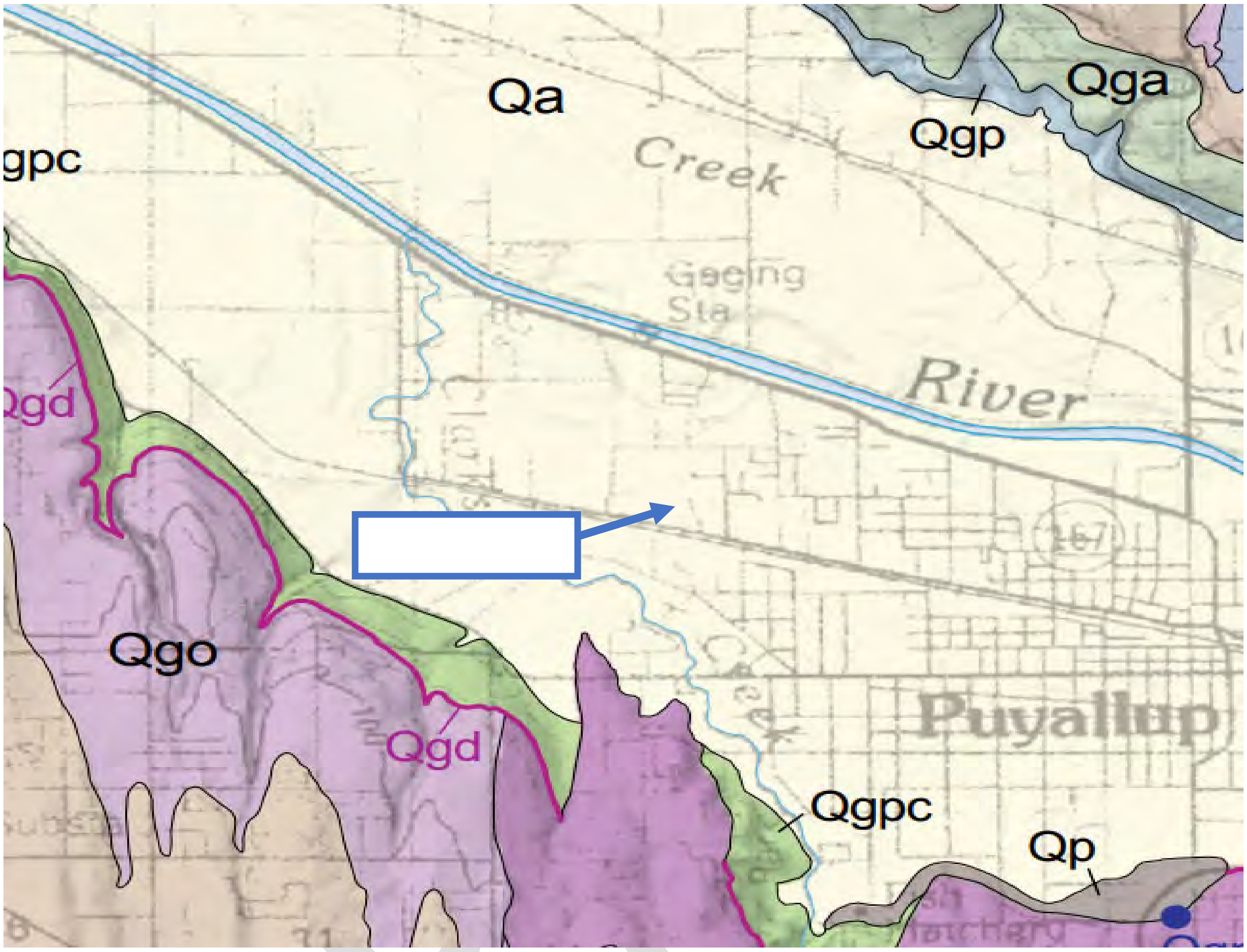
Vegetation on site is largely comprised of tall grasses in the vicinity of Lot 2, and younger cedar along the western, eastern, and northern margins of the site. Scattered brush is encountered throughout the property, and within designated landscaping areas within Lot 1. The subject property is relatively level, with minimal grade change observed over its extent.

No hydrologic features were observed on site, such as seeps, springs, ponds and streams, though scattered ponding had been observed within tire ruts along the south side of the Lot 2.

<u>3.2 Soil Conditions</u>

We observed subgrade conditions through the advancement of two test pit explorations, one in the general vicinity of the proposed infiltration trench for this project, with the second being conducted towards the north end of the proposed pervious driveway alignment. Underlying a surface mantle of sod and topsoil, we encountered poorly consolidated alluvial soils, which ranged in composition from fine silty sand to silt. Given the geographic location of the project area, native soils are associated with the flood plains of the adjacent Puyallup River. Extensive soil mottling was observed throughout the soil column but was highly concentrated within the larger silt lenses. Poorly consolidated alluvial soils were observed through the termination of the explorations conducted for this project, a maximum depth of 9 feet below existing grade.

In the *Geologic Map of the Tacoma 1:100,000-scale Quadrangle, Washington,* as prepared by the Washington State Department of Natural Resources (2015), the project site is mapped as containing Qa, or Quaternary Alluvium. Additionally, the National Cooperative Soil Survey (NCSS) for Pierce County, Washington, classifies soils within the northern half of the property as 42A-Sultan silt loam, and soils within the southern half of the property as 6A-Briscot loam. Each soil group reportedly formed in alluvial flood plain deposits, and is texturally comprised of sand, loam, silt loam and clay loam. Our field observations generally conform with the site classifications prepared by both the USGS and NCSS. An excerpt from the referenced geologic mapping is presented below (page 5).



The enclosed exploration logs (Appendix A) provide a detailed description of the soil strata encountered in our subsurface explorations.

3.3 Groundwater Conditions

During the advancement of our test pit explorations (December 31, 2020), we encountered perched groundwater along a depth of 3½ to 5 feet below existing grade. Given the topographic and geographic setting of the project area, we do not believe that this is indicative of actual groundwater levels, but rather representative of seasonally perched groundwater. Additionally, we installed five, 6-foot monitoring wells along the course of the pervious driveway and proposed infiltration trench, and conducted regular groundwater measurements between December 31, 2020, and April 30, 2021. In total, we conducted 17 weekly groundwater measurements over this timeframe, with maximum groundwater levels being observed as shown in Table 2. Additional monitoring was done after heavy rain events. We anticipate that perched groundwater will be observed along shallow elevations over the "rainy season" (November 1 to March 31), or during periods of extended precipitation. Groundwater levels fluctuate with localized geology and precipitation. Table 2 below shows the depth to water in each monitoring port over this time frame. The Daily field report are attached.

	MW-1	MW-2	MW-3	MW-4	MW-5
1/4/2021	0	9.5	11	4.5	11
1/13/2021	0	8	7.5	5.5	14
1/22/2021	24	31	32	33	27
1/29/2021	28	35	36	37.5	41
2/2/2021	18.5	25	27	28	31.5
2/12/2021	24	31	33	34	36.5
2/19/2021	23	30	31.5	32.5	36.5
2/22/2021	3.5	13.5	16	14.5	11
3/5/2021	29.5	36.5	38	40.5	43
3/12/2021	53.5	60	57.5	53.5	NA
3/19/2021	54.5	60	38	40.5	43
3/26/2021	29.5	36.5	38	40.5	43
4/2/2021	56.5	62.5	61	NA	NA
4/9/2021	62	NA	66.5	NA	NA
4/16/2021	NA	NA	NA	NA	NA
4/23/2021	NA	NA	NA	NA	NA
4/30/2021	NA	NA	NA	NA	NA

Measurement are depth from ground surface to water level in inches.

*NA - No water present

3.4 Infiltration Conditions and Infiltration Rate

As indicated in the *Soil Conditions* section of the report, the site is underlain by slowly permeable alluvial soils, with seepage being encountered at approximately 3 ½ to 5 feet. These hydrogeologic conditions would generally translate into poor infiltration conditions; however, it is our understanding that field infiltration testing is necessary to validate the infeasibility of stormwater retention. As such, we conducted two Small-Scale Pilot Infiltration Tests adjacent to proposed improvements, at the location indicated in the attached Figure 2. After adding the requisite amount of water to achieve 12-inches of head within the test area, no additional water was needed to maintain these levels during the steady-state period, and no drawdown was observed over the falling head period of the test. With a net field infiltration rate of zero for both the steady-state and falling head periods of the test, we interpret infiltration as being infeasible for this project, and site-produced stormwater should be managed through dispersion or collected and diverted to an existing system along Stewart St.

4.0 CONCLUSIONS AND RECOMMENDATIONS

Development plans involve the construction of a new single-family residence towards the center of the south end of Lot 2, directly north of the west end of the existing greenhouse. The existing gravel driveway will also be improved and expanded to access the proposed residence. Site produced stormwater will be retained on site if feasible, and the improved driveway will be constructed using pervious pavement. We offer these recommendations:

- Feasibility: Based on our field explorations, research, and evaluations, the proposed development appears feasible from a geotechnical standpoint.
- Infiltration Conditions: The site is underlain by slowly permeable alluvial soils, with seepage being encountered at approximately 3 ½ to 5 feet. These hydrogeologic conditions generally translate into poor infiltration conditions, which was verified by conducting two Small-Scale Pilot Infiltration Tests adjacent to proposed improvements. With a net field infiltration rate of zero for both the steady-state and falling head periods of the tests, we interpret infiltration as being infeasible for this project, and site-produced stormwater should be managed through dispersion, or collected and diverted to an existing system along Stewart St.

The following sections present our specific geotechnical conclusions and recommendations concerning site preparation, spread footings, slab-on-grade floors, subgrade walls, and structural fill. The Washington State Department of Transportation (WSDOT) Standard Specifications and Standard Plans cited herein refer to WSDOT publications M41-10, *Standard Specifications for Road, Bridge, and Municipal Construction*, and M21-01, *Standard Plans for Road, Bridge, and Municipal Construction*, respectively.

4.1 Site Preparation

Preparation of the project site should involve erosion control, temporary drainage, cutting, filling, excavations, and subgrade compaction.

Erosion Control: Before new construction begins, an appropriate erosion control system should be installed. This system should collect and filter all surface water runoff through silt fencing. We anticipate a system of berms and drainage ditches around construction areas will provide an adequate collection system. Silt fencing fabric should meet the requirements of WSDOT Standard Specification 9-33.2 Table 3. In addition, silt fencing should embed a minimum of 6 inches below existing grade. An erosion control system requires occasional observation and maintenance. Specifically, holes in the filter and areas where the filter has shifted above ground surface should be replaced or repaired as soon as they are identified.

Temporary Drainage: We recommend intercepting and diverting any potential sources of surface or near-surface water within the construction zones before stripping of surficial organic soils begins. Because the selection of an appropriate drainage system will depend on the water quantity, season, weather conditions, construction sequence, and contractor's methods, final decisions regarding drainage systems are best made in the field at the time of construction. Based on our current understanding of the construction plans and surface and subsurface conditions, we anticipate that curbs, berms, or ditches placed around the work areas will adequately intercept surface water runoff.

Clearing and Stripping: After surface and near-surface water sources have been controlled, sod, topsoil, and root-rich soil should be stripped from the site. Stripping has largely been conducted across the project site, although organic-laden soils still extend upwards of 6 inches across the subject lot.

Site Excavations: Based on our explorations, we expect that site excavations will encounter poorly consolidated alluvial soils, which range in composition from fine silty sand to silt, which can be readily excavated using standard excavation equipment.

Dewatering: Perched groundwater was encountered at a depth of 3½ to 5 feet during the advancement of supplemental explorations. Additionally, as evidenced by our groundwater monitoring, stormwaters saturate near surface soils and begin to sheet flow after heavy periods of precipitation. If groundwater is encountered during project excavations, we anticipate that an internal system of ditches, sump holes, and pumps will be adequate to temporarily dewater excavations.

Subgrade Compaction: Exposed subgrades for footings, slabs, and floors should be compacted to a firm, unyielding state before new concrete or fill soils are placed. Any localized zones of looser granular soils observed within a subgrade should be compacted to a density commensurate with the surrounding soils. In contrast, any organic, soft, or pumping soils observed within a subgrade should be over-excavated and replaced with a suitable structural fill material. Surface compaction of all footing and slab subgrades is recommended, although surface compaction could become problematic during wet weather conditions or when in situ site soils become wet.

Site Filling: Our conclusions regarding the reuse of onsite soils and our comments regarding wet-weather filling are presented subsequently. Regardless of soil type, all fill should be placed and compacted according to our recommendations presented in the *Structural Fill* section of this report. Specifically, building pad fill soil should be compacted to a uniform density of at least 95 percent (based on ASTM D-1557).

Onsite Soils: We offer the following evaluation of these onsite soils in relation to potential use as structural fill:

- *Surficial Organic Soils*: Sod, topsoil, and forest duff are *not* suitable for use as structural fill under any circumstances, due to their high organic content. Consequently, these materials can be used only for non-structural purposes, such as in landscaping areas.
- *Alluvial Soils*: As encountered onsite, this material ranges in composition from fine silty sand to silt. Additionally, this material is often encountered in an oversaturated in situ condition and will require substantial moisture conditioning prior to reuse as structural fill. This material should be considered extremely moisture sensitive and will be difficult if not impossible to adequately reuse this material as a structural fill during periods of extended precipitation. If substantial fill soils are required for this project, we recommend importing a manufactured material such as a crushed rock.

Temporary Cut Slopes: All temporary cut slopes in site soils should be no steeper than 1½ H:1V and should conform to Washington Industrial Health and Safety Act (WISHA) regulations.

Permanent Slopes: All permanent cut slopes and fill slopes should be adequately inclined to reduce long-term raveling, sloughing, and erosion. We generally recommend that no permanent slopes be steeper than 2H:1V. For all soil types, the use of flatter slopes (such as 2½H:1V) would further reduce long-term erosion and facilitate revegetation.

Slope Protection: We recommend that a permanent berm, swale, or curb be constructed along the top edge of all permanent slopes to intercept surface flow. Also, a hardy vegetative groundcover should be established as soon as feasible, to further protect the slopes from runoff water erosion. Alternatively, permanent slopes could be armored with quarry spalls or a geosynthetic erosion mat.

5.0 RECOMMENDED ADDITIONAL SERVICES

Because the future performance and integrity of the structural elements will depend largely on proper site preparation, drainage, fill placement, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. Subsequently, we recommend that MGI be retained to provide the following post-report services:

- Review all construction plans and specifications to verify that our design criteria presented in this report have been properly integrated into the design,
- Prepare a letter summarizing all review comments (if required),
- Check all completed subgrades for footings and slab-on-grade floors before concrete is poured to verify their bearing capacity, and
- Prepare a post-construction letter summarizing all field observations, inspections, and test results (if required).

6.0 CLOSURE

The conclusions and recommendations presented in this report are based, in part, on the explorations that we observed for this study; therefore, if variations in the subgrade conditions are observed at a later time, we may need to modify this report to reflect those changes. Also, because the future performance and integrity of the project elements depend largely on proper initial site preparation, drainage, and construction procedures, monitoring and testing by experienced geotechnical personnel should be considered an integral part of the construction process. MGI is available to provide geotechnical monitoring of soils throughout construction.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

MIGIZI GROUP, INC.

Zach L. Logan, LG
Project Geologist

Casey R. Lowe, PE
Principal Engineer

APPENDIX A
SOIL CLASSIFICATION CHART AND KEY TO TEST DATA

TEST PIT LOGS

MIGIZI GROUP, INC.

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Tacoma, Washington 98448

PHONE (253) 537-9400
FAX (253) 537-9401

November 2, 2022

Danny Foster
2345 W Stewart St
Puyallup, WA 98371

Subject: **Response to City Comments**
Farris Short Plat – Lot 2
2345 W Stewart St
Puyallup, WA 98371
Parcel No. 0420207029

MGI Project P2271-T20

Dear Mr. Foster:

Migizi Group, Inc. (MGI) is pleased to submit this response to City of Puyallup comments highlighted in an email chain with the client and the civil engineer of record Azure Green Consultants on April 21, 2022, for the site located at the above-referenced address in Puyallup, WA. The corrections and responses are noted below.

Corrections:
"Fire will require that a Geotech evaluate the existing gravel/soils to ensure it meets the necessary loading requirements of an emergency vehicle per the currently adopted Fire Code. As long as the existing gravel can meet emergency vehicle needs, additional paving beyond the first 50′ of the driveway will not be required. Note that the fire truck turnaround is still necessary, and any proposed gravel is considered new pollution generating hard surfaces as outlined by the Ecology manual. Lastly, the Geotech should speak to the trenching that will be done within the driveway for utilities and how the trench shall be compacted/backfilled such that the soil structure is not compromised for an emergency vehicle."

Response:
The existing gravel driveway and the proposed alignment of the fire truck turnaround has been serving the Farris Vet Clinic for access and overflow parking since its founding in the early 1980's. As such, it has seen surcharge vehicle loads that has resulted in extensive subgrade consolidation across these regions. This was verified onsite on September 28, 2022 when MGI personnel observed a proof roll of the driveway/turnaround alignment. The proof roll was conducted with a fully loaded backhoe with rubber tires, which weighs ± 12,500-lbs unloaded, roughly equivalent

to an empty fire truck. The existing subgrade was observed in a firm and unyielding condition, with no deflection and/or rutting being observed. Additionally, conversations with the property owner indicate that a large fire developed onsite in 2008, which resulted in the mobilization of 8 to 9 service vehicles to quell the flames. The service trucks were able to access the property without getting stuck or unduly hindered during operations. Based upon these observations it is our opinion that additional paving beyond the first 50 feet of the driveway is not necessary, and that the existing driveway can support loading requirements of an emergency vehicle per the currently adopted Fire Code. Additionally, it is our understanding that additional trenching along the existing driveway for utility installation is not currently being proposed, with relevant utilities already being in-place.

We appreciate the opportunity to be of service on this project. If you have any questions regarding this report or any aspects of the project, please feel free to contact our office.

Respectfully submitted,

MIGIZI GROUP, INC.

21013986
Zachary L. Logan

JAMES E. BRIGHAM
20540

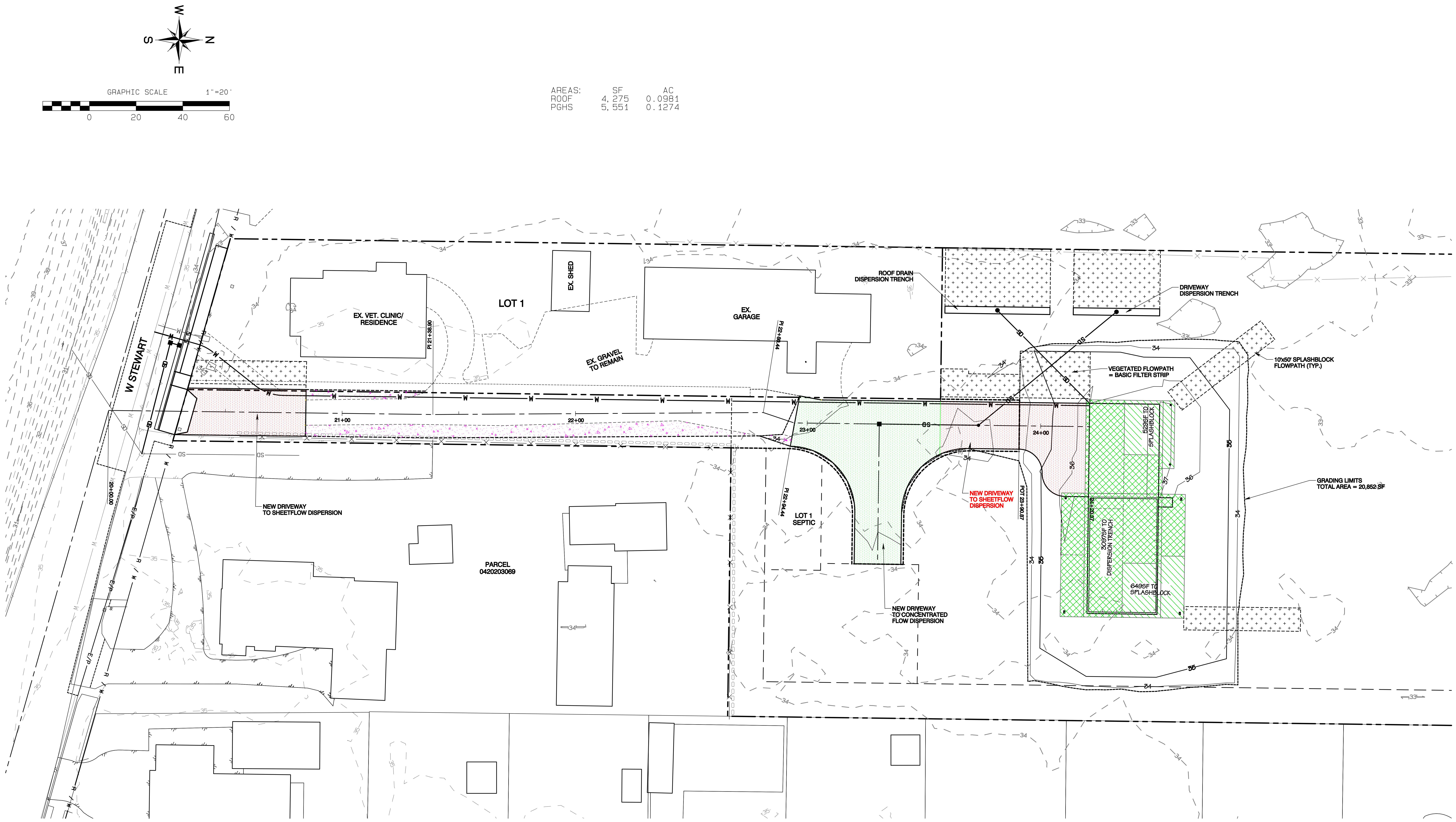
11/02/22

Zach Logan, LG
Project Geologist

James E. Brigham, P.E.
Senior Principal Engineer

Farris Short Plat - Lot 2 Drainage Report

Section 29, Township 20 N, Range 4 E, Willamette Meridian, Pierce County, Washington



AREAS:	SF	AC
ROOF	4,275	0.0981
PGHS	5,551	0.1274

4/13/2023
ROBERT A. TRIVITT
43715

REVISION	DATE
1 Revised per City review.	4/12/23
2	
3	
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5	
6	
7	
8	
9	
10	

JOB NO: 2349
DATE: December 18, 2022
DESIGNED BY: Rob Trivitt
DRAWN BY: Rob Trivitt
CHECKED BY: Jim Job
APPROVED BY: Paul Green

AZURE | GREEN
CONSULTANTS
+feasibility +planning +engineering +surveying
409 East Pioneer, Suite A - Puyallup, WA 98372 phone: 253.770.3144 fax: 253.770.3142

Drainage Areas

Farris Short Plat

Richard & Kathy Farris
2401 W Stewart
Puyallup, WA, 98371
Phone 253.255.3413 Fax

DRAWING
D-1
SHEET 1
OF 1

Project Desc.: Farris Short Plat Path: F:\Jobs\2349 - Farris Short Plat\Tmwin\Farris 20230413.pro Plot Date/Time: 4/13/2023/10:14:15AM