Drainage Report
Mainbrook Townhomes
PFN: M2017-

for

Rick Hansen
P.O. Box 2289
Snohomish, WA 98291

SITE LOCATION:
1237 West Main St.
Monroe, WA 98272

Prepared by:
Joseph M. Smeby, P.E.

Job No: 17-0807
September 2017

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1. INTRODUCTION

This document is intended to provide engineering information necessary to support the preliminary plat application to the City of Monroe for an 18-unit townhome project with future commercial building(s) and parking proposed on this site. The site covers 1.42 acres, all of which is proposed to be disturbed as a result of this project. The site will take access from an existing road/drive isle which will be improved on the east side and extended to the north to serve this project.

This project proposes to construct improvements to the existing private access. Some work within West Main St will be required to extend sewer and water services onto this property. This project will require the construction of driveways for each future townhome, parking for the future commercial building, stormwater facilities and other utilities. The existing on-site soils are highly permeable at a depth of 5-6' below existing grade. Therefore, infiltration will be viable for this project. Refer to the geotechnical report prepared by Liu and Associates.

2. DRAINAGE INFORMATION SUMMARY FORM

Project: **Mainbrook Townhomes**
PFN: **M2017-**
Engineer: **Omega Engineering, Inc.**
2707 Wetmore Ave
Everett, WA 98201
Attention: Joseph Smeby, P.E.

Total site area: **1.42 acres**
Offsite area: **0.00 acres**
Disturbed area: **1.38 acres**

Applicant: **Hanson Homes**
P.O. Box 2289
Snohomish, WA 98291

Number of lots/Bldg: **5**

Drainage Basin Information	**East Basin**
On-site Developed Area	1.42 acres
Off-site Improved Area	0.00 acres
Types of storage proposed	Infiltration Trenches
Approximate total storage volume	Varies
Soil Types	Type A/B
Basin Data	
Pre-developed run-off rates: 2-year	0.002 cfs
50-year	0.014 cfs
Post-developed run-off rates: 2-year	0.00 cfs
50-year	0.00 cfs

3. EXISTING SITE CHARACTERISTICS and ASSUMPTIONS

The site is located north of West Main St. taking access off of an existing private access within an easement just west of Academy Way. The project is located in Section 1, Township 21N, Range 6E, Willamette Meridian. See Figure 1 - Vicinity Map. The entire property consists of a single lot totaling 1.42 acres.

Land use around the site is single-family residential to the north and east and commercial to the west and south. This site is currently vacant covered in grasses, brush and some trees. Frontage improvements will not be required West Main St but some utility work will occur within the R/W.

The existing site is irregular in shape approximately 450-feet long running north-south and 180-feet running east-west. The grades on the site are flat. The vegetation found on the existing property is a mixture of landscaping including grasses and shrubs and native vegetation.

Grades on the site generally run from south to north. The existing soils on this site are silty fine sand to a depth of 4-6' over gravelly fine to coarse sand to 9'+. Please refer to the attached geotechnical report in Appendix C for further discussion of the existing on-site soils. A site visit was conducted on August 8, 2017. The weather was clear with temperatures in the 70's. No surface water was observed on this site.

The soil hydrologic types for this site have been identified as Type C for the upper soil stratum and A/B for the lower stratum. The soil type mapped for this site is Sultan Silt Loam. However, soil tests on this site found permeable soils at 4-6'. Refer to Geotechnical Report in Appendix C. The project Geotech therefore has recommended that infiltration be used for this project.

4. NARRATIVE OF DEVELOPED SITE CHARACTERISTICS

This development proposes to create 5 new buildings totaling 18-units for this project. The infiltration systems will be designed to mitigate for all of the future hard surfaces and landscaping proposed for this project. The systems have been sized to meet the 2012 DOE stormwater flow control and water quality standards.

The new on-site access, parking, roof and landscaping areas will be collected in the on-site conveyance system and directed infiltration trenches spread around the site. The storm drainage system for this project has been designed to collect, treat and infiltrate all of the new landscaping and impervious areas on this site. The off-site impervious areas disturbed for the utility construction will not be accounted for since the land cover will not change as a result of this project.

The infiltration and water quality system has been designed using the WWHM2012 software which meets the City standards.

4A. DOE MINIMUM REQUIREMENTS

MINIMUM REQUIREMENT #1: PREPARATION OF STORMWATER SITE PLANS

This project proposes to construct new impervious surfaces in excess of the minimum threshold so a final storm water site plan is being prepared with the full engineering plans for this project.

MINIMUM REQUIREMENT #2: CONSTRUCTION STORMWATER POLLUTION PREVENTION (SWPPP)

1: Mark Clearing Limits
One of the first steps in the "Construction Sequence" included on the clearing and grading plan sheets is for a surveyor to stake the limits of clearing and to have construction or silt fencing placed along the limits prior to any other construction activity.

2: Establish Construction Access
The SWPPP calls for the proposed construction entrance to be installed as the second step after the staking of clearing limits. A detail is provided on the plans.

3: Control Flow Rates
This project will construct an interceptor swale system to capture site runoff and allow the water to infiltrate on-site in areas not proposed for future/permanent infiltration systems.

4: Install Sediment Controls
This site and SWPPP proposes to construct a construction entrance to collect and contain the sediment on this site. In addition, inlet filters will be installed in the existing catch basins adjacent to the site. and check dams will be installed in the on-site interceptor swales. The proposed on-site CBs will be installed with inlet filters but the outlet pipes connecting to infiltration trenches will be plugged until the site has been stabilized and the conveyance system flushed and cleaned. These features are intended to minimize the opportunity for sediment to leave the site via stormwater or on vehicles. The construction of these features is one of the first items required in the "Construction Sequence".

5: Stabilize Soils
The "Construction Sequence" and "TESC Notes" call for the stabilization of soils that remain unworked for certain lengths of time based on the time of year. Stabilization techniques may include but not limited to mulching, plastic sheeting or hydroseeding, notes have been added to the plan regarding protection for the stock pile area if necessary.

6: Protect Slopes
No slopes are expected on this site; however, any stockpile area will be protected as noted above.

7: Protect Drain Inlets
All existing & proposed catch basins and area drains will have inlet filters installed to protect the conveyance system.

8: Stabilize Channels and Outlets
Check dams will be used in any existing/proposed ditch on-site or adjacent to the site. Also, interceptor swales with check dams. These features will protect the existing and proposed channels from erosion.

9: Control Pollutants
No outside chemicals are expected to be necessary for the construction of this project. All vehicles working on and around the site would need to meet the State requirements for emissions.

10: Control DeWatering
Dewatering runoff will be infiltrated on-site. The contractor shall monitor the temporary system to ensure no erosion or excessive sedimentation occurs in the disposal areas.

11: Maintain BMPs
The construction supervisor will be responsible for maintaining all BMPs during construction and working with the City to relocate or add BMPs as necessary as site conditions change.

12: Manage the Project
It will be the responsibility of the Contractor and Developer to manage this project and coordinate with the City Inspector and Engineer.

Inspection and Monitoring:
Site inspections shall be done by a person who is knowledgeable in the principles and practices of erosion and sediment control. The person must have skills to first assess the site conditions and construction activities that could impact the quality of stormwater, and second assess the effectiveness of erosion and sediment control measures used to control the quality of stormwater discharges.
Whenever inspection and/or monitoring reveals that the BMPs identified in the Construction 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:
The construction 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 days following inspection.

MINIMUM REQUIREMENT #3: SOURCE CONTROL OF POLLUTANTS

The improvements proposed on this site will create 5 buildings with 18 unites and new private access, parking and driveways. Office buildings and Residential townhomes do not require additional source control BMPS, but basic water quality is proposed on this site.

MINIMUM REQUIREMENT #4: PRESERVATION OF NATURAL DRAINAGE SYSTEMS AND OUTFALLS

The runoff generated from the finished project will be fully infiltrated up to the 100-year storm event.

MINIMUM REQUIREMENT #5: ON-SITE STORMWATER MANAGEMENT

Runoff from the new private access, parking lot, roofs and landscaping will be collected in CBs or yard drains and conveyed to different infiltration trenches spread around the site.

MINIMUM REQUIREMENT #6: RUNOFF TREATMENT

A soil treatment layer will be provided in the bottom of all infiltration trenches receiving runoff from PGHS. This design meets the basic water quality treatment requirement for residential projects.

MINIMUM REQUIREMENT #7: FLOW CONTROL

The design and analysis for this project requires the construction of an infiltration system which was sized using the WWHM2012 software.

MINIMUM REQUIREMENT #8: WETLAND PROTECTION

Full infiltration will recharge the groundwater and protect downstream critical areas.

MINIMUM REQUIREMENT #9: BASIN/WATERSHED PLANNING

The scope of this project is too small to justify a Watershed Plan.

MINIMUM REQUIREMENT #10: OPERATION AND MAINTENANCE

A complete O&M manual will be provided with the full drainage report.

5. DESCRIPTION OF PROPOSED EROSION CONTROL BMP's

Clearing, grading, and temporary erosion and sediment control plans have be prepared for this project. However, since a construction site is dynamic it will be necessary to re-assess the erosion control BMP's during construction and install additional measures when and if necessary.

Proposed temporary measures for this project will include the following BMP's:
-Installation of stabilized rock construction entrance(s).
-Interceptor swales
-Rip-Rap check dams
-Straw mulch, hydroseed or other mulching and planting method to stabilized unworked areas.
-Silt Fencing

Permanent measures to reduce or eliminate erosion or water quality degradation will include the following BMP's: (Under Future Phase/Permit)
-Paving all traffic areas
-Drainage collection system, including catch basins and floatable material separators
-Permanent landscaping in pervious areas.
-Limiting cut and fill slopes to 2:1 maximum
-Routine maintenance and inspection of the grounds and response to developing problems.

These proposed erosion control BMP's have been engineered for anticipated conditions in compliance with DOE guidelines. With proper installation, maintenance and inspection the proposed BMP's should result in minimal impact to the surrounding environment. The City retains the authority by code to require additional measures should the existing measures prove insufficient.

A. SITE GRADING/EROSION CONTROL RISK ASSESSMENT

SLOPE: Existing grades onsite slope down from north to south to northwest to southeast ranging from 0% to approximately 3.0%. The proposed internal access grades will be no greater than 2%.
CRITICAL AREAS: None on or adjacent to the site.
SOILS: In the development area of the site soils are hydrologic group C but underlain with group A/B, (from Geotechnical Report).
GROUND MOVEMENT POTENTIAL: N/A
SOURCES OF WATER FOR EROSION: Rainfall will be the only significant source of onsite runoff.
MEASURES PROPOSED TO PREVENT/MINIMIZE EROSION:
TEMPORARY MEASURES: Mulch cover, rock construction entrance(s), diversion swales, silt fencing are all proposed to be used to prevent or minimize erosion and siltation during construction.
PERMANENT MEASURES: Future measures will include permanent vegetative cover in pervious areas, limiting permanent cut and fill slopes to 2:1 maximum unless protected with a rockery face, asphalt pavement to stabilize all vehicle traffic areas and a piped conveyance system to control the location of runoff release. Routine maintenance of the grounds and response to developing problems will be a function of the property owner.
CONCLUSION: Proposed erosion control BMP's in compliance with DOE guidelines have been engineered for anticipated conditions. Civil construction plans include a detailed ESC plan that provides details and notes for the proposed BMP's. With proper installation, maintenance and inspection, the proposed BMP's should result in minimal impact to the surrounding environment. Based on the above information the Erosion Risk for this site is Low to Moderate. Reports, studies and designs for this site include:

SEPA Checklist, by Others
Getechnical Report, by Liu & Associates, Inc.

B. Minimum Elements

1: Mark Clearing Limits
One of the first steps in the "Construction Sequence" included on the clearing and grading plan sheets is for a surveyor to stake the limits of clearing and to have construction or silt fencing placed along the limits prior to any other construction activity.

2: Establish Construction Access
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3: Control Flow Rates
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4: Install Sediment Controls
This site and SWPPP proposes to construct a construction entrance to collect and contain the sediment on this site. In addition, inlet filters will be installed in the existing catch basins adjacent to the site. and check dams will be installed in the on-site interceptor swales. The proposed on-site CBs will be installed with inlet filters but the outlet pipes connecting to infiltration trenches will be plugged until the site has been stabilized and the conveyance system flushed and cleaned. These features are intended to minimize the opportunity for sediment to leave the site via stormwater or on vehicles. The construction of these features is one of the first items required in the "Construction Sequence".

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9: Control Pollutants
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10: Control DeWatering
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11: Maintain BMPs
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12: Manage the Project
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Inspection and Monitoring:
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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 days following inspection.

6. OFFSITE DRAINAGE ANALYSIS - UPSTREAM

From field observation and review of the available topography, it appears that some small areas to the south of this project will drain onto the site but this is limited to only the private access. These flows are negligible in the existing condition and will be collected on-site and infiltrated with the other areas in the developed condition.

7. OFFSITE DRAINAGE ANALYSIS - DOWNSTREAM

The project is bordered to the north, south, east and west by developed properties. Since the proposed project will account for the upstream offsite flows this project will fully infiltrate all runoff generated on-site and tributary to the site.

8. DETENTION STORAGE CALCULATIONS

Current City code requires this site be analyzed using the 2012 DOE manual. The WWHM2012 has been selected to size the appropriate drainage mitigation system for this project. The 2012 drainage manual calls for the use of an approved continuous runoff hydrology model and the WWHM2012 stormwater software meets this requirement.

Since this site proposes using multiple infiltration systems to fully infiltrate the runoff from the developed site infiltration trenches have been sized to accommodate the developed conditions for this project up to the 100-year condition.

Refer to appendix 'A' for the full output from the WWHM2012 software.

9. WATER QUALITY DESIGN

Water quality for this project will be provided in the form of a soil treatment layer in the bottom of any infiltration trench receiving runoff from PGHS. This meets the basic water quality requirements.

10. CONVEYANCE CALCULATIONS

All of the proposed pipes designed for this project will receive much less than 2.5 cfs peak flows from the 100-year storm event. These pipes are designed as 12" pipes (S=0.5%, min.) with a peak flowing full capacity of over 2.7 cfs and therefore ore then adequate capacity to handle the expected flows.

Therefore, all pipes designed for this project have more capacity then required based on the expected flow to each leg of the pipe system.

11. OPERATIONS AND MAINTENANCE MANUAL

The Property Owners and HOA will be responsible for maintaining the stormwater and landscaping facilities within this development. Included in this manual are checklists for each feature specific to this project. Copies should be made of the checklists as necessary during routine inspections and required maintenance. Specific problems can be recorded along with the appropriate action taken.

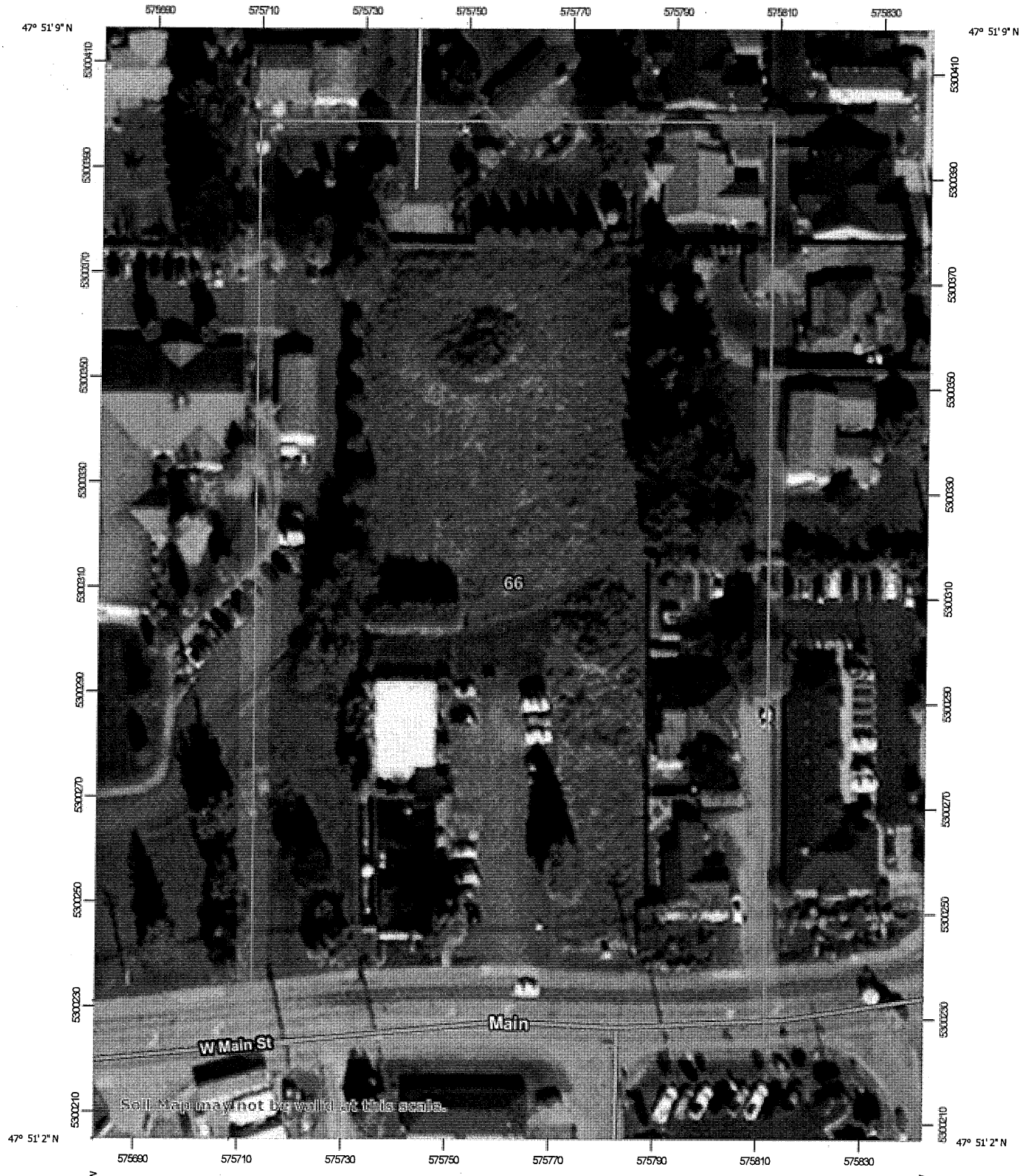
These checklists are a guide for inspections and maintenance. The frequency of the inspections/maintenance is identified in the left hand column with the following abbreviations:

A = Annual (March or April preferred)
M = Monthly
S = After Major Storms (Use 1-inch in 24 hours as a guideline)

Routine inspections and maintenance will improve the long-term performance of the stormwater facilities. If at any time you are unsure if a problem exists or how to address a specific problem, contact a Professional Engineer.

Refer to Appendix B for a list of each facility to be maintained and the appropriate maintenance checklist.

Soil Map—Snohomish County Area, Washington
(Main Brook Townhomes)



Map Scale: 1:1,030 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 10N WGS84

APPENDIX A

STORMWATER CALCULATIONS

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	17-0807 - infil
Site Name:	MAINBROOK
Site Address:	MAIN STREET
City:	MONROE
Report Date:	9/14/2017
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.20
Version Date:	2016/02/25
Version:	4.2.12

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
A B, Forest, Flat	1.38
Pervious Total	1.38
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.38

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

LOTS 19-21

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.09
Pervious Total	0.09

Impervious Land Use	acre
ROOF TOPS FLAT	0.1
PARKING FLAT	0.2
Impervious Total	0.3

Basin Total	0.39

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 1	Gravel Trench Bed 1	

LOTS 1-19, TRACT 997

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
A B, Lawn, Flat	0.26
Pervious Total	0.26

Impervious Land Use	acre
ROADS FLAT	0.17
ROOF TOPS FLAT	0.37
DRIVEWAYS FLAT	0.17
SIDEWALKS FLAT	0.02
Impervious Total	0.73
Basin Total	0.99

Element Flows To:

Surface	Interflow	Groundwater
Gravel Trench Bed 2	Gravel Trench Bed 2	

Routing Elements
Predeveloped Routing

Mitigated Routing

Gravel Trench Bed 1

Bottom Length:	75.00 ft.
Bottom Width:	10.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.35
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	4
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	58.067
Total Volume Through Riser (ac-ft.):	0.001
Total Volume Through Facility (ac-ft.):	58.068
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0
Discharge Structure	
Riser Height:	4 ft.
Riser Diameter:	8 in.

Element Flows To:
Outlet 1 Outlet 2
Channel 1

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.017	0.000	0.000	0.000
0.0556	0.017	0.000	0.000	0.069
0.1111	0.017	0.000	0.000	0.069
0.1667	0.017	0.001	0.000	0.069
0.2222	0.017	0.001	0.000	0.069
0.2778	0.017	0.001	0.000	0.069
0.3333	0.017	0.002	0.000	0.069
0.3889	0.017	0.002	0.000	0.069
0.4444	0.017	0.002	0.000	0.069
0.5000	0.017	0.003	0.000	0.069
0.5556	0.017	0.003	0.000	0.069
0.6111	0.017	0.003	0.000	0.069
0.6667	0.017	0.004	0.000	0.069
0.7222	0.017	0.004	0.000	0.069
0.7778	0.017	0.004	0.000	0.069
0.8333	0.017	0.005	0.000	0.069
0.8889	0.017	0.005	0.000	0.069
0.9444	0.017	0.005	0.000	0.069
1.0000	0.017	0.006	0.000	0.069
1.0556	0.017	0.006	0.000	0.069
1.1111	0.017	0.006	0.000	0.069
1.1667	0.017	0.007	0.000	0.069
1.2222	0.017	0.007	0.000	0.069
1.2778	0.017	0.007	0.000	0.069

1.3333	0.017	0.008	0.000	0.069
1.3889	0.017	0.008	0.000	0.069
1.4444	0.017	0.008	0.000	0.069
1.5000	0.017	0.009	0.000	0.069
1.5556	0.017	0.009	0.000	0.069
1.6111	0.017	0.009	0.000	0.069
1.6667	0.017	0.010	0.000	0.069
1.7222	0.017	0.010	0.000	0.069
1.7778	0.017	0.010	0.000	0.069
1.8333	0.017	0.011	0.000	0.069
1.8889	0.017	0.011	0.000	0.069
1.9444	0.017	0.011	0.000	0.069
2.0000	0.017	0.012	0.000	0.069
2.0556	0.017	0.012	0.000	0.069
2.1111	0.017	0.012	0.000	0.069
2.1667	0.017	0.013	0.000	0.069
2.2222	0.017	0.013	0.000	0.069
2.2778	0.017	0.013	0.000	0.069
2.3333	0.017	0.014	0.000	0.069
2.3889	0.017	0.014	0.000	0.069
2.4444	0.017	0.014	0.000	0.069
2.5000	0.017	0.015	0.000	0.069
2.5556	0.017	0.015	0.000	0.069
2.6111	0.017	0.015	0.000	0.069
2.6667	0.017	0.016	0.000	0.069
2.7222	0.017	0.016	0.000	0.069
2.7778	0.017	0.016	0.000	0.069
2.8333	0.017	0.017	0.000	0.069
2.8889	0.017	0.017	0.000	0.069
2.9444	0.017	0.017	0.000	0.069
3.0000	0.017	0.018	0.000	0.069
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3.1667	0.017	0.019	0.000	0.069
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3.8333	0.017	0.023	0.000	0.069
3.8889	0.017	0.023	0.000	0.069
3.9444	0.017	0.023	0.000	0.069
4.0000	0.017	0.024	0.000	0.069
4.0556	0.017	0.025	0.092	0.069
4.1111	0.017	0.026	0.255	0.069
4.1667	0.017	0.027	0.441	0.069
4.2222	0.017	0.027	0.610	0.069
4.2778	0.017	0.028	0.730	0.069
4.3333	0.017	0.029	0.799	0.069
4.3889	0.017	0.030	0.873	0.069
4.4444	0.017	0.031	0.933	0.069
4.5000	0.017	0.032	0.989	0.069

4.5556	0.017	0.033	1.043	0.069
4.6111	0.017	0.034	1.094	0.069
4.6667	0.017	0.035	1.143	0.069
4.7222	0.017	0.036	1.189	0.069
4.7778	0.017	0.037	1.234	0.069
4.8333	0.017	0.038	1.277	0.069
4.8889	0.017	0.039	1.319	0.069
4.9444	0.017	0.040	1.360	0.069
5.0000	0.017	0.041	1.399	0.069

Gravel Trench Bed 2

Bottom Length:	220.00 ft.
Bottom Width:	8.00 ft.
Trench bottom slope 1:	0 To 1
Trench Left side slope 0:	0 To 1
Trench right side slope 2:	0 To 1
Material thickness of first layer:	4
Pour Space of material for first layer:	0.35
Material thickness of second layer:	0
Pour Space of material for second layer:	0
Material thickness of third layer:	0
Pour Space of material for third layer:	0
Infiltration On	
Infiltration rate:	4
Infiltration safety factor:	1
Total Volume Infiltrated (ac-ft.):	141.532
Total Volume Through Riser (ac-ft.):	0.005
Total Volume Through Facility (ac-ft.):	141.537
Percent Infiltrated:	100
Total Precip Applied to Facility:	0
Total Evap From Facility:	0

Discharge Structure

Riser Height:	4 ft.
Riser Diameter:	8 in.

Element Flows To:

Outlet 1 Outlet 2

Channel 1

Gravel Trench Bed Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.040	0.000	0.000	0.000
0.0556	0.040	0.000	0.000	0.163
0.1111	0.040	0.001	0.000	0.163
0.1667	0.040	0.002	0.000	0.163
0.2222	0.040	0.003	0.000	0.163
0.2778	0.040	0.003	0.000	0.163
0.3333	0.040	0.004	0.000	0.163
0.3889	0.040	0.005	0.000	0.163
0.4444	0.040	0.006	0.000	0.163
0.5000	0.040	0.007	0.000	0.163
0.5556	0.040	0.007	0.000	0.163
0.6111	0.040	0.008	0.000	0.163
0.6667	0.040	0.009	0.000	0.163
0.7222	0.040	0.010	0.000	0.163
0.7778	0.040	0.011	0.000	0.163
0.8333	0.040	0.011	0.000	0.163
0.8889	0.040	0.012	0.000	0.163
0.9444	0.040	0.013	0.000	0.163
1.0000	0.040	0.014	0.000	0.163
1.0556	0.040	0.014	0.000	0.163
1.1111	0.040	0.015	0.000	0.163
1.1667	0.040	0.016	0.000	0.163
1.2222	0.040	0.017	0.000	0.163
1.2778	0.040	0.018	0.000	0.163
1.3333	0.040	0.018	0.000	0.163
1.3889	0.040	0.019	0.000	0.163

1.4444	0.040	0.020	0.000	0.163
1.5000	0.040	0.021	0.000	0.163
1.5556	0.040	0.022	0.000	0.163
1.6111	0.040	0.022	0.000	0.163
1.6667	0.040	0.023	0.000	0.163
1.7222	0.040	0.024	0.000	0.163
1.7778	0.040	0.025	0.000	0.163
1.8333	0.040	0.025	0.000	0.163
1.8889	0.040	0.026	0.000	0.163
1.9444	0.040	0.027	0.000	0.163
2.0000	0.040	0.028	0.000	0.163
2.0556	0.040	0.029	0.000	0.163
2.1111	0.040	0.029	0.000	0.163
2.1667	0.040	0.030	0.000	0.163
2.2222	0.040	0.031	0.000	0.163
2.2778	0.040	0.032	0.000	0.163
2.3333	0.040	0.033	0.000	0.163
2.3889	0.040	0.033	0.000	0.163
2.4444	0.040	0.034	0.000	0.163
2.5000	0.040	0.035	0.000	0.163
2.5556	0.040	0.036	0.000	0.163
2.6111	0.040	0.036	0.000	0.163
2.6667	0.040	0.037	0.000	0.163
2.7222	0.040	0.038	0.000	0.163
2.7778	0.040	0.039	0.000	0.163
2.8333	0.040	0.040	0.000	0.163
2.8889	0.040	0.040	0.000	0.163
2.9444	0.040	0.041	0.000	0.163
3.0000	0.040	0.042	0.000	0.163
3.0556	0.040	0.043	0.000	0.163
3.1111	0.040	0.044	0.000	0.163
3.1667	0.040	0.044	0.000	0.163
3.2222	0.040	0.045	0.000	0.163
3.2778	0.040	0.046	0.000	0.163
3.3333	0.040	0.047	0.000	0.163
3.3889	0.040	0.047	0.000	0.163
3.4444	0.040	0.048	0.000	0.163
3.5000	0.040	0.049	0.000	0.163
3.5556	0.040	0.050	0.000	0.163
3.6111	0.040	0.051	0.000	0.163
3.6667	0.040	0.051	0.000	0.163
3.7222	0.040	0.052	0.000	0.163
3.7778	0.040	0.053	0.000	0.163
3.8333	0.040	0.054	0.000	0.163
3.8889	0.040	0.055	0.000	0.163
3.9444	0.040	0.055	0.000	0.163
4.0000	0.040	0.056	0.000	0.163
4.0556	0.040	0.058	0.092	0.163
4.1111	0.040	0.061	0.255	0.163
4.1667	0.040	0.063	0.441	0.163
4.2222	0.040	0.065	0.610	0.163
4.2778	0.040	0.067	0.730	0.163
4.3333	0.040	0.070	0.799	0.163
4.3889	0.040	0.072	0.873	0.163
4.4444	0.040	0.074	0.933	0.163
4.5000	0.040	0.076	0.989	0.163
4.5556	0.040	0.079	1.043	0.163
4.6111	0.040	0.081	1.094	0.163

4.6667	0.040	0.083	1.143	0.163
4.7222	0.040	0.085	1.189	0.163
4.7778	0.040	0.088	1.234	0.163
4.8333	0.040	0.090	1.277	0.163
4.8889	0.040	0.092	1.319	0.163
4.9444	0.040	0.094	1.360	0.163
5.0000	0.040	0.097	1.399	0.163

Channel 1

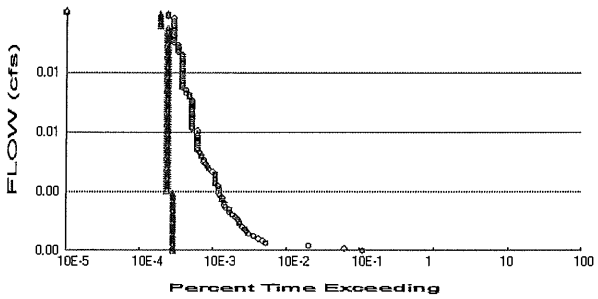
Bottom Length:	100.00 ft.
Bottom Width:	10.00 ft.
Manning's n:	0.03
Channel bottom slope 1:	1 To 1
Channel Left side slope 0:	0.1 To 1
Channel right side slope 2:	0.1 To 1
Discharge Structure	
Riser Height:	0 ft.
Riser Diameter:	0 in.
Element Flows To:	
Outlet 1	Outlet 2

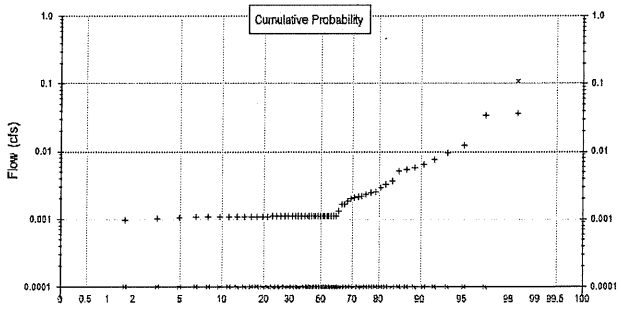
Channel Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.023	0.000	0.000	0.000
0.0222	0.023	0.000	0.870	0.000
0.0444	0.023	0.001	2.755	0.000
0.0667	0.023	0.001	5.401	0.000
0.0889	0.023	0.002	8.702	0.000
0.1111	0.023	0.002	12.59	0.000
0.1333	0.023	0.003	17.01	0.000
0.1556	0.023	0.003	21.94	0.000
0.1778	0.023	0.004	27.35	0.000
0.2000	0.023	0.004	33.20	0.000
0.2222	0.023	0.005	39.47	0.000
0.2444	0.023	0.005	46.15	0.000
0.2667	0.023	0.006	53.23	0.000
0.2889	0.023	0.006	60.67	0.000
0.3111	0.023	0.007	68.48	0.000
0.3333	0.023	0.007	76.64	0.000
0.3556	0.023	0.008	85.14	0.000
0.3778	0.023	0.008	93.97	0.000
0.4000	0.023	0.009	103.1	0.000
0.4222	0.023	0.009	112.5	0.000
0.4444	0.023	0.010	122.3	0.000
0.4667	0.023	0.010	132.3	0.000
0.4889	0.023	0.011	142.7	0.000
0.5111	0.023	0.011	153.3	0.000
0.5333	0.023	0.012	164.2	0.000
0.5556	0.023	0.012	175.3	0.000
0.5778	0.023	0.013	186.7	0.000
0.6000	0.023	0.013	198.4	0.000
0.6222	0.023	0.014	210.3	0.000
0.6444	0.023	0.015	222.5	0.000
0.6667	0.023	0.015	234.9	0.000
0.6889	0.023	0.016	247.5	0.000
0.7111	0.023	0.016	260.4	0.000
0.7333	0.023	0.017	273.5	0.000
0.7556	0.023	0.017	286.8	0.000
0.7778	0.023	0.018	300.4	0.000
0.8000	0.023	0.018	314.1	0.000
0.8222	0.023	0.019	328.1	0.000
0.8444	0.023	0.019	342.2	0.000
0.8667	0.023	0.020	356.6	0.000

0.8889	0.023	0.020	371.2	0.000
0.9111	0.023	0.021	385.9	0.000
0.9333	0.023	0.021	400.9	0.000
0.9556	0.023	0.022	416.0	0.000
0.9778	0.023	0.022	431.4	0.000
1.0000	0.023	0.023	446.9	0.000
1.0222	0.023	0.024	462.6	0.000
1.0444	0.023	0.024	478.5	0.000
1.0667	0.023	0.025	494.5	0.000
1.0889	0.024	0.025	510.7	0.000
1.1111	0.024	0.026	527.1	0.000
1.1333	0.024	0.026	543.7	0.000
1.1556	0.024	0.027	560.4	0.000
1.1778	0.024	0.027	577.3	0.000
1.2000	0.024	0.028	594.4	0.000
1.2222	0.024	0.028	611.6	0.000
1.2444	0.024	0.029	629.0	0.000
1.2667	0.024	0.029	646.5	0.000
1.2889	0.024	0.030	664.2	0.000
1.3111	0.024	0.030	682.0	0.000
1.3333	0.024	0.031	700.0	0.000
1.3556	0.024	0.032	718.2	0.000
1.3778	0.024	0.032	736.4	0.000
1.4000	0.024	0.033	754.8	0.000
1.4222	0.024	0.033	773.4	0.000
1.4444	0.024	0.034	792.1	0.000
1.4667	0.024	0.034	811.0	0.000
1.4889	0.024	0.035	829.9	0.000
1.5111	0.024	0.035	849.1	0.000
1.5333	0.024	0.036	868.3	0.000
1.5556	0.024	0.036	887.7	0.000
1.5778	0.024	0.037	907.2	0.000
1.6000	0.024	0.037	926.8	0.000
1.6222	0.024	0.038	946.6	0.000
1.6444	0.024	0.039	966.5	0.000
1.6667	0.024	0.039	986.5	0.000
1.6889	0.024	0.040	1006.	0.000
1.7111	0.024	0.040	1026.	0.000
1.7333	0.024	0.041	1047.	0.000
1.7556	0.024	0.041	1067.	0.000
1.7778	0.024	0.042	1088.	0.000
1.8000	0.024	0.042	1109.	0.000
1.8222	0.024	0.043	1130.	0.000
1.8444	0.024	0.043	1151.	0.000
1.8667	0.024	0.044	1172.	0.000
1.8889	0.024	0.045	1193.	0.000
1.9111	0.024	0.045	1214.	0.000
1.9333	0.024	0.046	1236.	0.000
1.9556	0.024	0.046	1257.	0.000
1.9778	0.024	0.047	1279.	0.000
2.0000	0.024	0.047	1301.	0.000
2.0222	0.024	0.048	1322.	0.000

Analysis Results
POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.38
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.35
Total Impervious Area: 1.03

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.001584
5 year	0.003435
10 year	0.005511
25 year	0.009625
50 year	0.014222
100 year	0.02063

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0
5 year	0
10 year	0
25 year	0
50 year	0
100 year	0

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.001	0.000
1950	0.003	0.000
1951	0.002	0.000
1952	0.001	0.000
1953	0.001	0.000
1954	0.008	0.000
1955	0.006	0.000
1956	0.001	0.000
1957	0.001	0.000
1958	0.001	0.000

1959	0.002	0.000
1960	0.002	0.000
1961	0.005	0.112
1962	0.001	0.000
1963	0.001	0.000
1964	0.004	0.000
1965	0.001	0.000
1966	0.001	0.000
1967	0.002	0.000
1968	0.001	0.000
1969	0.001	0.000
1970	0.001	0.000
1971	0.005	0.000
1972	0.001	0.000
1973	0.001	0.000
1974	0.003	0.000
1975	0.001	0.000
1976	0.003	0.000
1977	0.001	0.000
1978	0.001	0.000
1979	0.002	0.000
1980	0.001	0.000
1981	0.001	0.000
1982	0.002	0.000
1983	0.001	0.000
1984	0.001	0.000
1985	0.002	0.000
1986	0.010	0.000
1987	0.006	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.001	0.000
1991	0.001	0.000
1992	0.001	0.000
1993	0.001	0.000
1994	0.001	0.000
1995	0.001	0.000
1996	0.012	0.000
1997	0.034	0.000
1998	0.001	0.000
1999	0.001	0.000
2000	0.002	0.000
2001	0.001	0.000
2002	0.001	0.000
2003	0.001	0.000
2004	0.001	0.000
2005	0.001	0.000
2006	0.037	0.000
2007	0.001	0.000
2008	0.002	0.000
2009	0.001	0.000

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.0367	0.1116
2	0.0342	0.0000
3	0.0125	0.0000

4	0.0097	0.0000
5	0.0076	0.0000
6	0.0064	0.0000
7	0.0058	0.0000
8	0.0054	0.0000
9	0.0052	0.0000
10	0.0036	0.0000
11	0.0032	0.0000
12	0.0029	0.0000
13	0.0025	0.0000
14	0.0025	0.0000
15	0.0023	0.0000
16	0.0022	0.0000
17	0.0022	0.0000
18	0.0021	0.0000
19	0.0020	0.0000
20	0.0019	0.0000
21	0.0017	0.0000
22	0.0016	0.0000
23	0.0013	0.0000
24	0.0011	0.0000
25	0.0011	0.0000
26	0.0011	0.0000
27	0.0011	0.0000
28	0.0011	0.0000
29	0.0011	0.0000
30	0.0011	0.0000
31	0.0011	0.0000
32	0.0011	0.0000
33	0.0011	0.0000
34	0.0011	0.0000
35	0.0011	0.0000
36	0.0011	0.0000
37	0.0011	0.0000
38	0.0011	0.0000
39	0.0011	0.0000
40	0.0011	0.0000
41	0.0011	0.0000
42	0.0011	0.0000
43	0.0011	0.0000
44	0.0011	0.0000
45	0.0011	0.0000
46	0.0011	0.0000
47	0.0011	0.0000
48	0.0011	0.0000
49	0.0011	0.0000
50	0.0011	0.0000
51	0.0011	0.0000
52	0.0011	0.0000
53	0.0011	0.0000
54	0.0011	0.0000
55	0.0011	0.0000
56	0.0011	0.0000
57	0.0011	0.0000
58	0.0011	0.0000
59	0.0010	0.0000
60	0.0010	0.0000
61	0.0008	0.0000

Duration Flows
The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0008	2355	6	0	Pass
0.0009	1329	6	0	Pass
0.0011	434	6	1	Pass
0.0012	112	6	5	Pass
0.0013	103	6	5	Pass
0.0015	89	6	6	Pass
0.0016	77	6	7	Pass
0.0017	66	6	9	Pass
0.0019	61	6	9	Pass
0.0020	58	6	10	Pass
0.0021	54	6	11	Pass
0.0023	50	6	12	Pass
0.0024	49	6	12	Pass
0.0026	47	6	12	Pass
0.0027	43	6	13	Pass
0.0028	40	6	15	Pass
0.0030	36	6	16	Pass
0.0031	36	6	16	Pass
0.0032	32	6	18	Pass
0.0034	31	6	19	Pass
0.0035	31	6	19	Pass
0.0036	29	6	20	Pass
0.0038	29	6	20	Pass
0.0039	27	6	22	Pass
0.0040	26	6	23	Pass
0.0042	26	5	19	Pass
0.0043	26	5	19	Pass
0.0045	25	5	20	Pass
0.0046	23	5	21	Pass
0.0047	23	5	21	Pass
0.0049	23	5	21	Pass
0.0050	23	5	21	Pass
0.0051	23	5	21	Pass
0.0053	21	5	23	Pass
0.0054	19	5	26	Pass
0.0055	18	5	27	Pass
0.0057	17	5	29	Pass
0.0058	16	5	31	Pass
0.0059	16	5	31	Pass
0.0061	15	5	33	Pass
0.0062	15	5	33	Pass
0.0064	14	5	35	Pass
0.0065	13	5	38	Pass
0.0066	13	5	38	Pass
0.0068	13	5	38	Pass
0.0069	13	5	38	Pass
0.0070	13	5	38	Pass
0.0072	13	5	38	Pass
0.0073	13	5	38	Pass
0.0074	13	5	38	Pass
0.0076	13	5	38	Pass
0.0077	11	5	45	Pass
0.0078	11	5	45	Pass

0.0080	11	5	45	Pass
0.0081	11	5	45	Pass
0.0083	11	5	45	Pass
0.0084	11	5	45	Pass
0.0085	11	5	45	Pass
0.0087	11	5	45	Pass
0.0088	11	5	45	Pass
0.0089	11	5	45	Pass
0.0091	11	5	45	Pass
0.0092	11	5	45	Pass
0.0093	11	5	45	Pass
0.0095	10	5	50	Pass
0.0096	10	5	50	Pass
0.0097	9	5	55	Pass
0.0099	9	5	55	Pass
0.0100	8	5	62	Pass
0.0102	8	5	62	Pass
0.0103	8	5	62	Pass
0.0104	8	5	62	Pass
0.0106	8	5	62	Pass
0.0107	8	5	62	Pass
0.0108	8	5	62	Pass
0.0110	8	5	62	Pass
0.0111	8	5	62	Pass
0.0112	8	5	62	Pass
0.0114	8	5	62	Pass
0.0115	8	5	62	Pass
0.0116	8	5	62	Pass
0.0118	8	5	62	Pass
0.0119	8	5	62	Pass
0.0121	7	5	71	Pass
0.0122	7	5	71	Pass
0.0123	7	5	71	Pass
0.0125	7	5	71	Pass
0.0126	6	5	83	Pass
0.0127	6	5	83	Pass
0.0129	6	5	83	Pass
0.0130	6	5	83	Pass
0.0131	6	5	83	Pass
0.0133	6	5	83	Pass
0.0134	6	5	83	Pass
0.0135	6	4	66	Pass
0.0137	6	4	66	Pass
0.0138	6	4	66	Pass
0.0140	6	4	66	Pass
0.0141	5	4	80	Pass
0.0142	5	4	80	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

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

LID Report

LID Technique	Used for Treatment ?	Total Volume Needs Treatment (ac-ft)	Volume Through Facility (ac-ft)	Infiltration Volume (ac-ft)	Cumulative Volume Infiltration Credit	Percent Volume Infiltrated	Water Quality	Percent Water Quality Treated	Comment
Channel 1 POC	☐	0.01			☐	0.00			
Gravel Trench Bed 1	☐	52.97			☐	99.76			
Gravel Trench Bed 2	☐	128.94			☐	99.89			
Total Volume Infiltrated		181.91	0.00	0.00		99.85	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Passed

Model Default Modifications

Total of 0 changes have been made.

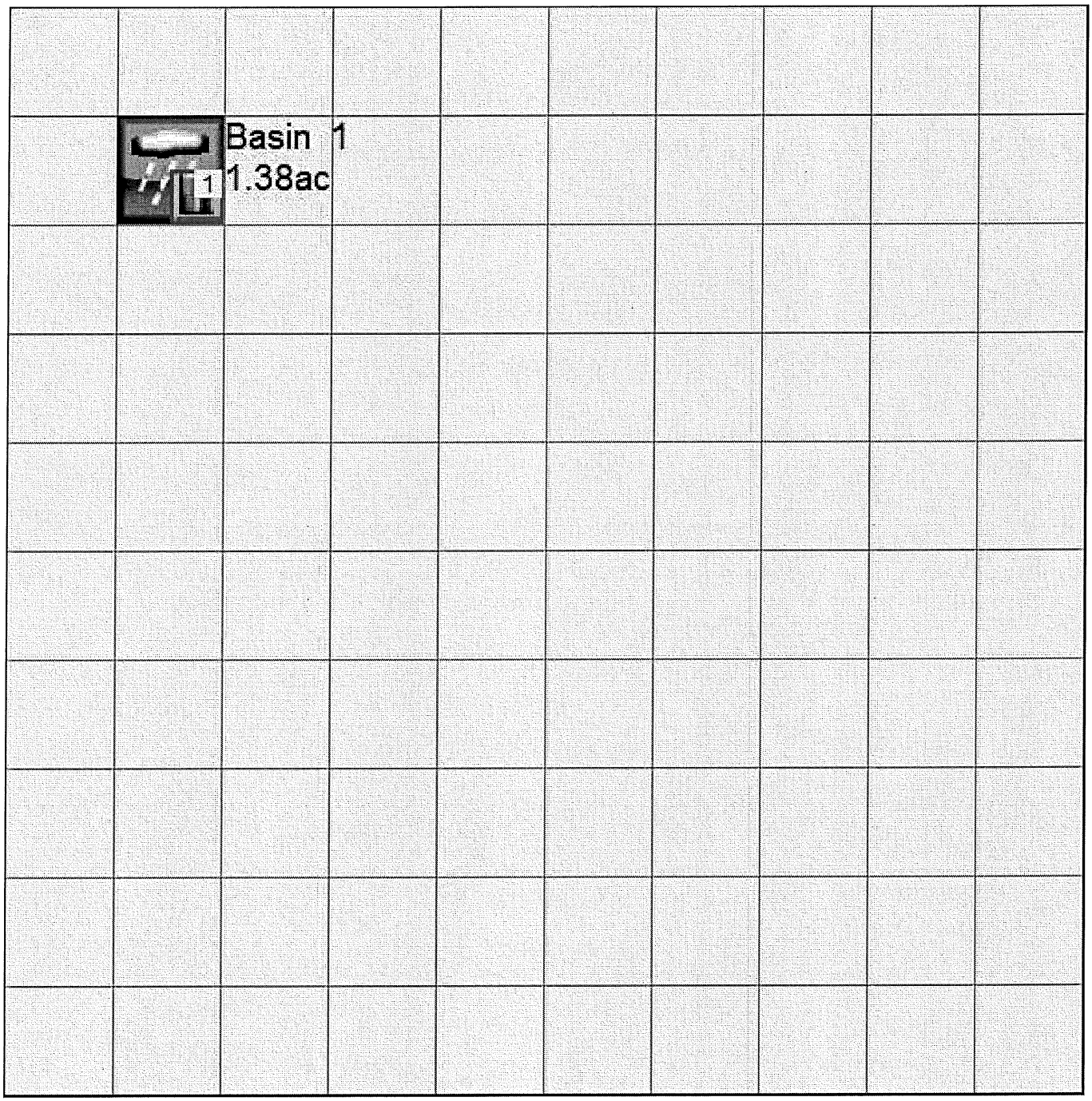
PERLND Changes

No PERLND changes have been made.

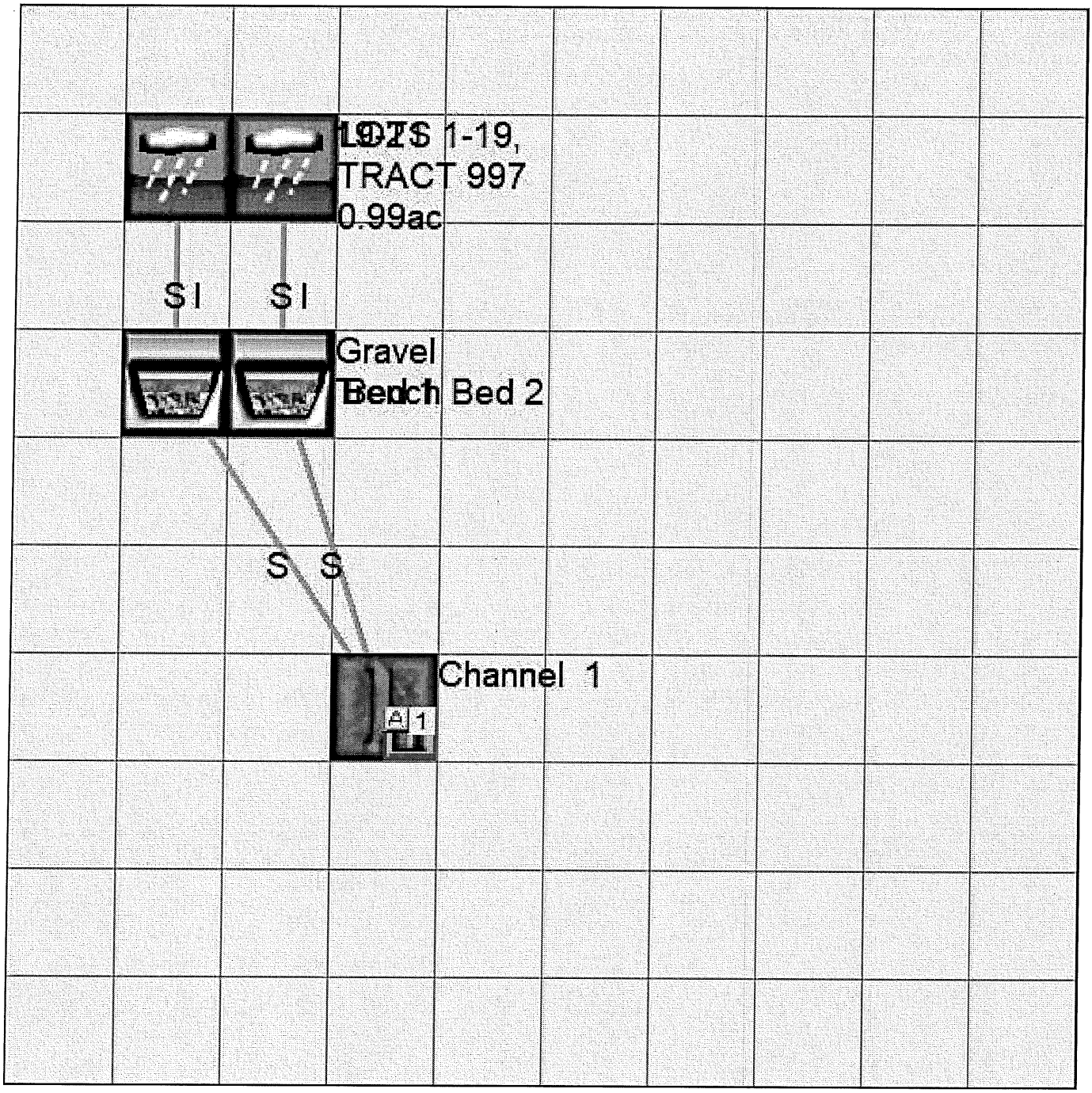
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01         END    2009 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   17-0807 - infil.wdm
MESSU       25   Pre17-0807 - infil.MES
            27   Pre17-0807 - infil.L61
            28   Pre17-0807 - infil.L62
            30   POC17-0807 - infil1.dat
END FILES

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

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
    1          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  *********
    1          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 ***
      1         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
      1              0         5         2       400      0.05        0.3      0.996
    END PWAT-PARM2

    PWAT-PARM3
      <PLS >      PWATER input info: Part 3         ***
      # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
      1              0         0         2         2         0         0         0
    END PWAT-PARM3
    PWAT-PARM4
      <PLS >     PWATER input info: Part 4                              ***
      # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
      1          0.2       0.5      0.35         0       0.7       0.7
    END PWAT-PARM4

    PWAT-STATE1
      <PLS > *** Initial conditions at start of simulation
                 ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
      # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS       GWVS
      1             0         0         0         0         3         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   1                        1.38      COPY   501      12
PERLND   1                        1.38      COPY   501      13

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

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



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

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

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
```

```
WDM       1 EVAP     ENGL    0.76            PERLND   1 999 EXTNL  PETINP
WDM       1 EVAP     ENGL    0.76            IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

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

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

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


END MASS-LINK

END RUN
```

```
RUN

GLOBAL
  WWHM4 model simulation
  START       1948 10 01         END    2009 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   17-0807 - infil.wdm
MESSU       25   Mit17-0807 - infil.MES
            27   Mit17-0807 - infil.L61
            28   Mit17-0807 - infil.L62
            30   POC17-0807 - infil1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND        7
      IMPLND        4
      IMPLND       11
      IMPLND        1
      IMPLND        5
      IMPLND        8
      RCHRES        1
      RCHRES        2
      RCHRES        3
      COPY          1
      COPY        501
      DISPLY        1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Channel  1                  MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
    7     A/B, 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 ***
```

```
    7         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  *********
    7         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 ***
    7         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
    7               0         5       0.8       400       0.05        0.3      0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3          ***
    # -   # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
    7               0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                                  ***
    # -   #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
    7           0.1       0.5      0.25         0       0.7      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -   # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
    7               0         0         0         0         3          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
   11       PARKING/FLAT          1    1    1   27    0
    1       ROADS/FLAT            1    1    1   27    0
    5       DRIVEWAYS/FLAT        1    1    1   27    0
    8       SIDEWALKS/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
   11         0    0    1    0    0    0
    1         0    0    1    0    0    0
    5         0    0    1    0    0    0
    8         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
   11         0    0    4    0    0    0    1    9
    1         0    0    4    0    0    0    1    9
```

```
      5          0    0    4    0    0    0    1    9
      8          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
     11          0    0    0    0    0
      1          0    0    0    0    0
      5          0    0    0    0    0
      8          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
     11             400       0.01       0.1        0.1
      1             400       0.01       0.1        0.1
      5             400       0.01       0.1        0.1
      8             400       0.01       0.1        0.1
    END IWAT-PARM2

    IWAT-PARM3
      <PLS >       IWATER input info: Part 3          ***
      # -   # ***PETMAX    PETMIN
      4               0          0
     11               0          0
      1               0          0
      5               0          0
      8               0          0
    END IWAT-PARM3

    IWAT-STATE1
      <PLS > *** Initial conditions at start of simulation
      # -   # ***  RETS       SURS
      4               0          0
     11               0          0
      1               0          0
      5               0          0
      8               0          0
    END IWAT-STATE1

  END IMPLND

  SCHEMATIC
  <-Source->                  <--Area-->      <-Target->   MBLK    ***
  <Name>   #                  <-factor->      <Name>   #   Tbl#    ***
  LOTS 19-21***
  PERLND   7                       0.09      RCHRES   1      2
  PERLND   7                       0.09      RCHRES   1      3
  IMPLND   4                        0.1      RCHRES   1      5
  IMPLND  11                        0.2      RCHRES   1      5
  LOTS 1-19, TRACT 997***
  PERLND   7                       0.26      RCHRES   2      2
  PERLND   7                       0.26      RCHRES   2      3
  IMPLND   1                       0.17      RCHRES   2      5
  IMPLND   4                       0.37      RCHRES   2      5
  IMPLND   5                       0.17      RCHRES   2      5
  IMPLND   8                       0.02      RCHRES   2      5

  ******Routing******
  RCHRES   1                          1      RCHRES   3      7
  RCHRES   1                                 COPY     1     17
  RCHRES   2                          1      RCHRES   3      7
  RCHRES   2                                 COPY     1     17
  RCHRES   3                          1      COPY   501     16
  END SCHEMATIC
```

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



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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<------------------><---> User T-series  Engl Metr LKFG            ***
                                       in  out                               ***
    1     Gravel Trench Be-005    2    1    1    1   28    0    1
    2     Gravel Trench Be-007    2    1    1    1   28    0    1
    3     Channel  1              1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # HYFG ADFG CNFG HTFG SDFG GQFG OXFG NUFG PKFG PHFG ***
    1         1    0    0    0    0    0    0    0    0    0
    2         1    0    0    0    0    0    0    0    0    0
    3         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags ******************* PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
    3         4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  HYDR-PARM1
    RCHRES  Flags for each HYDR Section                                   ***
    # -  #  VC A1 A2 A3  ODFVFG for each *** ODGTFG for each     FUNCT  for each
          FG FG FG FG  possible  exit  *** possible  exit       possible  exit
           *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1      0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    2      0  1  0  0    4  5  0  0  0       0  0  0  0  0       2  2  2  2  2
    3      0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

  HYDR-PARM2
    # -  #    FTABNO       LEN      DELTH      STCOR        KS       DB50       ***
  <------><--------><--------><--------><--------><--------><--------->       ***
    1              1      0.01       0.0        0.0       0.5       0.0
    2              2      0.04       0.0        0.0       0.5       0.0
    3              3      0.02       0.0        0.0       0.5       0.0
  END HYDR-PARM2
  HYDR-INIT
    RCHRES  Initial conditions for each HYDR section                      ***
    # -  # ***   VOL     Initial  value  of COLIND     Initial  value  of OUTDGT
         *** ac-ft     for each possible exit        for each possible exit
  <------><-------->     <---><---><---><---><---> *** <---><---><---><---><---->
    1            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    2            0         4.0  5.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
    3            0         4.0  0.0  0.0  0.0  0.0       0.0  0.0  0.0  0.0  0.0
  END HYDR-INIT
END RCHRES

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
```

92 5

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Outflow2 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.017218	0.000000	0.000000	0.000000		
0.055556	0.017218	0.000335	0.000000	0.069444		
0.111111	0.017218	0.000670	0.000000	0.069444		
0.166667	0.017218	0.001004	0.000000	0.069444		
0.222222	0.017218	0.001339	0.000000	0.069444		
0.277778	0.017218	0.001674	0.000000	0.069444		
0.333333	0.017218	0.002009	0.000000	0.069444		
0.388889	0.017218	0.002344	0.000000	0.069444		
0.444444	0.017218	0.002678	0.000000	0.069444		
0.500000	0.017218	0.003013	0.000000	0.069444		
0.555556	0.017218	0.003348	0.000000	0.069444		
0.611111	0.017218	0.003683	0.000000	0.069444		
0.666667	0.017218	0.004017	0.000000	0.069444		
0.722222	0.017218	0.004352	0.000000	0.069444		
0.777778	0.017218	0.004687	0.000000	0.069444		
0.833333	0.017218	0.005022	0.000000	0.069444		
0.888889	0.017218	0.005357	0.000000	0.069444		
0.944444	0.017218	0.005691	0.000000	0.069444		
1.000000	0.017218	0.006026	0.000000	0.069444		
1.055556	0.017218	0.006361	0.000000	0.069444		
1.111111	0.017218	0.006696	0.000000	0.069444		
1.166667	0.017218	0.007031	0.000000	0.069444		
1.222222	0.017218	0.007365	0.000000	0.069444		
1.277778	0.017218	0.007700	0.000000	0.069444		
1.333333	0.017218	0.008035	0.000000	0.069444		
1.388889	0.017218	0.008370	0.000000	0.069444		
1.444444	0.017218	0.008704	0.000000	0.069444		
1.500000	0.017218	0.009039	0.000000	0.069444		
1.555556	0.017218	0.009374	0.000000	0.069444		
1.611111	0.017218	0.009709	0.000000	0.069444		
1.666667	0.017218	0.010044	0.000000	0.069444		
1.722222	0.017218	0.010378	0.000000	0.069444		
1.777778	0.017218	0.010713	0.000000	0.069444		
1.833333	0.017218	0.011048	0.000000	0.069444		
1.888889	0.017218	0.011383	0.000000	0.069444		
1.944444	0.017218	0.011718	0.000000	0.069444		
2.000000	0.017218	0.012052	0.000000	0.069444		
2.055556	0.017218	0.012387	0.000000	0.069444		
2.111111	0.017218	0.012722	0.000000	0.069444		
2.166667	0.017218	0.013057	0.000000	0.069444		
2.222222	0.017218	0.013391	0.000000	0.069444		
2.277778	0.017218	0.013726	0.000000	0.069444		
2.333333	0.017218	0.014061	0.000000	0.069444		
2.388889	0.017218	0.014396	0.000000	0.069444		
2.444444	0.017218	0.014731	0.000000	0.069444		
2.500000	0.017218	0.015065	0.000000	0.069444		
2.555556	0.017218	0.015400	0.000000	0.069444		
2.611111	0.017218	0.015735	0.000000	0.069444		
2.666667	0.017218	0.016070	0.000000	0.069444		
2.722222	0.017218	0.016405	0.000000	0.069444		
2.777778	0.017218	0.016739	0.000000	0.069444		
2.833333	0.017218	0.017074	0.000000	0.069444		
2.888889	0.017218	0.017409	0.000000	0.069444		
2.944444	0.017218	0.017744	0.000000	0.069444		
3.000000	0.017218	0.018079	0.000000	0.069444		
3.055556	0.017218	0.018413	0.000000	0.069444		
3.111111	0.017218	0.018748	0.000000	0.069444		
3.166667	0.017218	0.019083	0.000000	0.069444		
3.222222	0.017218	0.019418	0.000000	0.069444		
3.277778	0.017218	0.019752	0.000000	0.069444		
3.333333	0.017218	0.020087	0.000000	0.069444		
3.388889	0.017218	0.020422	0.000000	0.069444		
3.444444	0.017218	0.020757	0.000000	0.069444		
3.500000	0.017218	0.021092	0.000000	0.069444		
3.555556	0.017218	0.021426	0.000000	0.069444		
3.611111	0.017218	0.021761	0.000000	0.069444		
3.666667	0.017218	0.022096	0.000000	0.069444		

3.722222	0.017218	0.022431	0.000000	0.069444
3.777778	0.017218	0.022766	0.000000	0.069444
3.833333	0.017218	0.023100	0.000000	0.069444
3.888889	0.017218	0.023435	0.000000	0.069444
3.944444	0.017218	0.023770	0.000000	0.069444
4.000000	0.017218	0.024105	0.000000	0.069444
4.055556	0.017218	0.025061	0.092279	0.069444
4.111111	0.017218	0.026018	0.255267	0.069444
4.166667	0.017218	0.026974	0.441835	0.069444
4.222222	0.017218	0.027931	0.610909	0.069444
4.277778	0.017218	0.028887	0.730523	0.069444
4.333333	0.017218	0.029844	0.799562	0.069444
4.388889	0.017218	0.030800	0.872951	0.069444
4.444444	0.017218	0.031757	0.933224	0.069444
4.500000	0.017218	0.032713	0.989833	0.069444
4.555556	0.017218	0.033670	1.043376	0.069444
4.611111	0.017218	0.034627	1.094302	0.069444
4.666667	0.017218	0.035583	1.142961	0.069444
4.722222	0.017218	0.036540	1.189631	0.069444
4.777778	0.017218	0.037496	1.234539	0.069444
4.833333	0.017218	0.038453	1.277869	0.069444
4.888889	0.017218	0.039409	1.319778	0.069444
4.944444	0.017218	0.040366	1.360396	0.069444
5.000000	0.017218	0.041322	1.399836	0.069444
5.055556	0.017218	0.042279	1.438194	0.069444

END FTABLE 1

FTABLE 2

92 5

Depth (ft)	Area (acres)	Volume (acre-ft)	Outflow1 (cfs)	Outflow2 (cfs)	Velocity (ft/sec)	Travel Time*** (Minutes)***
0.000000	0.040404	0.000000	0.000000	0.000000		
0.055556	0.040404	0.000786	0.000000	0.162963		
0.111111	0.040404	0.001571	0.000000	0.162963		
0.166667	0.040404	0.002357	0.000000	0.162963		
0.222222	0.040404	0.003143	0.000000	0.162963		
0.277778	0.040404	0.003928	0.000000	0.162963		
0.333333	0.040404	0.004714	0.000000	0.162963		
0.388889	0.040404	0.005499	0.000000	0.162963		
0.444444	0.040404	0.006285	0.000000	0.162963		
0.500000	0.040404	0.007071	0.000000	0.162963		
0.555556	0.040404	0.007856	0.000000	0.162963		
0.611111	0.040404	0.008642	0.000000	0.162963		
0.666667	0.040404	0.009428	0.000000	0.162963		
0.722222	0.040404	0.010213	0.000000	0.162963		
0.777778	0.040404	0.010999	0.000000	0.162963		
0.833333	0.040404	0.011785	0.000000	0.162963		
0.888889	0.040404	0.012570	0.000000	0.162963		
0.944444	0.040404	0.013356	0.000000	0.162963		
1.000000	0.040404	0.014141	0.000000	0.162963		
1.055556	0.040404	0.014927	0.000000	0.162963		
1.111111	0.040404	0.015713	0.000000	0.162963		
1.166667	0.040404	0.016498	0.000000	0.162963		
1.222222	0.040404	0.017284	0.000000	0.162963		
1.277778	0.040404	0.018070	0.000000	0.162963		
1.333333	0.040404	0.018855	0.000000	0.162963		
1.388889	0.040404	0.019641	0.000000	0.162963		
1.444444	0.040404	0.020426	0.000000	0.162963		
1.500000	0.040404	0.021212	0.000000	0.162963		
1.555556	0.040404	0.021998	0.000000	0.162963		
1.611111	0.040404	0.022783	0.000000	0.162963		
1.666667	0.040404	0.023569	0.000000	0.162963		
1.722222	0.040404	0.024355	0.000000	0.162963		
1.777778	0.040404	0.025140	0.000000	0.162963		
1.833333	0.040404	0.025926	0.000000	0.162963		
1.888889	0.040404	0.026712	0.000000	0.162963		
1.944444	0.040404	0.027497	0.000000	0.162963		
2.000000	0.040404	0.028283	0.000000	0.162963		
2.055556	0.040404	0.029068	0.000000	0.162963		
2.111111	0.040404	0.029854	0.000000	0.162963		
2.166667	0.040404	0.030640	0.000000	0.162963		

```
 2.222222  0.040404  0.031425  0.000000  0.162963
 2.277778  0.040404  0.032211  0.000000  0.162963
 2.333333  0.040404  0.032997  0.000000  0.162963
 2.388889  0.040404  0.033782  0.000000  0.162963
 2.444444  0.040404  0.034568  0.000000  0.162963
 2.500000  0.040404  0.035354  0.000000  0.162963
 2.555556  0.040404  0.036139  0.000000  0.162963
 2.611111  0.040404  0.036925  0.000000  0.162963
 2.666667  0.040404  0.037710  0.000000  0.162963
 2.722222  0.040404  0.038496  0.000000  0.162963
 2.777778  0.040404  0.039282  0.000000  0.162963
 2.833333  0.040404  0.040067  0.000000  0.162963
 2.888889  0.040404  0.040853  0.000000  0.162963
 2.944444  0.040404  0.041639  0.000000  0.162963
 3.000000  0.040404  0.042424  0.000000  0.162963
 3.055556  0.040404  0.043210  0.000000  0.162963
 3.111111  0.040404  0.043996  0.000000  0.162963
 3.166667  0.040404  0.044781  0.000000  0.162963
 3.222222  0.040404  0.045567  0.000000  0.162963
 3.277778  0.040404  0.046352  0.000000  0.162963
 3.333333  0.040404  0.047138  0.000000  0.162963
 3.388889  0.040404  0.047924  0.000000  0.162963
 3.444444  0.040404  0.048709  0.000000  0.162963
 3.500000  0.040404  0.049495  0.000000  0.162963
 3.555556  0.040404  0.050281  0.000000  0.162963
 3.611111  0.040404  0.051066  0.000000  0.162963
 3.666667  0.040404  0.051852  0.000000  0.162963
 3.722222  0.040404  0.052637  0.000000  0.162963
 3.777778  0.040404  0.053423  0.000000  0.162963
 3.833333  0.040404  0.054209  0.000000  0.162963
 3.888889  0.040404  0.054994  0.000000  0.162963
 3.944444  0.040404  0.055780  0.000000  0.162963
 4.000000  0.040404  0.056566  0.000000  0.162963
 4.055556  0.040404  0.058810  0.092279  0.162963
 4.111111  0.040404  0.061055  0.255267  0.162963
 4.166667  0.040404  0.063300  0.441835  0.162963
 4.222222  0.040404  0.065544  0.610909  0.162963
 4.277778  0.040404  0.067789  0.730523  0.162963
 4.333333  0.040404  0.070034  0.799562  0.162963
 4.388889  0.040404  0.072278  0.872951  0.162963
 4.444444  0.040404  0.074523  0.933224  0.162963
 4.500000  0.040404  0.076768  0.989833  0.162963
 4.555556  0.040404  0.079012  1.043376  0.162963
 4.611111  0.040404  0.081257  1.094302  0.162963
 4.666667  0.040404  0.083502  1.142961  0.162963
 4.722222  0.040404  0.085746  1.189631  0.162963
 4.777778  0.040404  0.087991  1.234539  0.162963
 4.833333  0.040404  0.090236  1.277869  0.162963
 4.888889  0.040404  0.092480  1.319778  0.162963
 4.944444  0.040404  0.094725  1.360396  0.162963
 5.000000  0.040404  0.096970  1.399836  0.162963
 5.055556  0.040404  0.099214  1.438194  0.162963
END FTABLE  2
FTABLE      3
 91    4
   Depth      Area     Volume  Outflow1 Velocity  Travel Time***
    (ft)   (acres) (acre-ft)    (cfs)   (ft/sec)    (Minutes)***
0.000000  0.022957  0.000000  0.000000
0.022222  0.022977  0.000510  0.870124
0.044444  0.022998  0.001021  2.755333
0.066667  0.023018  0.001532  5.401836
0.088889  0.023039  0.002044  8.702821
0.111111  0.023059  0.002556  12.59127
0.133333  0.023079  0.003069  17.01911
0.155556  0.023100  0.003582  21.94920
0.177778  0.023120  0.004096  27.35151
0.200000  0.023141  0.004610  33.20092
0.222222  0.023161  0.005124  39.47594
0.244444  0.023182  0.005639  46.15785
0.266667  0.023202  0.006155  53.23005
```

0.288889	0.023223	0.006670	60.67772
0.311111	0.023243	0.007187	68.48747
0.333333	0.023264	0.007703	76.64708
0.355556	0.023284	0.008221	85.14535
0.377778	0.023305	0.008738	93.97197
0.400000	0.023326	0.009256	103.1173
0.422222	0.023346	0.009775	112.5726
0.444444	0.023367	0.010294	122.3293
0.466667	0.023387	0.010813	132.3797
0.488889	0.023408	0.011333	142.7164
0.511111	0.023429	0.011854	153.3324
0.533333	0.023449	0.012375	164.2212
0.555556	0.023470	0.012896	175.3766
0.577778	0.023490	0.013418	186.7925
0.600000	0.023511	0.013940	198.4634
0.622222	0.023532	0.014463	210.3838
0.644444	0.023552	0.014986	222.5486
0.666667	0.023573	0.015510	234.9529
0.688889	0.023594	0.016034	247.5919
0.711111	0.023614	0.016558	260.4611
0.733333	0.023635	0.017083	273.5562
0.755556	0.023656	0.017609	286.8730
0.777778	0.023677	0.018135	300.4074
0.800000	0.023697	0.018661	314.1556
0.822222	0.023718	0.019188	328.1138
0.844444	0.023739	0.019715	342.2783
0.866667	0.023760	0.020243	356.6458
0.888889	0.023780	0.020771	371.2128
0.911111	0.023801	0.021300	385.9760
0.933333	0.023822	0.021829	400.9324
0.955556	0.023843	0.022358	416.0787
0.977778	0.023863	0.022889	431.4121
1.000000	0.023884	0.023419	446.9297
1.022222	0.023905	0.023950	462.6287
1.044444	0.023926	0.024481	478.5063
1.066667	0.023947	0.025013	494.5599
1.088889	0.023968	0.025546	510.7870
1.111111	0.023988	0.026079	527.1850
1.133333	0.024009	0.026612	543.7516
1.155556	0.024030	0.027146	560.4844
1.177778	0.024051	0.027680	577.3810
1.200000	0.024072	0.028215	594.4392
1.222222	0.024093	0.028750	611.6569
1.244444	0.024114	0.029285	629.0319
1.266667	0.024135	0.029822	646.5622
1.288889	0.024156	0.030358	664.2457
1.311111	0.024177	0.030895	682.0804
1.333333	0.024198	0.031433	700.0645
1.355556	0.024218	0.031971	718.1960
1.377778	0.024239	0.032509	736.4731
1.400000	0.024260	0.033048	754.8940
1.422222	0.024281	0.033587	773.4570
1.444444	0.024302	0.034127	792.1603
1.466667	0.024323	0.034667	811.0023
1.488889	0.024344	0.035208	829.9813
1.511111	0.024365	0.035749	849.0957
1.533333	0.024386	0.036291	868.3440
1.555556	0.024407	0.036833	887.7246
1.577778	0.024429	0.037376	907.2360
1.600000	0.024450	0.037919	926.8768
1.622222	0.024471	0.038462	946.6455
1.644444	0.024492	0.039006	966.5407
1.666667	0.024513	0.039551	986.5610
1.688889	0.024534	0.040096	1006.705
1.711111	0.024555	0.040641	1026.972
1.733333	0.024576	0.041187	1047.359
1.755556	0.024597	0.041734	1067.867
1.777778	0.024618	0.042280	1088.493
1.800000	0.024639	0.042828	1109.237
1.822222	0.024661	0.043376	1130.096

```
   1.844444  0.024682  0.043924  1151.071
   1.866667  0.024703  0.044473  1172.160
   1.888889  0.024724  0.045022  1193.361
   1.911111  0.024745  0.045571  1214.674
   1.933333  0.024766  0.046121  1236.098
   1.955556  0.024788  0.046672  1257.631
   1.977778  0.024809  0.047223  1279.272
   2.000000  0.024830  0.047775  1301.021
   END FTABLE  3
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    1.2            PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2            IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76           PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76           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***
RCHRES   3 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   3 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
END EXT TARGETS

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

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

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

  MASS-LINK        7
RCHRES     OFLOW  OVOL   1                 RCHRES         INFLOW IVOL
  END MASS-LINK    7

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

  MASS-LINK       17
RCHRES     OFLOW  OVOL   1                 COPY           INPUT  MEAN
  END MASS-LINK   17


END MASS-LINK

END RUN
```

APPENDIX B

MAINTENANCE & OPERATIONS MANUAL

No. 2 – Infiltration

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Poisonous/Noxious Vegetation	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Contaminants and Pollution	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Rodent Holes	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1)
Storage Area	Sediment	Water ponding in infiltration pond after rainfall ceases and appropriate time allowed for infiltration. Treatment basins should infiltrate Water Quality Design Storm Volume within 48 hours, and empty within 24 hours after cessation of most rain events. (A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	Sediment is removed and/or facility is cleaned so that infiltration system works according to design.
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Piping	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Emergency Overflow Spillway	Rock Missing	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
	Erosion	See "Detention Ponds" (No. 1).	See "Detention Ponds" (No. 1).
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%.	No Trash or debris located immediately in front of catch basin or on grate opening.
		Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe.	No trash or debris in the catch basin.
		Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height.	Inlet and outlet pipes free of trash or debris.
		Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch (Intent is to make sure no material is running into basin).	Top slab is free of holes and cracks.
		Frame not sitting flush on top slab, i.e., separation of more than 3/4 inch of the frame from the top slab. Frame not securely attached	Frame is sitting flush on the riser rings or top slab and firmly attached.
	Fractures or Cracks in Basin Walls/ Bottom	Maintenance person judges that structure is unsound.	Basin replaced or repaired to design standards.
		Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening.	No vegetation blocking opening to basin.
		Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.

No. 5 – Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Catch basin cover is closed
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread.	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. (Intent is keep cover from sealing off access to maintenance.)	Cover can be removed by one maintenance person.
Ladder	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, not securely attached to basin wall, misalignment, rust, cracks, or sharp edges.	Ladder meets design standards and allows maintenance person safe access.
Metal Grates (If Applicable)	Grate opening Unsafe	Grate with opening wider than 7/8 inch.	Grate opening meets design standards.
	Trash and Debris	Trash and debris that is blocking more than 20% of grate surface inletting capacity.	Grate free of trash and debris.
	Damaged or Missing.	Grate missing or broken member(s) of the grate.	Grate is in place and meets design standards.

No. 6 – Debris Barriers (e.g., Trash Racks)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris	Trash or debris that is plugging more than 20% of the openings in the barrier.	Barrier cleared to design flow capacity.
Metal	Damaged/ Missing Bars.	Bars are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4 inch.
		Bars are missing or entire barrier missing.	Bars in place according to design.
		Bars are loose and rust is causing 50% deterioration to any part of barrier.	Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

APPENDIX C

GEOTECHNICAL REPORT

LIU & ASSOCIATES, INC.

Geotechnical Engineering | Engineering Geology | Earth Science

March 31, 2017

Mr. Rick Hanson
Hanson Homes
P. O. Box 2289
Snohomish, WA 98291

Dear Mr. Hanson:

Subject: Geotechnical Investigation
Main Street Townhomes
1237 West Main Street
Monroe, Washington
L&A Job No. 17-038

INTRODUCTION

We understand the development of a townhome project is proposed for the subject property, located at the above address in Monroe, Washington. The project site is a flag-stone shaped parcel. The proposed development is to build four townhome buildings in the "flag" portion of the site initially, with the two north buildings each containing four townhome units and the two south buildings each containing 6 units. Two more buildings are to be constructed in the "handle bar" portion of the site in the future. We also understand that onsite stormwater disposal by infiltration is being considered for the development. At your request, we have completed a geotechnical investigation for the proposed development project.

The purpose of this investigation is to explore and characterize subsurface conditions of the project site, evaluate feasibility of onsite stormwater disposal by infiltration, and

19213 Kenlake Place NE · Kenmore, Washington 98028
Phone (425) 483-9134 · Fax (425) 486-2746

provide geotechnical recommendations on grading, onsite stormwater disposal, erosion mitigation, surface and ground water drainage control, and foundation support to buildings for the proposed development. Presented in this report are our findings of the site conditions, conclusion, and geotechnical recommendations.

PROJECT DESCRIPTION

The proposed townhome buildings are to be three-story, above-grade, wood-framed structures supported on perimeter concrete foundation walls and interior load-bearing walls, beams, and columns. The site is to be accessed from West Main Street via a paved driveway along the west side of the "handle bar" portion and extending northward into the middle of the "flag" portion of the site. Due to the nearly flat terrain of the site, grading and construction of the residences will require minimal cut and fill.

SCOPE OF SERVICES

Our scope of services for this study comprises specifically the following:

1 Review the geologic and soil conditions at the site based on a published geologic map.

2. Explore the site for subsurface conditions with backhoe test pits to depth where a firm bearing soil stratum or a soil layer suitable for disposing stormwater by infiltration is encountered, or to the maximum depth (about 10 feet) capable by the backhoe used in excavating the test pits, whichever occurs first.

3. Perform geotechnical analyses and provide geotechnical recommendations on onsite stormwater disposal, erosion mitigation, surface and ground water drainage

control, and foundation support to buildings for the proposed development based on subsurface conditions encountered by the test pits and results of our geotechnical analyses and laboratory tests on soil samples.

4. Prepare a written report to present our findings, conclusions, and recommendations.

SITE CONDITIONS

SURFACE CONDITION

The general location of the project site is shown on Plate 1 – Vicinity Map. The site is situated in a flood plain of the nearby Skykomish River and its tributary creeks. For our use in this investigation, you provided us with a site and layout plan of the proposed development. The project site is bounded by West Main Street to the south, and adjoined a mixture of commercial and residential development to the east and west and by residential development to the north. The project site is nearly level with a shallow mount along the south side of the "flag" portion of the site, possibly formed by stockpiled soils excavated previously out of the "handle bar" portion of the site.

The terrain within the project site is nearly flat. The site is currently undeveloped and is covered by lawn grass.

GEOLOGIC SETTING

The Surficial Geologic Map of the Skykomish and Snoqualmie Rivers Area, Snohomish and King Counties, Washington, by Derek B Booth, published by U. S. Geological Survey in 1990, was referenced for the geologic condition of the project site. According

to this publication, the surficial soil unit at and in the vicinity of the project site is mapped as Alluvium Deposits (Q_a).

The alluvium deposits were geologically recent sediment transported and deposited by flooding water of the nearby Skykomish River and its tributary creeks, following the retreat of the last glaciation, the Vashon Stade of the Fraser Glaciation, which occurred during the later stages of the Pleistocene Epoch and retreated from the region some 12,500 years ago. The coarser materials of the alluvium deposits, such as coarse sand, gravel, cobble and boulder, were deposited closer to the river and tributary creek channels and are highly permeable, while the finer materials of the alluvium deposits, such as clay, silt and fine sand, were laid down farther away from the river/tributary creek channels and are less permeable. The younger alluvium deposits had not been over-ridden by glacier and are generally loose to medium-dense in their natural, undisturbed state.

SOIL CONDITION

Subsurface conditions of the project site were explored with six test pits. The test pits were excavated on March 22, 2017, with a rubber-tired backhoe to depths from 8.0 to 9.0. The approximate locations of the test pits are shown on Plate 2 - Site and Exploration Location Plan. The test pits were located with either a tape measure or by visual reference to existing topographic features in the field and on the site survey map, and their locations should be considered as only accurate to the measuring method used.

A geotechnical engineer from our office was present during subsurface exploration, examined the soil and geologic conditions encountered, and completed logs of the test

pits. Soil samples obtained from each soil layer in the test pits were visually classified in general accordance with United Soil Classification System, a copy of which is presented on Plate 3. Detailed descriptions of soils encountered during site exploration are presented in test pit logs on Plates 4 through 6.

Test Pit 5, located in the northwest quadrant of the "handle bar" portion of the site, encountered fill with concrete rubble and chucks of asphalt pavement, glass bottles, plastic sheets, metal parts, fuel cans, etc., mixed in loose dark-brown, organic, soils down to and beyond the excavated depth of 8.5 feet. The remaining five test pits all encountered a layer of loose organic topsoil, about 12 to 16 inches thick, mantling the site. Under the topsoil are layers of weathered soil of brown, loose, silty fine sand and light-gray, medium-dense, silty fine sand, totaling from 3.6 to 5.3 feet thick. The weathered soils are underlain to the depths explored by a alluvium deposit of light-gray, medium-dense, gravelly, cobbly, fine to coarse sand.

GROUNDWATER CONDITION

Groundwater was not encountered by any of the six test pits excavated on the project site. The topsoil and weathered soils are of moderately-high permeability and would allow some storm runoff to infiltrate into the ground, while the underlying alluvium deposit is of very-high permeability and would allow water to seep through very easily. The test pits were excavated in early spring following a very wet winter. Therefore, the winter high groundwater table under the site should be at the site that it would have little or no impact on the proposed development.

GEOLOGIC HAZARDS AND MITIGATION

Erosion and Landslide Hazard

The site is nearly flat and is underlain at shallow depth by an alluvium deposit of medium-dense, gravelly and cobbly sand deposit of moderately high shear strength. Therefore, there should be little or no hazard for soil erosion and landslide to occur on the project site. To further minimize erosion hazard of the site, vegetation cover outside of construction areas should be protected and maintained. Concentrated stormwater should not be discharged uncontrolled onto the ground within the site. Stormwater over impervious surfaces, such as roofs and paved roadway, driveways and parking areas, should be captured by underground drain line systems connected to roof downspouts and catch basins installed in paved areas. Water collected into these drain line systems should be tightlined to discharge into a storm sewer or suitable stormwater disposal facilities.

Seismic Hazard

The Puget Sound region is in an active seismic zone. The project site is underlain at shallow depth by medium-dense, gravelly, cobbly sand soil of very-high permeability. Also, the site is nearly level. Therefore, the potential for seismic hazards, such as landslides, liquefaction, lateral soil spreading, to occur on the site should be minimal. The proposed townhome buildings, however, should be designed for seismic forces induced by strong earthquakes. Based on the soil conditions encountered by the test pits, it is our opinion that Seismic Use Group I and Site Class D should be used in the seismic design of the proposed residences in accordance with the 2012 International Building Code (IBC).

DISCUSSION AND RECOMMENDATIONS

GENERAL

Based on the soil conditions encountered by test pits excavated on the project site, it is our opinion that the project site is suitable for the proposed development from the geotechnical engineering viewpoint, provided that the recommendations in this report are fully implemented and observed during and following completion of construction. Conventional footing foundations constructed on or into the underlying medium-dense to dense alluvium deposit of gravelly sand deposit underlying the site at shallow depth may be used to support proposed residences. Unsuitable surficial topsoil and weak surficial weathered soil should be stripped within footprint of roadway, driveways, parking areas, and areas of structural fill. The fill in the "handle bar" portion of the site should be thoroughly removed down to firm alluvium soil for the development of the future buildings.

The surficial topsoil and weathered soils contain a high percentage of fines and can be easily disturbed when saturated. Grading work in wet winter months may cause significant complications and difficulties. Therefore, earth work should be scheduled and completed from April 1 and October 31, if possible. Otherwise, erosion protection and drainage control measures recommended in this report should be implemented for site stabilization and to facilitate earthwork if it is to be carried out beyond the above dryer period.

TEMPORARY DRAINAGE AND EROSION CONTROL

The onsite surficial weak soils are sensitive to moisture and can be easily disturbed by construction traffic. A layer of clean, 2-to-4-inch quarry spalls should be placed over areas of frequent traffic, such as the entrances to and exit from the site, as required, to protect the subgrade soils from disturbance by construction traffic.

A silt fence should be installed along the downhill sides of construction areas to minimize transport of sediment by storm runoff onto neighboring properties or streets. The bottom of the filter cloth of the silt fences should be anchored in a trench filled with onsite soil.

Intercepting ditches or trench drains should be installed around construction areas, as required, to intercept and drain away storm runoff and near-surface groundwater seepage. Water captured by such ditches or trench drains should be stored in temporary holding and settling ponds onsite. Only clear and clean water may be discharged into the alluvium deposit under the site or into a nearby storm inlet. The storm inlet into which collected stormwater is to be discharged should be covered with a non-woven filter fabric sock to prevent sediment from entering the storm sewer system. The filter sock should be cleaned frequently during construction to prevent clogging, and should be removed after completion of construction.

Spoil soils should be hauled off of the site as soon as possible. Spoil soils and imported structural fill material to be stored onsite should be securely covered with plastic tarps, as required, for protection against erosion.

SITE PREPARATION AND GENERAL GRADING

Vegetation within construction limits should be cleared and grubbed. Loose topsoil and unsuitable surficial soils should be completely stripped down to the medium-dense to dense alluvium deposit of gravelly sand soil within building pads of residences and within paved roadway, driveways, and parking areas. Exposed soils after stripping should be compacted to a non-yielding state with a vibratory mechanical compactor and proof-rolled with a piece of heavy earthwork equipment prior to roadway, driveway, and parking area construction.

EXCAVATION AND FILL SLOPES

Under no circumstance should excavation slopes be steeper than the limits specified by local, state and federal safety regulations if workers have to perform construction work in excavated areas. Unsupported temporary cuts greater than 4 feet in height should be no steeper than 1H:1V. Permanent cut banks should be no steeper than 2-1/4H:1V. Soil condition encountered by cuts and stability of cut slopes should be observed and verified by a geotechnical engineer during excavation.

Permanent fill embankments required to support structural or traffic load should be constructed with compacted structural fill placed over undisturbed, proof-rolled, firm, alluvium soils after the surficial unsuitable soils are completely stripped. The slope of permanent fill embankments should be no steeper than 2-1/4H:1V. Upon completion, the sloping face of permanent fill embankments should be thoroughly compacted to a non-yielding state with a hoe-pack. Permanent fill embankments constructed over ground of 20% or more should be structurally supported laterally.

The above recommended cut slopes and fill embankments are under the assumption that groundwater seepage would not be encountered during construction. If groundwater is encountered, the grading work should be immediately halted and the slope stability re-evaluated. The slopes may have to be flattened and other measures taken to stabilize the slopes. Stormwater should not allowed to flow uncontrolled over cut slopes and fill embankments. Permanent cut slopes or fill embankments should be seeded and vegetated as soon as possible for erosion protection and long-term stability, and should be securely covered with clear plastic sheets, as required, to protect them from erosion until the vegetation is fully established.

STRUCTURAL FILL

Structural fill is the fill that supports structural or traffic load. Structural fill should consist of clean granular soils free of organic, debris and other deleterious substances and with particles not larger than three inches. Structural fill should have a moisture content within one percent of its optimum moisture content at the time of placement. The optimum moisture content is the water content in the soils that enable the soils to be compacted to the highest dry density for a given compaction effort. Onsite soils meeting the above requirements may be used as structural fill. Imported material to be used as structural fill should be clean, free-draining, granular soils containing no more than 7.5 percent by weight finer than the No. 200 sieve based on the fraction of the material passing No. 4 sieve, and should have individual particles not larger than three inches.

The ground over which structural fill is to be placed should be prepared in accordance with recommendations in the SITE PREPARATION AND GENERAL GRADING and

EXCAVATION AND FILL SLOPES sections of this report. Structural fill should be placed in lifts no more than 10 inches thick in its loose state, with each lift compacted to a minimum percentage of the maximum dry density determined by ASTM D1557 (Modified Proctor Method) as follows:

Application	% of Maximum Dry Density
Within building pads and under foundations	95%
Roadway/driveway subgrade	95% for top 3 feet and 90% below
Retaining/foundation wall backfill	92%
Utility trench backfill	95% for top 4 feet and 90% below

In-situ density of structural fill should be tested with a nuclear densometer by a testing agency specialized in fill placement and construction work. Testing frequency should be one test per every 250 square feet per lift of fill.

ONSITE STORMWATER DISPOSAL

General

The alluvium soil deposit of gravelly, cobbly sand deposit underlying the site at the depth of about 5.0 to 6.0 feet below existing ground surface is of very-high permeability and would be able to support onsite stormwater disposal by infiltration easily.

Design Infiltration Rate

The alluvium deposit of gravelly cobbly sand underlying the project site is of such high permeability that it will allow water to seep through very quick. In-situ infiltration test in

this soil deposit would not be possible as water will not accumulate in test pits excavated into this deposit to allow for infiltration test. This type of alluvium deposit would have a in-situ infiltration rate of 40 iph or more. We recommend a design infiltration rate of 4.0 iph (inches per hour) with a factor of safety of 10 be used for sizing infiltration trenches.

Design Infiltration Rate

The alluvium deposit of gravelly cobbly sand underlying the project site is of such high permeability that it will allow water to seep through very quick. In-situ infiltration test in this soil deposit would not be possible as water will not accumulate in test pits excavated into this deposit to allow for infiltration test. This type of alluvium deposit would have a in-situ infiltration rate of 40 iph or more. We recommend a design infiltration rate of 4.0 iph (inches per hour) with a factor of safety of at least 10.0 be used for sizing infiltration trenches.

Infiltration Trench Construction

Infiltration trenches should be cut at least 12 inches into the alluvium deposit of gravelly sand soil. To reach this target soil stratum the trenches would have to be excavated to depths of about 6.0 to 7.0 feet or more. The condition of the soil unit at bottom of trenches should be verified by a geotechnical engineer. The stability of the trench cut banks should also be checked out by a geotechnical engineer during excavation.

The trenches should be at least 24 inches wide. The side walls (but not the bottom) of the trenches should be lined with a layer of non-woven filter fabric (MIRAFI 140NS). The

trenches are then to be filled with clean washed 3/4 to 1-1/2 inch gravel to within about 12 inches of finish grade. The dispersion pipes should be constructed of 4-inch rigid PVC pipes and laid level in the gravel or crushed rock filled trenches at about 24 inches below the top of trenches. The dispersion pipes should be spaced at no more than 4 feet apart if multiple dispersion pipes are used. The top of the gravel or crushed rock fill should also be covered with the filter fabric liner. The remaining trenches should then be backfilled in lifts with compacted onsite clean sandy soils. The gravel or crushed rock fill should be placed in lifts no more than 10 inches thick in loose state, with each lift compacted to a non-yielding state with a vibratory mechanical compactor. The compaction and densification of trench fill is critical if it is to support roadway or driveways or parking areas. Stormwater captured over paved roadway, driveways, or parking areas should be routed into a catch basin equipped with an oil-water separator before being released into the infiltration trenches.

If maintaining groundwater quality is critical, the bottom of trenches should be filled with a minimum 12-inch layer of uncompacted amended soil for filtering out pollutants. The amended soil should contain 40 percent (by volume) of compost, mixed with clean, medium to coarse, sand, to achieve an organic content of at least 10% by dry weight.

BUILDING FOUNDATIONS

Conventional footing foundations may be used to support the proposed residences. The footing foundations should be constructed on or into the medium-dense silty fine underlying weathered soil of light-gray, medium-dense, silty fine sand soil. Water should

not be allowed to accumulate in excavated footing trenches. Disturbed soils in footing trenches should be completely removed down to above competent deposit in their native, undisturbed state and footing bearing soils should be thoroughly compacted to a non-yielding state with a vibratory mechanical compactor prior to pouring concrete for footings.

If the above recommendations are followed, our recommended design criteria for footing foundations are as follows:

- The allowable soil bearing pressure for design of footing foundations, including dead and live loads, should be no greater than 2,500 psf. The footing bearing soils should be verified by a geotechnical engineer after the footing trenches are excavated and before the footings poured.
- The minimum depth to bottom of perimeter footings below adjacent final exterior grade should be no less than 18 inches. The minimum depth to bottom of the interior footings below top of floor slab should be no less than 12 inches.
- The minimum width should be no less than 18 inches for continuous footings, and no less than 24 inches for individual footings, except those footings supporting light-weight decks or porches.

A one-third increase in the above recommended allowable soil bearing pressure may be used when considering short-term, transitory, wind or seismic loads. For footing foundations designed and constructed per recommendations above, we estimate that the maximum total post-construction settlement of the buildings should be 3/4 inch or less and the differential settlement across building width should be 1/2 inch or less.

Lateral loads on the proposed residences may be resisted by the friction force between the foundations and the subgrade soils or the passive earth pressure acting on the below-grade portion of the foundations. For the latter, the foundations must be poured "neat" against undisturbed soils or backfilled with a clean, free-draining, compacted structural fill. We recommend that an equivalent fluid density (EFD) of 275 pcf (pounds per cubic foot) for the passive earth pressure be used for lateral resistance. The above passive pressure assumes that the backfill is level or inclines upward away from the foundations for a horizontal distance at least twice the depth of the foundations below the final grade. A coefficient of friction of 0.55 between the foundations and the subgrade soils may be used. The above soil parameters are unfactored values, and a proper factor of safety should be used in calculating the resisting forces against lateral loads on the buildings.

SLAB-ON-GRADE FLOORS

Slab-on-grade floors, if used for the proposed townhome buildings, should be placed on firm subgrade soil prepared as outlined in the SITE PREPARATION AND GENERAL EARTHWORK and the STRUCTURAL FILL sections of this report. Where moisture control is critical, the slab-on-grade floors should be placed on a capillary break which is in turn placed on the compacted subgrade. The capillary break should consist of a minimum four-inch-thick layer of clean, free-draining, 7/8-inch crushed rock, containing no more than 5 percent by weight passing the No. 4 sieve. A vapor barrier, such as a 6-mil plastic membrane, may be placed over the capillary break, as required, to keep moisture from migrating upwards.

PAVED ROADWAY/DRIVEWAYS AND PARKING AREAS

Performance of roadway, driveways, and parking area pavement is critically related to the conditions of the underlying subgrade soils. We recommend that the subgrade soils under the roadways, driveways and parking areas be treated and prepared as described in the SITE PREPARATION AND GENERAL EARTHWORK section of this report. Prior to placing base material, the subgrade soils should be compacted to a non-yielding state with a vibratory roller compactor and proof-rolled with a piece of heavy construction equipment, such as a fully-loaded dump truck. Any areas with excessive flexing or pumping should be over-excavated and re-compacted or replaced with a structural fill or crushed rock placed and compacted in accordance with the recommendations provided in the STRUCTURAL FILL section of this report.

We recommend that a layer of compacted, 7/8-inch crushed rock base (CRB), be placed for the roadways, driveways, and parking areas. This crushed rock base should be at least 6 inches for the public roadways and 4 inches for the private driveways and parking areas. This crushed rock base should be overlain with a 3-inch asphalt treated base (ATB) topped by a 2-inch-thick Class B asphalt concrete (AC) surficial course for the public roads and overlain by a 3-inch-thick Class B asphalt concrete (AC) surficial course for private driveways and parking areas.

DRAINAGE CONTROL

Building Footprint Excavation

Footprint excavation for the proposed townhome buildings, if encountering groundwater seepage, should have bottom of excavation sloped slightly and ditches excavated along

bases of the cut banks to direct collected groundwater into sump pits from which water can be pumped out. A layer of 2-inch crushed rock should be placed over footing bearing subgrade soils, as required, to protect the soils from disturbance by construction traffic. This crushed rock base should be built to a few inches above groundwater level, but not less than 6 inches thick. The crush rock base should be compacted in 12-inch lifts to a non-yielding state with a vibratory mechanical compactor.

Runoff over Impervious Surfaces

Storm runoff over impervious surfaces, such as roofs, paved roadway, driveways and parking areas, should be collected by underground drain line systems connected to downspouts and by catch basins installed in paved roadways, driveways and parking areas. Stormwater thus collected should be tightlined to discharge into a storm sewer or suitable stormwater disposal facilities.

Building Footing Drains

A footing subdrain should be installed around the perimeter footing foundations of each townhome building. The subdrains should consist of a 4-inch-minimum-diameter, perforated, rigid, drain pipe, laid a few inches below bottom of the perimeter footings of the buildings. The trenches and the drain lines should have a sufficient gradient (0.5% minimum) to generate flow by gravity. The drain lines should be wrapped in a non-woven filter fabric sock and completely enclosed in clean washed gravel. The remaining trenches may be backfilled with clean onsite soils. Water collected by the perimeter footing subdrain systems should be tightlined, separately from the roof and surface

stormwater drain lines, to discharge into a storm sewer or suitable stormwater disposal facilities.

Surface Drainage

Water should not be allowed to stand in any areas where footings, on-grade slabs, or pavement is to be constructed. Finish ground surface should be graded to direct surface runoff away from the adjacent buildings. We recommend the finish ground be sloped at a gradient of 3 percent minimum for a distance of at least 10 feet away from buildings, except in the areas to be paved.

Cleanouts

Sufficient number of cleanouts at strategic locations should be provided for underground drain lines. The underground drain lines should be cleaned and maintained periodically to prevent clogging.

RISK EVALUATION STATEMENT

The subject site is underlain at shallow depth by an alluvium deposit of medium-dense, gravelly, cobbly sand. This deposit is of moderately-high shear strength and the site is nearly level. Therefore, the site should be quite stable. It is our opinion that if the recommendations in this report are fully implemented and observed during and following completion of construction, the areas disturbed by construction will be stabilized and will remain stable, and will not increase potential for soil movement. In our opinion, the risk for damages to the proposed development and from the development to adjacent properties due to soil movement should be minimal.

LIMITATIONS

This report has been prepared for the specific application to this project for the exclusive use by Hanson Homes and its associates, representatives, consultants and contractors. We recommend that this report, in its entirety, be included in the project contract documents for the information of prospective contractors for their estimating and bidding purposes and for compliance with the recommendations in this report during construction. The conclusions and interpretations in this report, however, should not be construed as a warranty of the subsurface conditions. The scope of this study does not include services related to construction safety precautions and our recommendations are not intended to direct the contractor's methods, techniques, sequences or procedures, except as specifically described in this report for design considerations. All geotechnical construction work should be monitored and inspected by a geotechnical engineer during construction.

Our recommendations and conclusions are based on the geologic and soil conditions encountered in the test pits excavated on the site, and our experience and engineering judgment. The conclusions and recommendations are professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area. No warranty, expressed or implied, is made.

The actual subsurface conditions of the site may vary from those encountered by the test pits excavated on the site. The nature and extent of such variations may not become evident until construction starts. If variations appear then, we should be retained to re-

evaluate the recommendations of this report, and to verify or modify them in writing prior to proceeding further with the construction of the proposed development of the site.

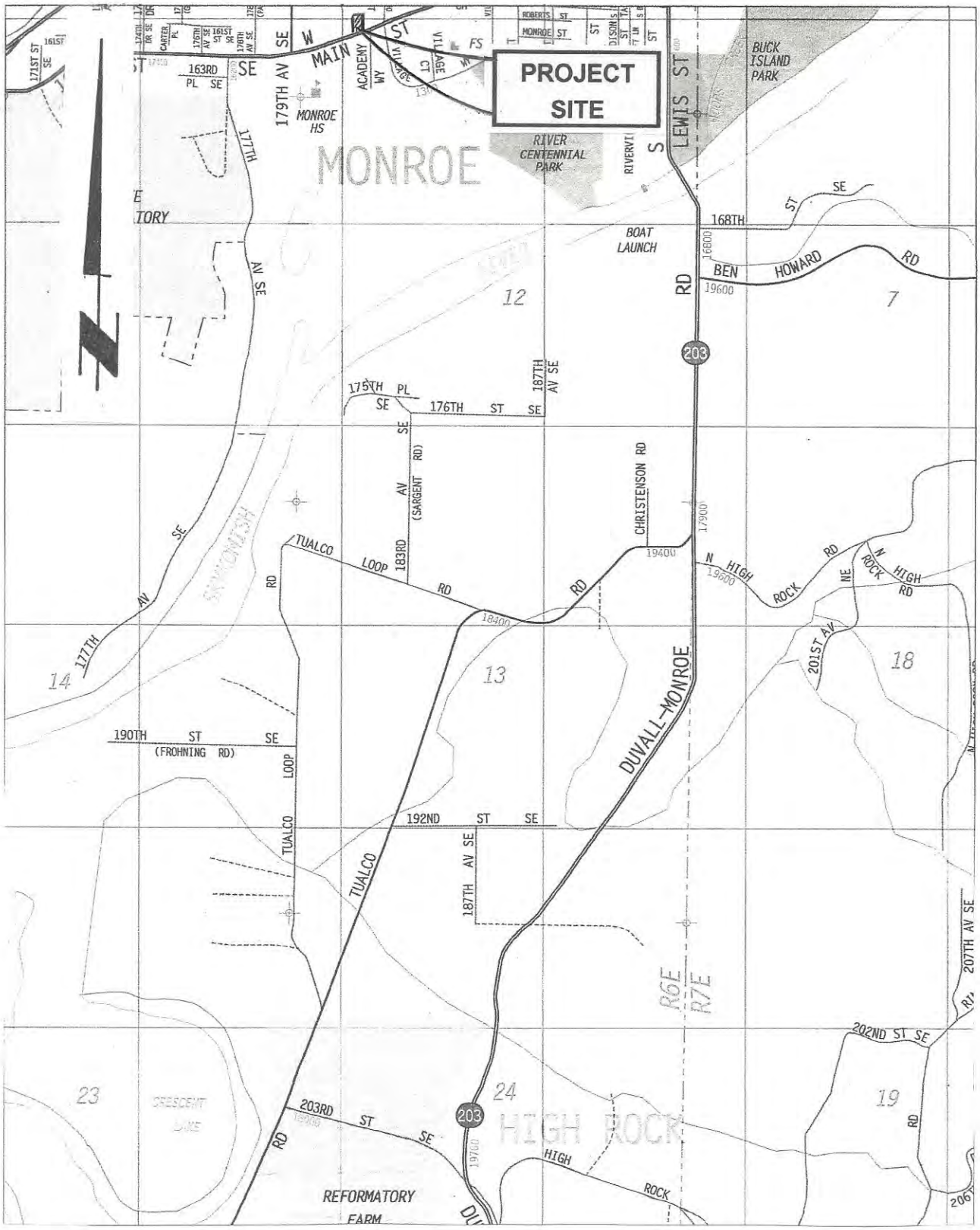
CLOSURE

We are pleased to be of service to you on this project. Please feel free to contact us if you have questions regarding this report or need further consultation.

Yours very truly,
LIU & ASSOCIATES, INC.

J. S. (Julian) Liu, Ph.D., P.E.
Principal

Attached: Six Plates and Appendix



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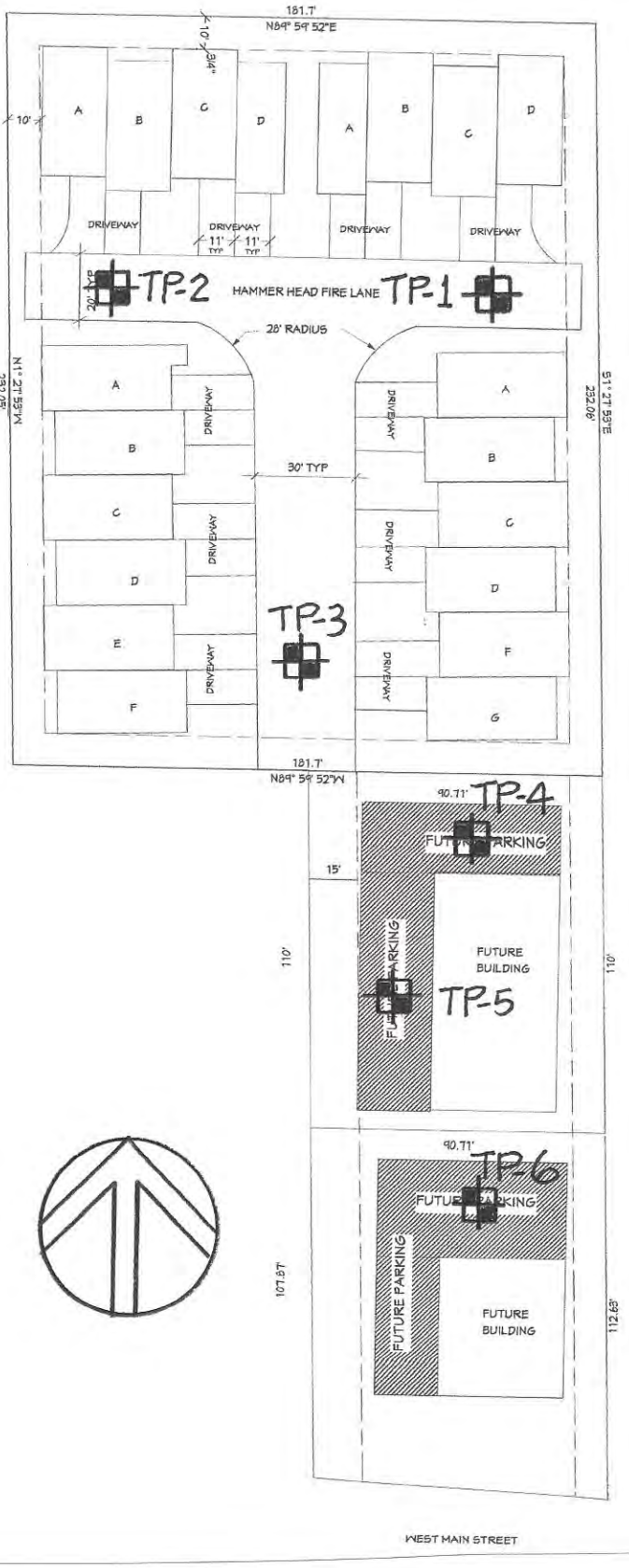
VICINITY MAP
MAIN STREET TOWNHOMES
1237 W MAIN STREET
MONROE, WASHINGTON

JOB NO. 17-038	DATE 3/30/2017	PLATE 1



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SITE AND EXPLORATION LOCATION PLAN
MAIN STREET TOWNHOMES
1237 W MAIN STREET
MONROE, WASHINGTON

JOB NO. 17-038	DATE 3/30/2017	PLATE 2

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOL	GROUP NAME
COARSE-GRAINED SOILS MORE THAN 50% RETAINED ON THE NO. 200 SIEVE	GRAVEL MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVEL	GW	WELL-GRADED GRAVEL, FINE TO COARSE GRAVEL
			GP	POORLY-GRADED GRAVEL
		GRAVEL WITH FINES	GM	SILTY GRAVEL
			GC	CLAYEY GRAVEL
	SAND MORE THAN 50% OF COARSE FRACTION PASSING NO. 4 SIEVE	CLEAN SAND	SW	WELL-GRADED SAND, FINE TO COARSE SAND
			SP	POORLY-GRADED SAND
		SAND WITH FINES	SM	SILTY SAND
			SC	CLAYEY SAND
FINE-GRAINED SOILS MORE THAN 50% PASSING ON THE NO. 200 SIEVE	SILT AND CLAY LIQUID LIMIT LESS THAN 50%	INORGANIC	ML	SILT
			CL	CLAY
		ORGANIC	OL	ORGANIC SILT, ORGANIC CLAY
	SILTY AND CLAY LIQUID LIMIT 50% OR MORE	INORGANIC	MH	SILT OF HIGH PLASTICITY, ELASTIC SILT
			CH	CLAY OF HIGH PLASTICITY, FAT CLAY
		ORGANIC	OH	ORGANIC SILT, ORGANIC SILT
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS

NOTES:

1. FIELD CLASSIFICATION IS BASED ON VISUAL EXAMINATION OF SOIL IN GENERAL ACCORDANCE WITH ASTM D2488-83.
2. SOIL CLASSIFICATION USING LABORATORY TESTS IS BASED ON ASTM D2487-83.
3. DESCRIPTIONS OF SOIL DENSITY OR CONSISTENCY ARE BASED ON INTERPRETATION OF BLOW-COUNT DATA, VISUAL APPEARANCE OF SOILS, AND/OR TEST DATA.

SOIL MOISTURE MODIFIERS:

DRY - ABSENCE OF MOISTURE, DUSTY, DRY TO THE TOUCH

SLIGHTLY MOIST - TRACE MOISTURE, NOT DUSTY

MOIST - DAMP, BUT NO VISIBLE WATER

VERY MOIST - VERY DAMP, MOISTURE FELT TO THE TOUCH

WET - VISIBLE FREE WATER OR SATURATED, USUALLY SOIL IS OBTAINED FROM BELOW WATER TABLE

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UNIFIED SOIL CLASSIFICATION SYSTEM

PLATE 3

TEST PIT NO. 1

Logged By: JSL Date: 3/22/2017 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, moist (TOPSOIL)			
2	SM	Light-brown, loose, silty fine SAND, moist			
3					
4	SM	Light-gray, medium-dense, silty fine sand, slightly-moist			
5					
6					
7	SW	Light-gray, medium-dense, gravelly, cobbly, fine to coarse sand, slightly-moist (ALLUVIUM DEPOSIT)			
8					
9					
10		Test pit terminated at 9.0 ft; groundwater not encountered,			

TEST PIT NO. 2

Logged By: JSL Date: 3/22/2017 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, moist (TOPSOIL)			
2	SM	Light-brown, loose, silty fine SAND, moist			
3	SM	Light-gray, medium-dense, silty fine sand, slightly-moist			
4					
5					
6	SW	Light-gray, medium-dense, gravelly, cobbly, fine to coarse sand, slightly-moist (ALLUVIUM DEPOSIT)			
7					
8					
9		Test pit terminated at 8.0 ft; groundwater not encountered,			
10					

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TEST PIT LOGS
MAIN STREET TOWNHOMES
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MONROE, WASHINGTON

JOB NO. 17-143 | DATE 3/22/2017 | PLATE 4

TEST PIT NO. 3

Logged By: JSL Date: 3/22/2017 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, moist (TOPSOIL)			
2	SM	Brown to light-brown, loose, silty fine SAND, moist			
3					
4					
5					
6	SM	Light-gray, medium-dense, silty fine sand, slightly-moist			
7	SW	Light-gray, medium-dense, gravelly, cobbly, fine to coarse sand, slightly-moist (ALLUVIUM DEPOSIT)			
8					
9					
10		Test pit terminated at 9.0 ft; groundwater not encountered,			

TEST PIT NO. 4

Logged By: JSL Date: 3/22/2017 Ground El. ±

Depth ft.	USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1	OL	Dark-brown, loose, organic, silty fine SAND, moist (TOPSOIL)			
2	SM	Brown to light-brown, loose, silty fine SAND, moist			
3					
4	SM	Light-gray, medium-dense, silty fine sand, slightly-moist			
5					
6	SW	Light-gray, medium-dense, gravelly, cobbly, fine to coarse sand, slightly-moist (ALLUVIUM DEPOSIT)			
7					
8					
9		Test pit terminated at 8.0 ft; groundwater not encountered,			
10					

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TEST PIT LOGS
MAIN STREET TOWNHOMES
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MONROE, WASHINGTON

JOB NO. 17-038 | DATE 3/22/2017 | PLATE 5

TEST PIT NO. 5

Logged By: JSL Date: 3/22/2017 Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1		OL	Dark-brown, loose, organic, silty fine SAND, with concrete rubble, asphalt fragments, glass bottles, plastic sheets, metal parts, fuel cans, etc. mixed in, moist			
2						
3						
4						
5						
6						
7						
8						
9			Test pit terminated at 8.5 ft; groundwater not encountered,			
10						

TEST PIT NO. 6

Logged By: JSL Date: 3/22/2017 Ground El. ±

Depth ft.		USCS CLASS.	Soil Description	Sample No.	W %	Other Test
1		OL	Dark-brown, loose, organic, silty fine SAND, moist (TOPSOIL)			
2		SM	Brown, loose, silty fine SAND, moist			
3						
4		SM	Light-gray, medium-dense, silty fine sand, slightly-moist			
5						
6						
7		SW	Light-gray, medium-dense, gravelly, cobbly, fine to coarse sand, slightly-moist (ALLUVIUM DEPOSIT)			
8						
9			Test pit terminated at 8.0 ft; groundwater not encountered,			
10						

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TEST PIT LOGS
MAIN STREET TOWNHOMES
1237 W MAIN STREET
MONROE, WASHINGTON

JOB NO. 17-038 | DATE 3/22/2017 | PLATE 6