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Preliminary Storm Drainage Report

Kestrel Ridge PRD
CPH Project No. 0026-19-016

Monroe, WA

Prepared for:

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PRELIMINARY STORM DRAINAGE REPORT

FOR

KESTREL RIDGE PRD

MONROE, WA

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SECTION 1 – PROJECT OVERVIEW

This Preliminary Storm Drainage Report (SDR) describes the engineering analysis of the surface water conditions, proposed development improvements, and required storm drainage facilities for the *Kestrel Ridge PRD* project located in Monroe, Washington. The report summarizes the design criteria for the storm drainage collection systems, associated flow control (i.e. detention) and water quality facilities, and temporary construction Best Management Practices (BMPs) proposed for the project. Figure 1 (Vicinity Map) illustrates the general location of the project site. Figures 2 and 3 of this report (see *Figures* section) illustrate the existing (i.e., pre-developed) and proposed developed conditions of the project area, respectively.

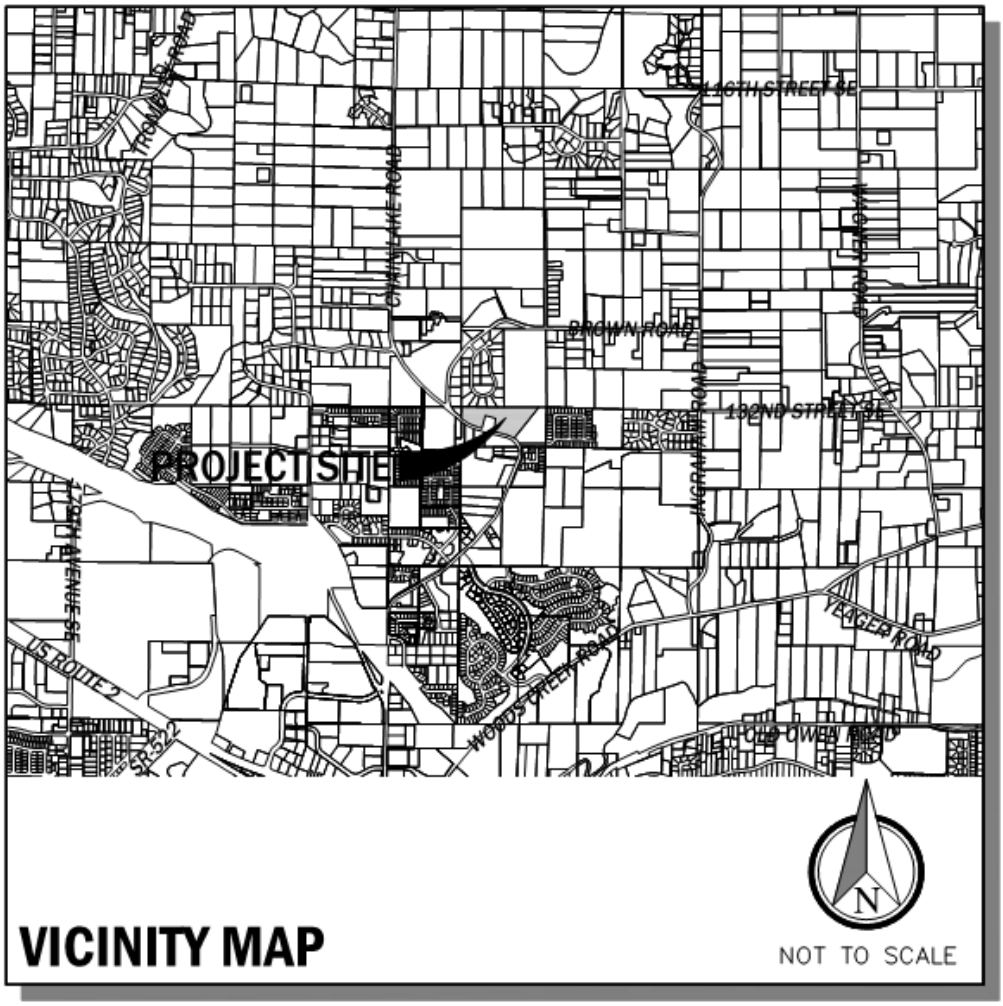


Figure 1 - Vicinity Map

The *Kestrel Ridge PRD* project proposes to develop 46 new single-family residential lots, per the requirements of R-4 zoning, through the City of Monroe's planned residential development process (PRD). The development will include associated roadway, storm drainage, sewer, and water infrastructure improvements to serve these proposed lots. Park and recreational open space will be provided on-site per PRD guidelines. Frontage improvements to Chain Lake Road will be provided, including pavement widening, curb and gutter, planter and sidewalk improvements adjacent to the property. The project site consists of an 8.76-acre assemblage of three developed parcels containing single-family residences, associated structures and outbuildings, and fenced yards consisting primarily of pasture within the Monroe city limits. Existing access to Kestrel Ridge PRD is provided via Chain Lake Road along the southern boundary of the site. The site is more generally located in portions of the NW ¼ of Section 31, Township 28N, Range 7 East, Willamette Meridian in Snohomish County, Washington.

The project site has moderate grade from higher elevations in the northwest corner sloping downward toward the eastern boundary with a total relief of approximately 38 feet. The project biologist identified and delineated two wetlands on the project site. Wetland A is an isolated Category IV wetland less than 4,000-square feet and meets the exemption requirements per MMC 20.05.050.B.1, therefore, Wetland A is exempt from the development provisions within MMC 20.05 and does not require an associated buffer. Wetland A will not be directly impacted and will be placed in a sensitive area tract. Wetland B has been designated by the biologist as a Category IV wetland approximately 1,545 square feet in size that does not appear to be isolated from all other surface waters, therefore, Wetland B is subject to the development provisions of MMC 20.05. No other potentially regulated wetlands or fish and wildlife habitat were identified within 300 feet of the subject property. On-site stormwater runoff flows over mainly pasture and some areas of impervious surface before reaching an existing ditch on the north side of Chain Lake Road. The basin ditch conveys runoff toward a culvert inlet that discharges southeasterly to a shallow, vegetated channel at the east side of Chain Lake Road and flows southeasterly through vegetated wetland areas. A downstream analysis has been completed as part of this report in Section 3 to confirm downstream capacity for developed site runoff.

SECTION 2 – EXISTING CONDITIONS SUMMARY

The project site is comprised of three real tax parcels (Snohomish County Parcel No. 28073100200600, 28073100202500, and 28073100202700) with a total area of approximately 8.76 acres. The existing parcels currently contain single-family residences, associated structures and outbuildings, and fenced yards consisting primarily of pasture. The site is bordered by single-family residences on all sides with access provided by Chain Lake Road at its southerly frontage. The general soil classification of the developable portion of the site is characterized by the Natural Resources Conservation Service (NRCS) as Tokul gravelly medial loam, with 0 to 8 and 8 to 15 percent slopes. A copy of the geotechnical report along with the NRCS Web Soil Survey data are provided in Appendix A.

The site generally descends from the northwestern property corner to the southeast with a total relief of 38 feet. The project site is contained in one drainage basin totaling approximately 8.51 acres on the north side of Chain Lake Road. Surface runoff primarily sheet flows across the mainly pastured areas toward an existing ditch on the north side of Chain Lake Road near the southeast corner of the site. This ditch discharges to a shallow, vegetated channel at the western frontage of the existing road and flows easterly toward an existing culvert that conveys runoff across Chain Lake Road and continues in a shallow vegetated channel.

See Figure 2 for a map of existing site conditions. A downstream analysis has been completed as part of this report in Section 3 to confirm downstream capacity for developed site runoff.

SECTION 3 – OFF-SITE ANALYSIS

This section summarizes the analysis of the onsite and offsite drainage conditions for the project. The methodology of the analysis and reporting of these conditions is in general accordance with the Department of Ecology's 2012 Stormwater Management Manual for Western Washington (SWMM), as amended in 2014. This analysis includes research of available information, a site visit, an upstream analysis, and a downstream analysis. Research sources include aerial photography, GIS information, Snohomish County Planning and Development Services (PDS) Map Portal, survey data, and as-built plans provided by the City of Monroe.

Site Visit

A site visit was completed on December 20, 2019 at 9:00 AM to observe drainage conditions in the project vicinity and to inspect the downstream conveyance system and assess its capacity for mitigated site discharge. The weather was approximately 48° and raining heavily. It had also been raining heavily prior to the site visit for some time. The ground appeared fully saturated and all conveyance facilities in the area were carrying significant flows.

Upstream Analysis

Based on the topography examined in the Snohomish County Planning and Development Services Map Portal (SCPDSMP), runoff flows onto and through the site from adjacent properties north and west of the site. Properties to the north of the project site are developed with single family residences and associated driveway and utilities. It appears a portion of these lots flow onto the project site, with the areas being primarily lawn and forest. The project site makes a U shape around another existing single-family residence, that is located to the west of lots 40, 41, and 43. A portion of this property flows southeast onto the site and is made up of lawn and impervious surface. Due to topography, properties further to the west, and east of the project site are unlikely to flow on site. A high point in Chain Lake Road exist adjacent to the west boundary of the project site, limiting any upstream flows from Chain Lake Road. The roadside ditch adjacent to Chain Lake Road in this area was observed full of water and did not appear to continue flowing southeast towards the site. Figure 4 shows the existing drainage basins.

Downstream Analysis

Runoff from the project site primarily sheet flows into the existing ditch on the north side of Chain Lake Road, some concentrated flows were also observed entering the ditch near the southeast corners of parcels 28073100202500, and 28073100202700. The site is located within one basin, discharging the site at the southeast corner into the ditch along the north side of Chain Lake Road. See Appendix D for the downstream analysis map and photos.

The on-site basin runoff flows into an existing ditch on the north side of Chain Lake Road. This ditch conveys runoff southeast through a series of culverts until reaching 134th Street SE. The series of ditch sections and culverts were all observed flowing with minimal blockages and no flooding. Some debris and leaves filled some portions of ditch but did not appear to present any problems. Near the intersection of Chain Lake Road and 134th Street SE, runoff from the roadside ditch appears to enter an underground culvert pipe crossing under 134th Street SE and discharging flows to a rock lined swale located in the frontage of the Easton Cove development, adjacent to the northeast side of Chain Lake Road. The swale conveys flows south into a series catch basins. Approximately 0.25 miles downstream

of the project site, the flows from the swale drain east into a sensitive area tract. The tract was observed with water flowing into it from the two catch basins as well as standing surface water.

Based off aerial imaging and Snohomish County Planning and Development Services Map Portal (SCPDSMP), runoff likely continues from the sensitive area tract southeast, entering an unnamed watercourse. This unnamed water course combines with Woods Creek approximately 0.75 miles downstream of the project site. Woods creak continues another 1.5 miles discharging to the Skykomish River. The downstream conveyance system appears to be properly functioning and has adequate capacity for its tributary drainage area. Runoff from the *Kestrel Ridge PRD* project will meet flow control standards set forth by the Department of Ecology 2012 Stormwater Management Manual for Western Washington. This will result in mitigated peak flows leaving the site for all major storm events and therefore is not expected to have an adverse impact on the downstream system. Appendix D contains a downstream map and photos from the analysis.

SECTION 4 – Permanent Stormwater Control Plan

Performance Standards, Goals and Facility Proposals

The storm drainage analysis and facilities design for this project are proposed in general accordance with the 2012 Department of Ecology Stormwater Management Manual for Western Washington (SMMWW), as amended in December 2014, and as adopted by current Monroe Municipal Code (MMC), section 15.01.025. The project is classified as New Development and will result in greater than 5,000 square-feet of new impervious surface, therefore all nine Minimum Requirements for stormwater management specified by the manual are applicable.

The hydrologic analysis of the runoff conditions for the project site was performed using the Western Washington Hydrologic Model 2012 (WWHM) software to generate peak design flow rates and volumes. A combined water quality/detention pond is proposed in the southeast corner of the site to treat and detain runoff. Appendix B contains the WWHM model results for the proposed stormwater pond.

Pre-developed Site Hydrology

Table 4.1 shows the pre-developed land use inputs used in the WWHM model and Table 4.2 summarizes the resulting peak design runoff rates. See Figure 4 for pre-developed drainage basins.

Table 4.1 – Pre-developed Drainage Subbasins

Basin	Land Use Area (ac)			
	Forested	Lawn	Impervious	Total
On Site Basin	8.508	0.000	0.000	8.508
Frontage Basin	0.296	0.000	0.000	0.296
Upstream Basin 1	1.413	1.250	0.662	3.325
Upstream Basin 2	0.000	0.268	0.110	0.378
Bypass	0.332	0.000	0.000	0.332

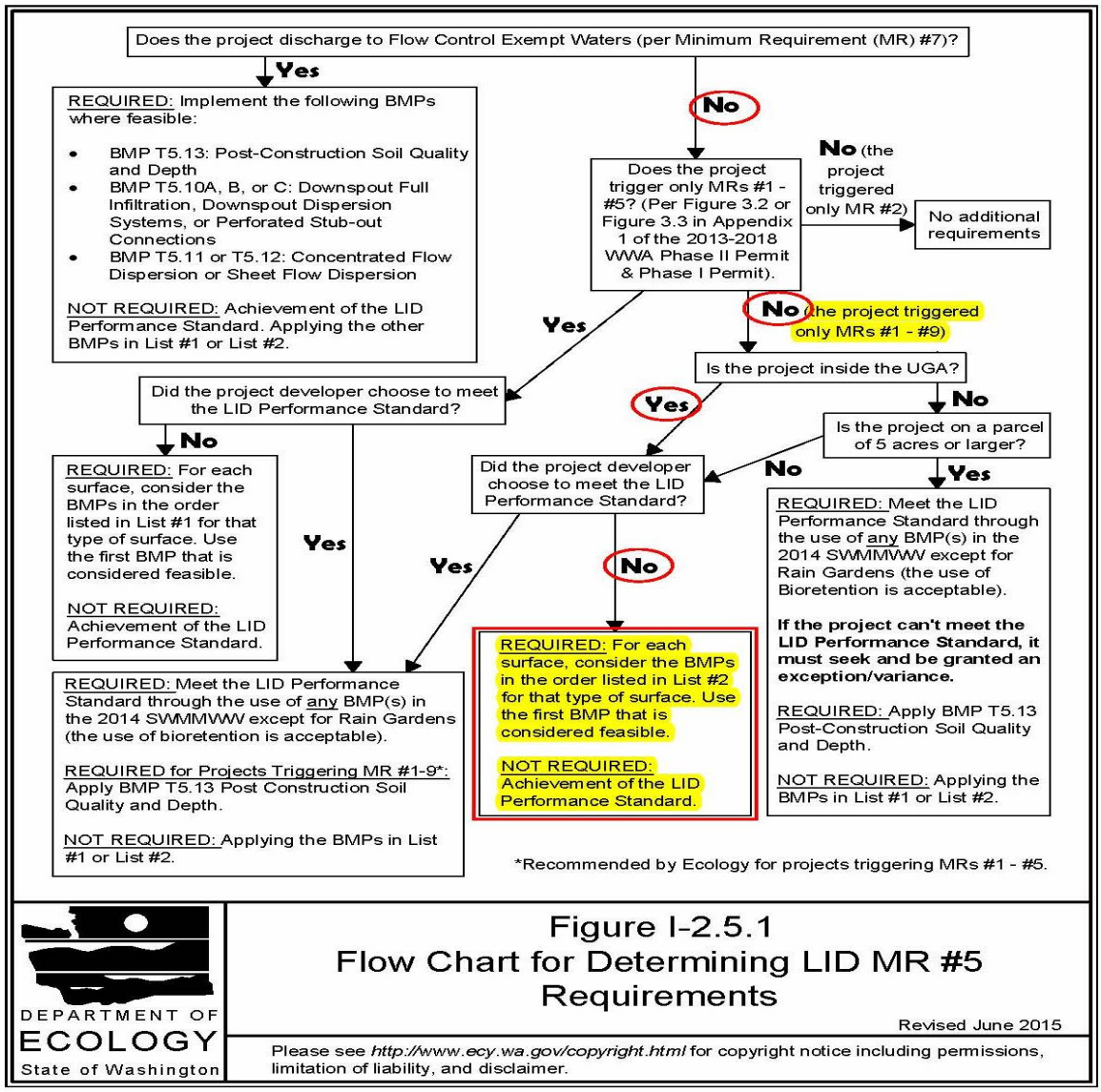
Table 4.2 –Pre-developed Peak Flows (POC 1)

Event	Flow Rate (cfs)
2-yr	0.956
10-yr	1.960
25-yr	2.607
50-yr	3.155
100-yr	3.763

On-Site Stormwater Management

Minimum Requirement #5 addresses the application of on-site stormwater management BMPs with the intent to "infiltrate, disperse, and retain stormwater runoff on-site to the extent feasible without causing flooding or erosion impacts." Requirements for this project are specified on Table I-2.5.1 and Figure I-2.5.1. These are included here with the relevant text highlighted.

Figure I-2.5.1 Flow Chart for Determining LID MR #5 Requirements



2014 Stormwater Management Manual for Western Washington

Volume I - Chapter 2 - Page 60

Table I-2.5.1 On-Site Stormwater Management Requirements for Projects Triggering Minimum Requirements #1 - #9

Project Type and Location	Requirement
New development on any parcel inside the UGA, or new development outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911); or List #2 (applicant option).
New development outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911).
Redevelopment on any parcel inside the UGA, or redevelopment outside the UGA on a parcel less than 5 acres	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911); or List #2 (applicant option).
Redevelopment outside the UGA on a parcel of 5 acres or larger	Low Impact Development Performance Standard and BMP T5.13: Post-Construction Soil Quality and Depth (p.911).
Note: This table refers to the Urban Growth Area (UGA) as designated under the Growth Management Act (GMA) (Chapter 36.70A RCW) of the State of Washington. If the Permittee is located in a county that is not subject to planning under the GMA, the city limits shall be used.	

The feasibility of the BMPs in DOE List #2 have been evaluated for the *Kestrel Ridge PRD* project as a new development inside the UGA. BMPs listed were considered in order for each type of surface to determine if their use/application for this project was feasible based on the following criteria:

1. Design criteria, limitations, and infeasibility criteria identified for each BMP in this manual; and
2. Competing Need Criteria listed in Chapter V-5 – On-Site Stormwater Management.

Lawn and landscaped areas:

1. **Post-Construction Soil Quality and Depth in accordance with BMP T5.13**

   This BMP is feasible. All soils in lawn and landscaped areas will meet the design guidelines of BMP T5.13. This will be accomplished through one or more of the following implementation methods identified in the manual:

   a. retention of undisturbed native vegetation and soil, or
   b. amendment of existing site topsoil, or
   c. stockpiling and reuse of existing topsoil, or import of approved topsoil mix.

Roofs:

1. **Dispersion in accordance with BMP T5.10A, BMP T5.10B, BMP T5.11, BMP T5.12, BMP T5.30**

   Full Dispersion BMP is not feasible except for the locations shown in Figure 4. The site plan, which is in accordance with City of Monroe PRD requirements, does not retain the minimum amount of native vegetation required to apply the Full Dispersion BMP.

   The other dispersion BMPs are not feasible except for where indicated in the Figure 4. The proposed lots, designed in accordance with City of Monroe PRD requirements, are not large enough to accommodate the vegetated flow path required for dispersion.

2. **Vegetated Roofs in accordance with BMP T5.17**

   This BMP is not feasible. The proposed single-family buildings do not support this BMP.

3. **Minimal Excavation Foundations in accordance with BMP T5.19**

   This BMP is not feasible. The proposed site requires heavy equipment for grading that could disturb native soil.

4. **Infiltration and Retention in accordance with BMP T5.10C, BMP T5.14A, BMP T5.14B, BMP T5.15**

   Infiltration and Retention BMPs are not feasible, which include Perforated Stub-out Connections, Rain Gardens, Bioretention, and other infiltration or retention BMPs. The glacial till soil on site exhibits low permeability and is not a suitable receptor for infiltration or retention facilities.

Other Hard Surfaces:

1. **Dispersion in accordance with BMP T5.11, BMP T5.12, BMP T5.18, BMP T5.30**

   Full Dispersion BMP is not feasible. The site plan, which is in accordance with City of Monroe PRD requirements, does not retain the minimum amount of native vegetation required to apply the Full Dispersion BMP. See Figure 4 for the proposed storm drainage infrastructure plan.

   The other dispersion BMPs are not feasible. The proposed lots, tracts, and rights-of-way, designed in accordance with City of Monroe PRD requirements, are not large enough to accommodate the vegetated flow path required for dispersion.

2. Infiltration and Retention in accordance with BMP T5.14A, BMP T5.14B, BMP T5.15

Infiltration and Retention BMPs are not feasible, which include Rain Gardens, Bioretention, and other infiltration or retention BMPs. The glacial till soil on site exhibits low permeability and is not a suitable receptor for infiltration or retention facilities.

The geotechnical report (see Appendix A) provides additional confirmation that infiltration stormwater management BMPs are not practically feasible based on in-situ soil conditions.

Developed Site Hydrology

The Standard Flow Control Requirement, part of Minimum Requirement #7, will be applied and states that, "Stormwater discharges shall match developed discharge durations to pre-developed durations for the range of pre-developed discharge rates from 50% of the 2-year peak flow up to the full 50-year peak flow."

Developed site conditions within the study area were modeled based on the sub-basin configuration shown in Figure 5 and the land use covers summarized in Table 4.4. The residential lots were modeled based on an expected maximum 60 percent impervious coverage as allowed by Monroe Municipal Code (MNC) Bulk Requirements Chapter 18.10.140. Impervious road and sidewalk surface, both on-site and frontage, was calculated from the proposed footprint shown on the improvement plans. The remaining lot area and open space area was modeled as grass. There is one on-site sub-basin that conveys site runoff to a detention and water quality pond located adjacent to the north side of Chain Lake Road near the southeast corner of the site. The developed basins are shown and detailed in Figure 5. There is one small sub-basin along the frontage that cannot be conveyed to the pond due to grade restrictions and is modeled in WWHM as bypass. There is a portion of proposed new pollution generating impervious surface along the frontage which will not be collected, however, an equivalent area of existing roadway upstream will be collected and conveyed to the pond.

A combined detention/water quality pond is proposed for the project. The pond has a volume of 3.173 ac-ft active storage and 0.721 ac-ft of water quality dead storage contained in two cells. The max water surface of the pond is elevation 336 and has a controlled discharge to the existing drainage system located in Chain Lake Road. Flow control is provided by an 18-in riser with a 3-orifice design used to meet the applicable standards and will discharge at the southeast corner of the project site.

Table 4.4 shows the developed land use inputs used in the WWHM model. Tables 4.5 and 4.6 summarizes the mitigated peak design flow rates.

Table 4.4- Developed Drainage Sub-basins

Basin	Land Use Area (ac)			
	Forested	Lawn	Impervious	Total
On Site Basin	0.000	3.720	4.788	8.508
Frontage Basin	0.000	0.200	0.096	0.296
Upstream Basin 1	1.413	1.250	0.393	3.055
Upstream Basin 2	0.000	0.268	0.110	0.378
Bypass Basin	0.000	0.047	0.285	0.332

Table 4.5 –Developed Peak Flows (POC 1)

Event	Flow Frequency Return Periods at Point of Compliance (cfs)
2-yr	0.395
10-yr	0.621
25-yr	0.760
50-yr	0.876
100-yr	1.003

Conveyance System Analysis and Design

A capacity analysis of the onsite conveyance system for the project will be performed and compiled with the final engineering plans. The capacity analysis will use WWHM to calculate 100-yr peak flows to be designed to contain the 100-yr peak flow with no overtopping of structures.

Water Quality Treatment

Basic water quality treatment, per Minimum Requirement #6, is required for surface water runoff from all new pollution generating surfaces created with development of the site. Water quality treatment will be provided by the application of a wetpond for the on-site runoff. The minimum required water quality design volume calculated from WWHM for the mitigated developed flows is 0.5023 acre-feet, or 21,880 cubic feet. The pond provides water quality treatment in two cells totaling a volume of 31,410 cf. The pond will detain and treat runoff prior to discharge into the existing drainage system in Chain Lake Road.

SECTION 5 – Construction Stormwater Pollution Prevention Plan

Storm Water Pollution Prevention Plan (SWPPP)

1. *Mark Clearing Limits*
   To prevent disturbance of project areas not designated for construction, a construction clearing limits fence or silt fence will be installed by the Contractor along the perimeter of the project site to protect existing native area outside of the mitigation area. These fences will be installed in accordance with the details and specifications provided in the Plans prior to any clearing and grading activities. All sensitive areas and buffers shall also be fenced prior to construction activities.

2. *Establish Construction Access*
   Heavy truck and equipment access during construction shall be limited to locations from Chain Lake Road. The contractor shall employ appropriate BMP measures to prevent transport of sediment offsite by motor vehicles.

3. *Control Flow Rates*
   The contractor will be responsible for installing temporary erosion control BMP's to control the release rate and water quality of surface water from active construction areas.

4. *Install Sediment Controls*
   On-site sediment retention will be controlled by a combination of silt fences, temporary interceptor trenches, and the proposed detention pond as shown on the Plans. The contractor shall inspect and provide regular maintenance of these facilities throughout the duration of construction to ensure maximum sediment control.

5. *Stabilize Soils*
   Temporary and permanent cover measures will be provided by the Contractor to protect disturbed areas. Straw mulching is typically used to provide temporary protection from erosion at exposed soil areas. Plastic covering may also be used in order to protect cut and fill slopes, and/or to encourage grass growth in newly seeded areas. Disturbed areas that remain unworked for at least 7 days will be seeded and mulched to provide permanent cover measure and to limit erosion potential.

   Water will be used by the Contractor as allowed by local agency regulations and applicable SWMM standards to prevent wind transport of exposed soils. Exposed soils will be sprayed until wet and re-sprayed as needed during dry weather periods.

6. *Protect Slopes*
   The project does not require any disturbance of soils within steep slope or erosion hazard areas. Temporary and permanent seeding to stabilize exposed soil areas is expected to be sufficient for protecting on-site slopes—whether constructed or at disturbed native areas. Plastic covering may also be used to protect cut and fill slopes if seasonal limitations warrant and/or to encourage grass growth in newly seeded areas. The contractor shall take all practical efforts including installation of temporary interceptor ditches to direct potential storm water runoff away from the top of on-site slopes.

7. *Protect Drain Inlet*
   All storm drain inlets made operable during construction or otherwise existing in the vicinity of work areas shall be protected using pre-manufactured filter fabric catch basin inserts to protect against construction storm water runoff entering the conveyance system. The Contractor will be responsible for maintenance of all temporary sediment control BMP's during construction, including removal of accumulated sediment, as well as for the ultimate removal of these controls and remaining accumulated sediment upon completion of construction.

8. *Stabilize Channels and Outlets*
   Methods of protection may include silt fence installation and maintenance, catch basin inserts, and temporary interceptor ditches. Vegetated areas shall be maintained whenever possible or practical to provide for natural filtration of construction storm water discharges.

9. *Control Pollutants*
   Special provisions shall be taken to reduce the risk of pollutant contamination from the construction access, concrete handling/wash areas, and sawcutting/surfacing activities. No water used in or contacting areas of construction shall be allowed to drain directly towards on-site buffer areas or wetlands without prior treatment. Vehicle maintenance shall only be performed at approved on-site areas and only after proper containment devices are in place downstream of those areas. Any flammable or otherwise hazardous liquids shall be stockpiled only at the approved construction staging area.

10. *Control Dewatering*
    Temporary dewatering efforts may be required to facilitate some elements of construction such as storm drainage and utilities installation. Any such dewatering volumes encountered will be collected and controlled using pumps and sediment traps or tanks. Discharge from these controlled onsite facilities will be dispersed to approved areas of native vegetation or otherwise treated using setting tanks or other mechanical filtration facilities prior to release to downstream systems as required to conform with General Construction Stormwater permit standards.

11. *Maintain BMPs*
    All TESC measures will be inspected and maintained on a regular basis following the maintenance requirements identified for each in the Plans and/or the project's Storm Water Pollution Prevention Plan (SWPPP). An ESC supervisor will be designated by the Contractor and the name, address and phone number of the ESC supervisor will be given to the regulatory jurisdiction prior to the start of construction.

    The ESC supervisor will inspect the site at least once a month during the dry season, weekly during the wet season, and within 24 hours of each runoff-producing storm event. An ESC maintenance report will be used as a written record of all maintenance in accordance with the project SWPPP

12. *Manage the Project*

    The Contractor will be responsible for the phasing of erosion and sediment controls during construction so that they are adequately coordinated with all construction activities. The Contractor will be responsible for maintenance of all temporary sediment control BMP's during construction, including removal of accumulated sediment, as well as for the ultimate removal of

these controls and cleaning of existing permanent storm drainage facilities upon completion of construction.

13. *Protect Low Impact Development BMPs*

    The onsite soils are not favorable for infiltrative BMPs per the NRCS Report. A Geotech Report will be included in the next submittal to confirm the infiltration potential. As such, no low impact development BMPs are proposed with this project. No special protection is required.

    Full dispersion trenches for roof runoff will be constructed in the critical area buffer as shown in Figure 4. The dispersion trenches will be utilized after construction is complete.

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FIGURES

Kestrel Ridge

Figure 2- Existing Site Conditions

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Redmond, WA 98052
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www.cphconsultants.com

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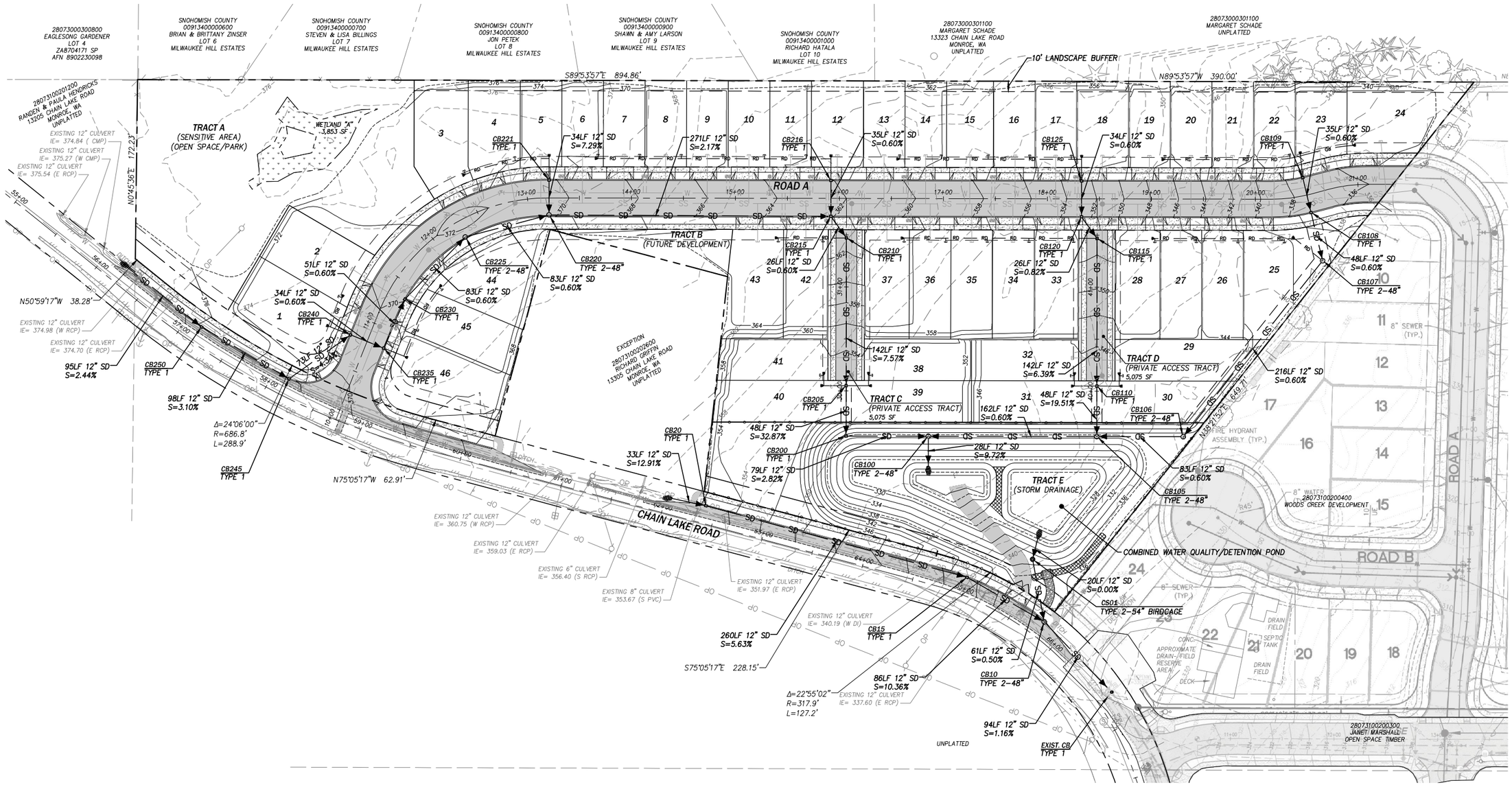

LEGEND

- MSE RETAINING WALL
- 160 EXIST. TOPOGRAPHIC CONTOUR
- 160 PROPOSED GRADE CONTOUR
- TYPE 1 STORM DRAINAGE CATCH BASIN
- TYPE 2 STORM DRAINAGE CATCH BASIN
- SD STORM DRAINAGE PIPE
- RD ROOF DRAIN CONNECTION

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Kestrel Ridge

Figure 3 - Developed Site Conditions

UPSTREAM BASIN 1
FOREST=1.413 AC
LAWN=1.250 AC
IMPERVIOUS=0.662 AC
TOTAL=3.325 AC

ON-SITE BASIN
FOREST=8.508 AC
LAWN=0.000 AC
IMPERVIOUS=0.000 AC
TOTAL=8.508 AC

UPSTREAM BASIN 2
FOREST=0.000 AC
LAWN=0.268 AC
IMPERVIOUS=0.110 AC
TOTAL=0.378 AC

FRONTAGE BASIN
FOREST=0.296 AC
LAWN=0.000 AC
IMPERVIOUS=0.000 AC
TOTAL=0.296 AC

BYPASS BASIN
FOREST=0.000 AC
LAWN=0.047 AC
IMPERVIOUS=0.285 AC
TOTAL=0.332 AC

CHAIN LAKE ROAD

15' ROW DEDICATION

PARCEL 2

N74°44'52"W 49.12'

N 89°49'50" W 437.77'

T-POST ON LINE

T-POST, 0.6' N. OF PROP. LINE

T-POST 0.8' N.

T-POST 0.8' N.

280731-002-004-00, DEED, A.F. NO. 200703010374

28073100200400 WOODS CREEK DEVELOPMENT

28073100202500 KESTREL RIDGE LLC

28073000300800 EAGLESONG GARDENER LOT 4 ZA8704171 SP AFN 8902230098

28073000201200 RANDEN & PAULA HENDRICKS 13206 CHAIN LAKE ROAD MONROE, WA UNPLATTED

SNOHOMISH COUNTY 00913400000600 BRIAN & BRITTANY ZINSER LOT 6 MILWAUKEE HILL ESTATES

SNOHOMISH COUNTY 00913400000700 STEVEN & LISA BILLINGS LOT 7 MILWAUKEE HILL ESTATES

SNOHOMISH COUNTY 00913400000800 JON PETEK LOT 8 MILWAUKEE HILL ESTATES

SNOHOMISH COUNTY 00913400000900 SHAWN & AMY LARSON LOT 9 MILWAUKEE HILL ESTATES

SNOHOMISH COUNTY 00913400001000 RICHARD HATALA LOT 10 MILWAUKEE HILL ESTATES

28073000301100 MARGARET SCHADE 13323 CHAIN LAKE ROAD MONROE, WA UNPLATTED

28073000301100 MARGARET SCHADE UNPLATTED

28073100202600 RICHARD GRIFFIN 13305 CHAIN LAKE ROAD MONROE, WA UNPLATTED

EXISTING 12" CULVERT IE= 374.84 (CMP)
EXISTING 12" CULVERT IE= 375.27 (W CMP)
EXISTING 12" CULVERT IE= 375.54 (E RCP)
EXISTING 12" CULVERT IE= 374.98 (W RCP)
EXISTING 12" CULVERT IE= 374.70 (E RCP)
EXISTING 12" CULVERT IE= 360.75 (W RCP)
EXISTING 12" CULVERT IE= 359.03 (E RCP)
EXISTING 6" CULVERT IE= 356.40 (S RCP)
EXISTING 8" CULVERT IE= 353.67 (S PVC)
EXISTING 12" CULVERT IE= 351.97 (E RCP)
EXISTING 12" CULVERT IE= 340.19 (W DI)
EXISTING 12" CULVERT IE= 337.60 (E RCP)
EX. SSMH=330.51 IE=323.60(SEPWC)

4' WIRE EXISTING FENCE
4' HOG WIRE EXISTING FENCE
3' WOOD EXISTING FENCE
5' CHAIN LINK EXISTING FENCE
EXISTING GATE
EXISTING FENCE
4' HOG WIRE FENCE

SHED (TBR)
BUILDING (TBR)
HOUSE
SHED
GRAVEL DRIVE
APPROX. DRAINFIELD (TBR)
APPROXIMATE LOCATION OF SEPTIC TANK, SAND FILTER & DRAINFIELD PATTERN SNO. CO. HEALTH DISTRICT RECORDS
EX. GRAVEL
CONC.
APPROXIMATE DRAIN- FIELD RESERVE AREA
EX. SFR
DECK
DRAIN FIELD
SEPTIC TANK
GARAGE
FOUND IRON PIPE
DITCH
TOE LINE
TOP
UNPLATTED

0 50 100
PLAN IN FEET

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Phone: (425) 285-2390 | FAX: (425) 285-2389
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P:\project\0026\19016\Reports\TIR\191223\CAD\Figure 4_Existing drainage basins.dwg
12/24/2019 12:51 PM CASEY TORRES

Kestrel Ridge

Figure 4 - Existing Drainage Basins

UPSTREAM BASIN 1
FOREST=1.413 AC
LAWN=1.250 AC
IMPERVIOUS=0.662 AC
TOTAL=3.325 AC

ON-SITE BASIN
FOREST=0.000 AC
LAWN=4.386 AC
IMPERVIOUS=4.122 AC
TOTAL=8.508 AC

UPSTREAM BASIN 2
FOREST=0.000 AC
LAWN=0.268 AC
IMPERVIOUS=0.110 AC
TOTAL=0.378 AC

FRONTAGE BASIN
FOREST=0.000 AC
LAWN=0.200 AC
IMPERVIOUS=0.096 AC
TOTAL=0.296 AC

BYPASS BASIN
FOREST=0.000 AC
LAWN=0.047 AC
IMPERVIOUS=0.285 AC
TOTAL=0.332 AC

BROWN ROAD

CHAIN LAKE ROAD

TRACT A
(SENSITIVE AREA)
(OPEN SPACE/PARK)
44,546 SF

TRACT B
(FUTURE DEVELOPMENT)
4,026 SF

TRACT C

TRACT E
(STORM DRAINAGE)
45,948 SF

WETLAND A
3,853 SF

15' ROW DEDICATION

DRAIN FIELD
SEPTIC TANK
APPROXIMATE DRAIN- FIELD RESERVE AREA
DECK

CP|H
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0 50 100
PLAN IN FEET

P:\project\0026\19016\Reports\TIR\191223\CAD\Figure 5_Developed drainage basins.dwg
12/24/2019 12:36 PM CASEY TORRES

Kestrel Ridge

Figure 5 - Developed Drainage Basins

CP|H
CONSULTANTS

APPENDIX A

NRCS SOILS DATA AND GEOTECHNICAL REPORT

Map Scale: 1:2,080 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 21, Sep 16, 2019

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 26, 2018—Oct 16, 2018

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
3	Alderwood gravelly sandy loam, 15 to 30 percent slopes	0.0	0.0%
72	Tokul gravelly medial loam, 0 to 8 percent slopes	0.8	8.7%
73	Tokul gravelly medial loam, 8 to 15 percent slopes	8.0	91.3%
Totals for Area of Interest		**8.7**	**100.0%**

Earth Solutions NW LLC

Geotechnical Engineering
Construction Observation/Testing
Environmental Services

UPDATED GEOTECHNICAL ENGINEERING STUDY
PROPOSED KESTREL RIDGE RESIDENTIAL PLAT
CHAIN LAKE ROAD
MONROE, WASHINGTON

ES-5859.01

15365 N.E. 90th Street, Suite 100 Redmond, WA 98052
(425) 449-4704 Fax (425) 449-4711
www.earthsolutionsnw.com

PREPARED FOR

TAYLOR DEVELOPMENT, INC.

December 26, 2019

For

Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

12/26/19

Kyle R. Campbell, P.E.
Principal Engineer

UPDATED GEOTECHNICAL ENGINEERING STUDY
PROPOSED KESTREL RIDGE RESIDENTIAL PLAT
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Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, you can benefit from a lowered exposure to problems associated with subsurface conditions at project sites and development of them that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed herein, contact your GBA-member geotechnical engineer. Active engagement in GBA exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Understand the Geotechnical-Engineering Services Provided for this Report

Geotechnical-engineering services typically include the planning, collection, interpretation, and analysis of exploratory data from widely spaced borings and/or test pits. Field data are combined with results from laboratory tests of soil and rock samples obtained from field exploration (if applicable), observations made during site reconnaissance, and historical information to form one or more models of the expected subsurface conditions beneath the site. Local geology and alterations of the site surface and subsurface by previous and proposed construction are also important considerations. Geotechnical engineers apply their engineering training, experience, and judgment to adapt the requirements of the prospective project to the subsurface model(s). Estimates are made of the subsurface conditions that will likely be exposed during construction as well as the expected performance of foundations and other structures being planned and/or affected by construction activities.

The culmination of these geotechnical-engineering services is typically a geotechnical-engineering report providing the data obtained, a discussion of the subsurface model(s), the engineering and geologic engineering assessments and analyses made, and the recommendations developed to satisfy the given requirements of the project. These reports may be titled investigations, explorations, studies, assessments, or evaluations. Regardless of the title used, the geotechnical-engineering report is an engineering interpretation of the subsurface conditions within the context of the project and does not represent a close examination, systematic inquiry, or thorough investigation of all site and subsurface conditions.

Geotechnical-Engineering Services are Performed for Specific Purposes, Persons, and Projects, and At Specific Times

Geotechnical engineers structure their services to meet the specific needs, goals, and risk management preferences of their clients. A geotechnical-engineering study conducted for a given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client.

Likewise, geotechnical-engineering services are performed for a specific project and purpose. For example, it is unlikely that a geotechnical-engineering study for a refrigerated warehouse will be the same as one prepared for a parking garage; and a few borings drilled during a preliminary study to evaluate site feasibility will not be adequate to develop geotechnical design recommendations for the project.

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project or purpose;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, the reliability of a geotechnical-engineering report can be affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying the recommendations in it. A minor amount of additional testing or analysis after the passage of time – if any is required at all – could prevent major problems.

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read the report in its entirety. Do not rely on an executive summary. Do not read selective elements only. *Read and refer to the report in full.*

You Need to Inform Your Geotechnical Engineer About Change

Your geotechnical engineer considered unique, project-specific factors when developing the scope of study behind this report and developing the confirmation-dependent recommendations the report conveys. Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- the elevation, configuration, location, orientation, function or weight of the proposed structure and the desired performance criteria;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project or site changes – even minor ones – and request an assessment of their impact. *The geotechnical engineer who prepared this report cannot accept*

responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface using various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing is performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgement to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team through project completion to obtain informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, they are not final, because the geotechnical engineer who developed them relied heavily on judgement and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* exposed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a continuing member of the design team, to:

- confer with other design-team members;
- help develop specifications;
- review pertinent elements of other design professionals' plans and specifications; and
- be available whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction-phase observations.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for information purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. This happens in part because soil and rock on project sites are typically heterogeneous and not manufactured materials with well-defined engineering properties like steel and concrete. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually provide environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not obtained your own environmental information about the project site, ask your geotechnical consultant for a recommendation on how to find environmental risk-management guidance.

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, the engineer's services were not designed, conducted, or intended to prevent migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration. Confront the risk of moisture infiltration*** by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

GEOPROFESSIONAL BUSINESS ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org www.geoprofessional.org

Earth Solutions NW LLC

Geotechnical Engineering, Construction
Observation/Testing and Environmental Services

December 26, 2019
ES-5859.01

Taylor Development, Inc.
15 Lake Bellevue Drive, Suite 102
Bellevue, Washington 98005

Attention: Mr. Robert Fitzmaurice

Dear Mr. Fitzmaurice:

Earth Solutions NW, LLC (ESNW) is pleased to present this geotechnical report to support your proposed project. Based on the results of our investigation, construction of the proposed residential structures is feasible from a geotechnical standpoint. Our explorations indicate the site is underlain predominately by glacial till deposits with areas of alluvial/outwash sand toward the eastern portion of the overall site. During our subsurface exploration completed on February 2, 2018 and December 6, 2019, groundwater seepage was encountered at shallow depths across much of the site. Mitigation of this groundwater prior to site excavation will be critical during the grading process, and is discussed in greater detail later in this report.

The proposed structures may be constructed on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil, suitable for support of the new foundations, will likely be encountered beginning at depths of two to three feet below existing grades. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with a suitable structural fill material, will be necessary.

In accordance with the Department of Ecology's Stormwater Management Manual adopted by the City of Monroe, infiltration is not feasible from a geotechnical standpoint. Weakly cemented glacial till deposits were observed roughly two feet below ground surface, as well as heavy groundwater flow at shallow depths.

We appreciate the opportunity to be of service to you on this project. If you have questions regarding the content of this geotechnical engineering study, please call.

Sincerely,

EARTH SOLUTIONS NW, LLC

For: Scott S. Riegel, L.G., L.E.G.
Senior Project Manager

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ES-5859.01

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Cont'd

ES-5859.01

UPDATED GEOTECHNICAL ENGINEERING STUDY
PROPOSED KESTREL RIDGE RESIDENTIAL PLAT
CHAIN LAKE ROAD
MONROE, WASHINGTON

ES-5859.01

INTRODUCTION

General

This geotechnical engineering study (study) was prepared for the proposed residential development to be constructed along the north side of Chain Lake Road, in Monroe, Washington. The purpose of this study was to provide geotechnical recommendations for currently proposed development plans. Our scope of services for completing this study included the following:

- Excavation, logging, and sampling of test pits for purposes of characterizing site soils;
- Laboratory testing of soil samples collected at the test pit locations;
- Engineering analyses, and;
- Preparation of this report.

The following documents and maps were reviewed as part of our study preparation:

- CP | H Consultants, Conceptual Site Plan dated November 7, 2019;
- Surficial geologic map of the Skykomish and Snoqualmie Rivers area, Snohomish and King Counties, Washington, prepared by Booth, 1990;
- Online Web Soil Survey (WSS) resource, provided by the United States Department of Agriculture (USDA), Natural Resources Conservation Service.

Project Description

Preliminary site layout indicates the subject site will be developed with a total of 70 single-family residences, a tract road, stormwater detention areas, and associated infrastructure improvements. At the time of this report submission, specific building load and grading plans were not available for review; however, we anticipate the proposed structures will be two to three stories in height and constructed utilizing relatively lightly loaded wood framing supported on a conventional foundation system. Perimeter footing loads will likely be 1 to 2 kips per lineal foot, and slab-on-grade loading is anticipated to be approximately 150 pounds per square foot (psf).

Stormwater will be managed primarily by two detention facilities located along the southern portion of the site, designated Tract A and Tract F on the referenced site plan. Given the moderate topography and elevation on the site, cuts and fills ranging up to about ten feet are expected.

If the above design assumptions are incorrect or change, ESNW should be contacted to review the recommendations provided in this report. ESNW should review final designs to confirm that our geotechnical recommendations been incorporated into the plans.

SITE CONDITIONS

Surface

The subject site is located north of Chain Lake Road approximately 300 feet east of the intersection with Brown Road, in Monroe, Washington. The approximate location of the property is illustrated on Plate 1 (Vicinity Map). The property is comprised of three adjoining tax parcels (Snohomish County Parcel Nos. 2807310020-600, -2500 and -2700) totaling about nine acres. The site is bordered to the north, east, and west by residential houses, and to the south by Chain Lake Road. Each parcel is currently occupied by single family residence and associated improvements. The site topography descends gently to the east and vegetation consists of forested areas, open pastures, brambles and landscaping.

Subsurface

A representative of ESNW observed, logged, and sampled five test pits, excavated at accessible locations within the site boundaries, on February 2, 2018 and again on December 6, 2019 using a mini-trackhoe and operator retained by our firm. The explorations were completed for purposes of assessment and classification of site soils as well as characterization of groundwater conditions within areas proposed for new development. The approximate locations of the explorations are depicted on Plate 2 (Test Pit Location Plan). Please refer to the test pit logs provided in Appendix A for a more detailed description of subsurface conditions. Representative soil samples collected at the test pit locations were evaluated in general accordance with Unified Soil Classification System (USCS) and United States Department of Agriculture (USDA) methods and procedures.

Topsoil and Fill

Topsoil was observed extending to depths of about 3 to 12 inches. The topsoil was characterized by the observed dark brown hue, the presence of fine organics, and small root intrusions.

Fill was not encountered at any of the test pit locations. Fill encountered during grading should be evaluated by ESNW during grading activities.

Native Soil

Underlying topsoil, native soils consisted primarily of medium dense to dense silty sand with gravel (USCS: SM). Native soils were primarily encountered in a moist to wet condition. The maximum exploration depth was approximately seven feet below the existing ground surface (bgs). Isolated layers of sand (USCS: SP, SP-SM) were encountered at several test pit explorations located along the eastern areas of the site.

Geologic Setting

The referenced geologic map resource identifies glacial till (Qvt) deposits as the primary native soil unit underlying the subject site. The till was deposited directly from the glacier as it advanced over bedrock and older Quaternary sediment and is often characterized as a silty sand with gravel. The referenced WSS resource identifies Tokul Medially Gravelly Loam (Map Unit Symbols: 72 and 73) as the primary soil units underlying the subject site. The Tokul was formed in glacial drift settings. Based on our field observations, on-site native soils are generally consistent with glacial till (Qvt) deposits.

Groundwater

During our subsurface exploration completed on February 2, 2018 heavy groundwater seepage was encountered at most locations. During our December 6, 2019 fieldwork, moderate groundwater seepage was observed at test pit location TP-109 perched at a depth of about two and one-half feet below existing grades. Moderate to heavy seepage was encountered from about one to three feet bgs across the site and likely represents interflow where groundwater travels within the shallow weathered zone. Water was observed to be entering excavations from a general northwestern direction, and is likely entering the site from the north side of the 13217 property. It is our opinion the contractor should anticipate and be prepared to respond to perched groundwater seepage during construction, especially within site excavations located within the northern half of the site. Groundwater seepage is common within relatively permeable soil lenses located above dense native soil deposits. Temporary measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches, sumps, and dewatering pumps. It should be noted that seepage rates and elevations fluctuate depending on many factors, including precipitation duration and intensity, the time of year, and soil conditions. In general, groundwater flow rates are higher during the wet season (October through April).

Geologically Hazardous Areas

Based on review of geologically hazardous areas in the Monroe Municipal Code 20.05.120, the subject site does not appear to be within, or immediately adjacent to, geologically hazardous areas, with the exception of potentially erodible geology. In our opinion, site susceptibility to erosion hazards may be considered low, provided that groundwater seepage is mitigated appropriately during construction, and temporary erosion control measures are included during grading activities.

DISCUSSION AND RECOMMENDATIONS

General

Based on the results of our investigation, construction of the proposed residential development is feasible from a geotechnical standpoint. The primary geotechnical considerations associated with the proposed development include foundation support, slab-on-grade subgrade support, groundwater/interflow drainage, and the suitability of using native soils as structural fill.

The proposed structures may be constructed on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil, suitable for support of the new foundations, will likely be encountered beginning at depths of two to three feet below existing grades. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with a suitable structural fill material, will be necessary.

Due to the heavy seepage present across most of the subject site, groundwater mitigation should be addressed prior to grading and sitework taking place. In our opinion, an interceptor trench along the upslope margins of the development envelope should be installed prior to the commencement of mass grading.

Glacial till was observed to be in a dense condition and weakly cemented roughly two feet below ground surface. Heavy groundwater flow was observed throughout the site of shallow depths. Given the shallow depths to groundwater and dense, native soils, infiltration is not recommended for this site.

This study has been prepared for the exclusive use of Taylor Development, Inc., and their representatives. A warranty is neither expressed nor implied. This study has been prepared 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.

Site Preparation and Earthwork

Initial site preparation activities will consist of installing temporary erosion control measures, establishing grading limits, performing site clearing and site stripping and installation of interceptor drains. Subsequent earthwork procedures will involve grading and related infrastructure improvements.

Temporary Erosion Control

Temporary construction entrances and drive lanes, consisting of at least six inches of quarry spalls, should be considered to both minimize off-site soil tracking and provide a stable access surface for construction vehicles. Geotextile fabric may be placed below the quarry spalls for greater stability of the temporary construction entrances. Erosion control measures should consist of silt fencing placed around appropriate portions of the site perimeter. Soil stockpiles should be covered or otherwise protected to reduce the potential for soil erosion during periods of wet weather. Temporary approaches for controlling surface water runoff should be established prior to beginning earthwork activities. Additional Best Management Practices (BMPs), as specified by the project civil engineer and indicated on the plans, should be incorporated into construction activities.

Construction Dewatering

Diversion of shallow groundwater should be implemented prior to mass grading and excavations on this site. An interception trench installed along the northern and western site boundaries will help control groundwater and should reduce the effects of on-site seepage. Completion of this trench as early as possible into the project will be key to reducing seepage onsite. The interceptor trench should be installed at a minimum depth of four feet below ground surface within dense, native till. A temporary detention pond, Baker tank, or another means of adequate water treatment and storage will be necessary due to the estimated high volume of groundwater. An ESNW representative should be onsite during trench construction and drainage program to confirm that groundwater is being managed adequately and to provide additional recommendations. A typical interceptor trench detail is provided on Plate 3. We recommend that prior to construction of the trench, ESNW should meet on-site with the client and contractor to finalize trench direction and locations. Additional drainage measures may be necessary on the site depending on the groundwater conditions at the time of construction.

Stripping

Topsoil was encountered within the upper approximately 3 to 12 inches of existing grades at the test pit locations. The organic-rich topsoil should be stripped and segregated into a stockpile for later use on site or to export. The material remaining immediately below the topsoil may have some root zones and will likely be variable in composition, density, and/or moisture content. The material exposed after initial topsoil stripping will likely not be suitable for direct structural support and will likely need to either be compacted in place or stripped and stockpiled for reuse as fill; depending on the time of year stripping occurs, the soil exposed below the topsoil may be too wet to compact adequately and may need to be aerated or otherwise treated. ESNW should observe initial stripping activities to provide recommendations regarding stripping depths and material suitability.

Excavations and Slopes

Reduction of groundwater flow will be critical to ensure that overall stability of site excavations remain in good condition while open. Based on the soil conditions observed at the test pit locations, the following allowable temporary slope inclinations, as a function of horizontal to vertical (H:V) inclination, may be used. The applicable Federal Occupation Safety and Health Administration (OSHA) and Washington Industrial Safety and Health Act (WISHA) soil classifications are also provided:

- Loose and medium dense soil or fill — 1.5H:1V (Type C)
- Areas exposing groundwater seepage — 1.5H:1V (Type C)
- Medium dense to dense native soil — 1H:1V (Type B)

Permanent slopes should be planted with vegetation to enhance stability and to minimize erosion and should maintain a gradient of 2H:1V or flatter. The presence of perched groundwater may cause localized sloughing of temporary slopes due to excess seepage forces. An ESNW representative should observe temporary and permanent slopes to confirm the slope inclinations are suitable for the exposed soil conditions and to provide additional excavation and slope recommendations, as necessary. If the recommended temporary slope inclinations cannot be achieved, temporary shoring may be necessary to support excavations. This is particularly important where detention vault excavations may be made near property lines.

In-situ and Imported Soils

In-situ soils are highly moisture sensitive and may not be suitable for use in structural fill applications unless the moisture content of the soil is at (or slightly above) the optimum moisture content at the time of placement and compaction. Successful use of native soils as structural fill will largely be dictated by in-situ moisture contents during construction. A contingency should be added to the budget in the event export of native soil and import of compactible fill is necessary.

Imported soil intended for use as structural fill should consist of a well-graded, granular soil with a moisture content that is at (or slightly above) the optimum level. Imported soil intended for use as structural fill should consist of a well-graded, granular soil with a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction).

Subgrade Preparation

Following site stripping, cuts and fills will be completed to establish proposed subgrade elevations across the site. ESNW should observe the subgrade areas during initial site preparation activities to confirm soil conditions are as anticipated and to provide supplementary recommendations for subgrade preparation. Complete restoration of voids resulting from previous grading activities must be executed as part of overall subgrade and building pad preparation activities.

The following guidelines for preparing building subgrade areas should be incorporated into the final design:

- Where voids and grading disturbances extend below planned subgrade elevations, restoration of these areas should be completed. Structural fill should be used to restore voids or unstable areas resulting from previous grading.
- Recompact, or over-excavate and replace, areas of existing fill exposed at building subgrade elevations. Over-excavations should extend into competent native soils and structural fill should be utilized to restore subgrade elevations as necessary.
- ESNW should confirm subgrade conditions, as well as the required level of recompaction and/or over-excavation and replacement, during site preparation activities. ESNW should also evaluate the overall suitability of prepared subgrade areas following site preparation activities.

Structural Fill

Structural fill is defined as compacted soil placed in foundation, slab-on-grade, and roadway areas. Fill placed to construct permanent slopes and throughout retaining wall and utility trench backfill areas is considered structural fill as well. Soils placed in structural areas, including slab-on-grade, utility trench, and pavement areas, should consist of a material devoid of organics or otherwise deleterious debris, be placed in loose lifts of 12 inches or less and compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by the Modified Proctor Method (ASTM D1557).

Foundations

The proposed structures may be supported on conventional continuous and spread footing foundations bearing on competent native soil, recompacted native soil, or new structural fill placed directly on competent native soil. In general, competent native soil, suitable for support of the new foundations, will likely be encountered at depths of about two to three feet below existing grades. Where loose or unsuitable soil conditions are exposed at foundation subgrade elevations, compaction of soils to the specifications of structural fill, or overexcavation and replacement with a suitable structural fill material, will be necessary. Provided the foundations will be supported as prescribed, the following parameters may be used for design:

- Allowable soil bearing capacity — 2,500 psf
- Passive earth pressure — 300 pcf (equivalent fluid)
- Coefficient of friction — 0.40

A one-third increase in the allowable soil bearing capacity may be assumed for short-term wind and seismic loading conditions. The above passive earth pressure and friction values include a factor-of-safety of 1.5. With structural loading as expected, total settlement in the range of one inch and differential settlement of about one-half inch is anticipated. The majority of the settlements should occur during construction, as dead loads are applied.

Seismic Design

The 2015 International Building Code recognizes the American Society of Civil Engineers (ASCE) for seismic site class definitions. Based on the soil conditions encountered at the test pit locations, in accordance with Table 20.3-1 of the ASCE Minimum Design Loads for Buildings and Other Structures manual, Site Class D should be used for design.

The referenced liquefaction susceptibility map indicates the site maintains a "very low to low" liquefaction susceptibility. Liquefaction is a phenomenon where saturated and loose sandy soils suddenly lose internal strength in response to increased pore water pressures resulting from an earthquake or other intense ground shaking. In our opinion, site susceptibility to liquefaction may be considered low. The relative density and gradation of the site soils is the primary basis for this consideration.

Slab-on-Grade Floors

Slab-on-grade floors for the proposed residential structures should be supported on firm and unyielding subgrades comprised of competent native soil, compacted structural fill, or new structural fill. Unstable or yielding areas of the subgrades should be recompacted, or over-excavated and replaced with suitable structural fill, prior to slab construction.

A capillary break, consisting of a minimum of four inches of free-draining crushed rock or gravel, should be placed below the slabs. The free-draining material should have a fines content of 5 percent or less (where the fines content is defined as the percent passing the Number 200 sieve, based on the minus three-quarter-inch fraction). In areas where slab moisture is undesirable, installation of vapor barriers below the slabs should be considered. If a vapor barrier is to be utilized, it should be a material specifically designed for use as a vapor barrier and should be installed in accordance with the specifications of the manufacturer.

Retaining Walls

Retaining walls must be designed to resist earth pressures and applicable surcharge loads. The following parameters may be used for design:

- Active earth pressure (yielding condition) — 35 pcf (equivalent fluid)
- At-rest earth pressure (restrained condition) — 55 pcf
- Traffic surcharge (passenger vehicles) — 70 psf (rectangular distribution)*
- Passive earth pressure — 300 pcf (equivalent fluid)
- Coefficient of friction — 0.40
- Seismic surcharge — 6H psf**

* *Where applicable*
** *Where H equals the retained height (in feet)*

The above design parameters are based on a level backfill condition and level grade at the wall toe. Revised design values will be necessary if sloping grades are to be used above or below retaining walls. Additional surcharge loading from adjacent foundations, sloped backfill, or other loads should be included in the retaining wall design, where applicable.

Retaining walls should be backfilled with free-draining material or suitable sheet drain that extends along the height of the wall and a distance of at least 18 inches behind the wall. The upper 12 inches of the wall backfill can consist of a less permeable soil, if desired. A perforated drainpipe should be placed along the base of the wall and connected to an approved discharge location. A typical retaining wall drainage detail is provided on Plate 4. If drainage is not provided, hydrostatic pressures should be included in the wall design.

Drainage

Heavy seepage was observed across the site during our fieldwork, in our opinion, zones of perched groundwater seepage should be anticipated in general site excavations; however, installing an interceptor trench, as described in this report, will help manage the effects of shallow interflow groundwater. Measures to control surface water runoff and groundwater during construction would likely involve interceptor trenches and sumps. ESNW should be consulted during preliminary grading to identify areas of seepage and to provide recommendations to reduce the potential for instability related to seepage effects.

Finish grades must be designed to direct surface water away from the new structures and/or slopes. Water must not be allowed to pond adjacent to the new structure and/or slopes. In our opinion, foundation drains should be installed along the building perimeter footings. A typical foundation drain detail is provided on Plate 5. If structures will include crawlspace configurations, we recommend installing conveyance measures to allow water to exit the building perimeter in the event water enters the foundation area.

Interception trenches built on-site should be considered as permanent installations. Civil engineering designs for the site must account for shallow groundwater conditions.

Infiltration Evaluation

As indicated in the *Subsurface* section of this study, native soils encountered during our fieldwork were characterized primarily as medium dense to dense, glacial till deposits. Given the cemented nature to the glacial till and shallow depths to heavy, pervasive seepage across the site, infiltration is not feasible from a geotechnical standpoint.

Preliminary Detention Vault Recommendations

Final storm detention design plans had not been finalized at the time of writing this report; however, we understand a detention vault will be constructed in the eastern area of the property. Vault foundations should be supported on competent native soil or crushed rock placed atop competent native soil. Final stormwater vault designs must incorporate adequate buffer space from property boundaries such that temporary excavations to construct the vault structure can be successfully completed or shoring will be required. Adequate buffer space is particularly important on this site given groundwater conditions and the adverse impacts to temporary slope inclinations. The presence of perched groundwater seepage should be anticipated during excavation activities for the vault.

The following parameters can be used for preliminary stormwater vault design:

- Allowable soil bearing capacity (dense native soil) 5,000 psf
- Active earth pressure 35 pcf
- Active earth pressure (hydrostatic) 80 pcf
- At-rest earth pressure (restrained) 55 pcf
- At-rest earth pressure (restrained, hydrostatic) 100 pcf
- Coefficient of friction 0.40
- Passive earth pressure 300 pcf
- Seismic surcharge 6H*

* *Where H equals the retained height*

Vault walls should be backfilled with at least 18 inches of free-draining material or suitable sheet drainage that extends along the height of the walls. The upper one foot of the wall backfill can consist of a less permeable soil, if desired. A perforated drain pipe should be placed along the base of the vault wall and connected to an approved discharge location. If the elevation of the vault bottom is such that gravity flow to an outlet is not possible, the portion of the vault below the drain must be designed to include hydrostatic pressure. Design values accounting for hydrostatic pressure are included above.

ESNW should observe grading operations for the vault and the subgrade conditions prior to concrete forming and pouring to confirm conditions are as anticipated, and to provide supplemental recommendations as necessary. Additionally, ESNW should be contacted to review final vault designs to confirm that appropriate geotechnical parameters have been incorporated.

Utility Support and Trench Backfill

In our opinion, native soils will generally be suitable for support of utilities. Organic-rich soils are not considered suitable for direct support of utilities and may require removal at utility grades if encountered. Remedial measures, such as overexcavation and replacement with structural fill and/or installation of geotextile fabric, may be necessary in some areas in order to provide support for utilities. Groundwater will likely be encountered within utility excavations, and caving of trench walls may occur where groundwater is encountered. Temporary construction dewatering, as well as temporary trench shoring, may be necessary during utility excavation and installation as conditions warrant.

Native soils will not be suitable for use as structural backfill throughout utility trench excavations, unless the soils are at (or slightly above) the optimum moisture content at the time of placement and compaction. Structural trench backfill should not be placed dry of the optimum moisture content. Each section of the site utility lines must be adequately supported in appropriate bedding material. Utility trench backfill should be placed and compacted to the specifications of structural fill as previously detailed in this report, or to the applicable specifications of the City of Monroe or other responsible jurisdiction or agency.

Preliminary Pavement Sections

The performance of site pavements is largely related to the condition of the underlying subgrade. To ensure adequate pavement performance, the subgrade should be in a firm and unyielding condition when subjected to proof rolling with a loaded dump truck. Structural fill in pavement areas should be compacted to the specifications previously detailed in this report. Soft, wet, or otherwise unsuitable subgrade areas may still exist after base grading activities. Areas containing unsuitable or yielding subgrade conditions will require remedial measures, such as over-excavation and/or placement of thicker crushed rock or structural fill sections, prior to pavement. Cement treatment of the subgrade soil can also be considered for stabilizing pavement subgrade areas if allowed by local jurisdictions.

For lightly loaded pavement areas subjected primarily to passenger vehicles, the following preliminary pavement sections may be considered:

- A minimum of two inches of hot mix asphalt (HMA) placed over four inches of crushed rock base (CRB), or;
- A minimum of two inches of HMA placed over three inches of asphalt treated base (ATB).

Heavier traffic areas generally require thicker pavement sections depending on site usage, pavement life expectancy, and site traffic. For preliminary design purposes, the following pavement sections for occasional truck traffic areas may be considered:

- Three inches of HMA placed over six inches of crushed rock base (CRB), or;
- Three inches of HMA placed over four-and-one-half inches of ATB.

The HMA, ATB and CRB materials should conform to WSDOT specifications. All soil base material should be compacted to a relative compaction of 95 percent, based on the laboratory maximum dry density as determined by ASTM D1557. Final pavement design recommendations, including recommendations for heavy traffic areas, access roads, and frontage improvement areas, can be provided once final traffic loading has been determined. Road standards utilized by the City of Monroe may supersede the recommendations provided in this report.

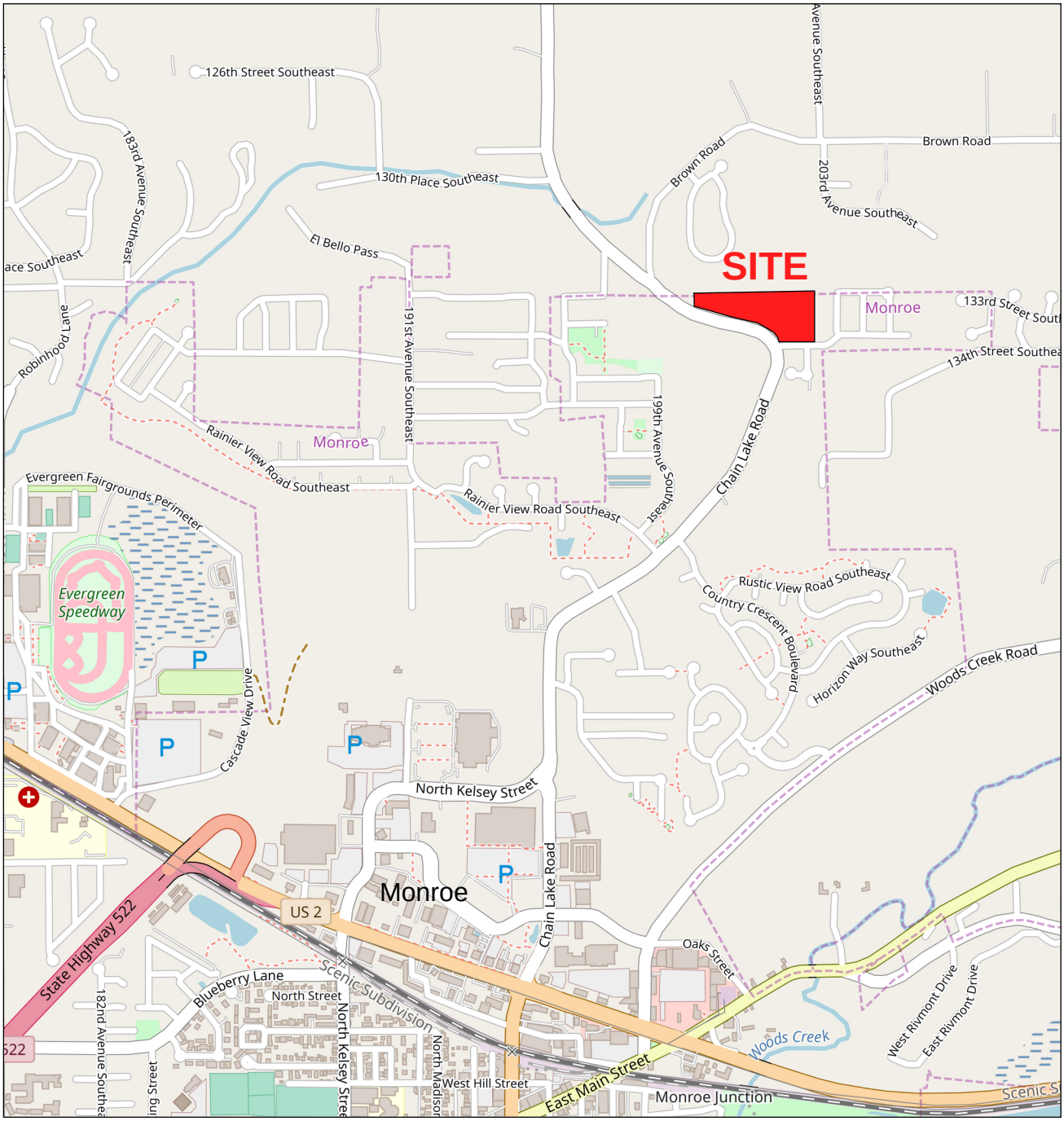
Given the groundwater conditions at site, it may be warranted to install a subgrade drainage system beneath roadways particularly if an inverted crown will be used. The need for such a system should be evaluated at the time of construction.

LIMITATIONS

The recommendations and conclusions provided in this study are professional opinions consistent with the level of care and skill that is typical of other members in the profession currently practicing under similar conditions in this area. A warranty is neither expressed nor implied. Variations in the soil and groundwater conditions observed at the test pit locations may exist and may not become evident until construction. ESNW should reevaluate the conclusions provided in this study if variations are encountered.

Additional Services

ESNW should have an opportunity to review final project plans with respect to the geotechnical recommendations provided in this study. ESNW should also be retained to provide testing and consultation services during construction.



Reference:
Snohomish County, Washington
OpenStreetMaps.org

NORTH

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

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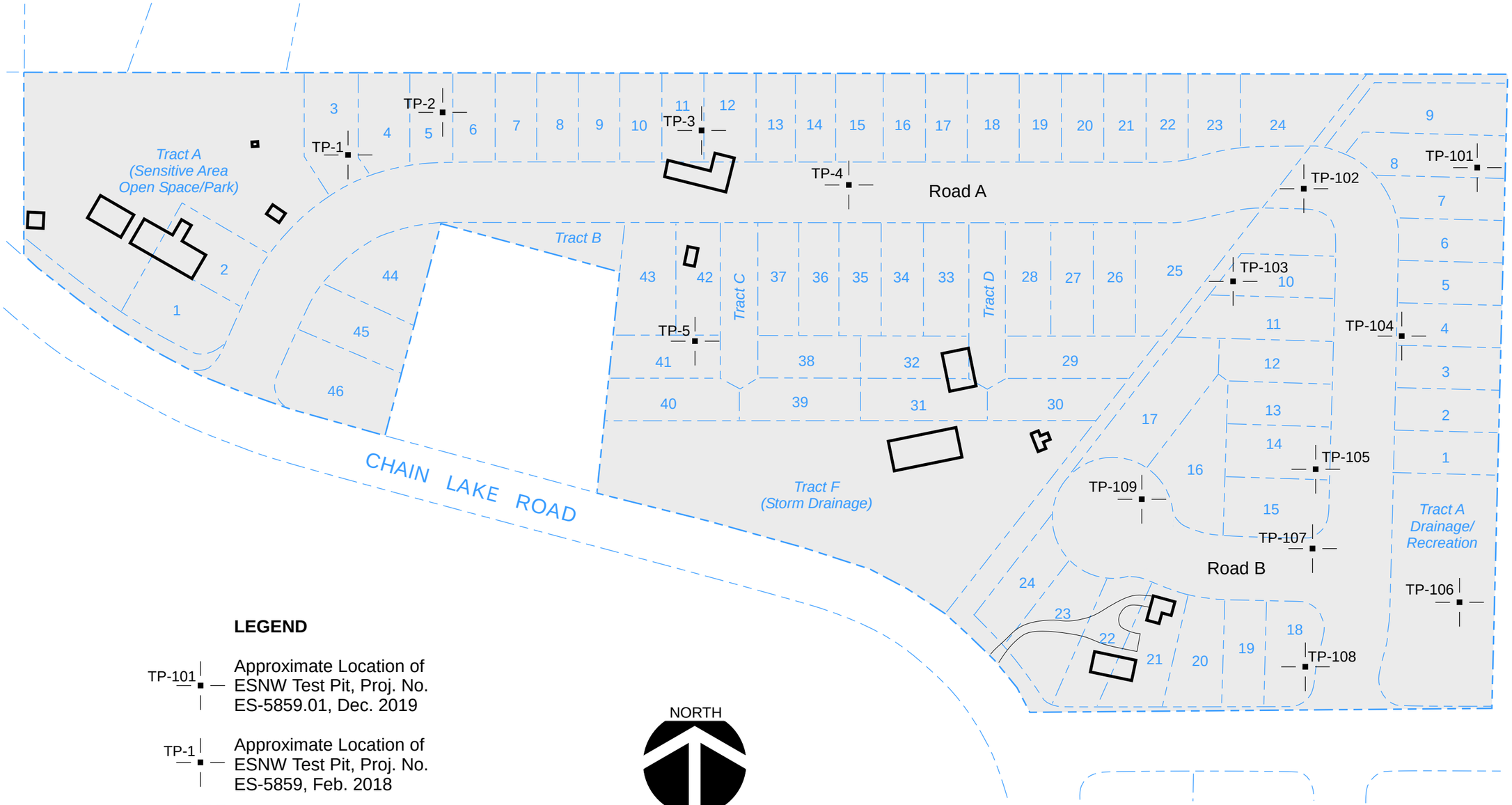
Vicinity Map
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 1



LEGEND

TP-101 — Approximate Location of ESNW Test Pit, Proj. No. ES-5859.01, Dec. 2019

TP-1 — Approximate Location of ESNW Test Pit, Proj. No. ES-5859, Feb. 2018

Subject Site

Existing Building

10 — Proposed Lot Number

NORTH

1"=100'

0 50 100 200

Scale in Feet

NOTE: The graphics shown on this plate are not intended for design purposes or precise scale measurements, but only to illustrate the approximate test locations relative to the approximate locations of existing and / or proposed site features. The information illustrated is largely based on data provided by the client at the time of our study. ESNW cannot be responsible for subsequent design changes or interpretation of the data by others.

NOTE: This plate may contain areas of color. ESNW cannot be responsible for any subsequent misinterpretation of the information resulting from black & white reproductions of this plate.

Test Pit Location Plan
Kestrel Ridge
Monroe, Washington

Earth Solutions NW LLC
Geotechnical Engineering, Construction Observation/Testing and Environmental Services

Earth Solutions NW LLC

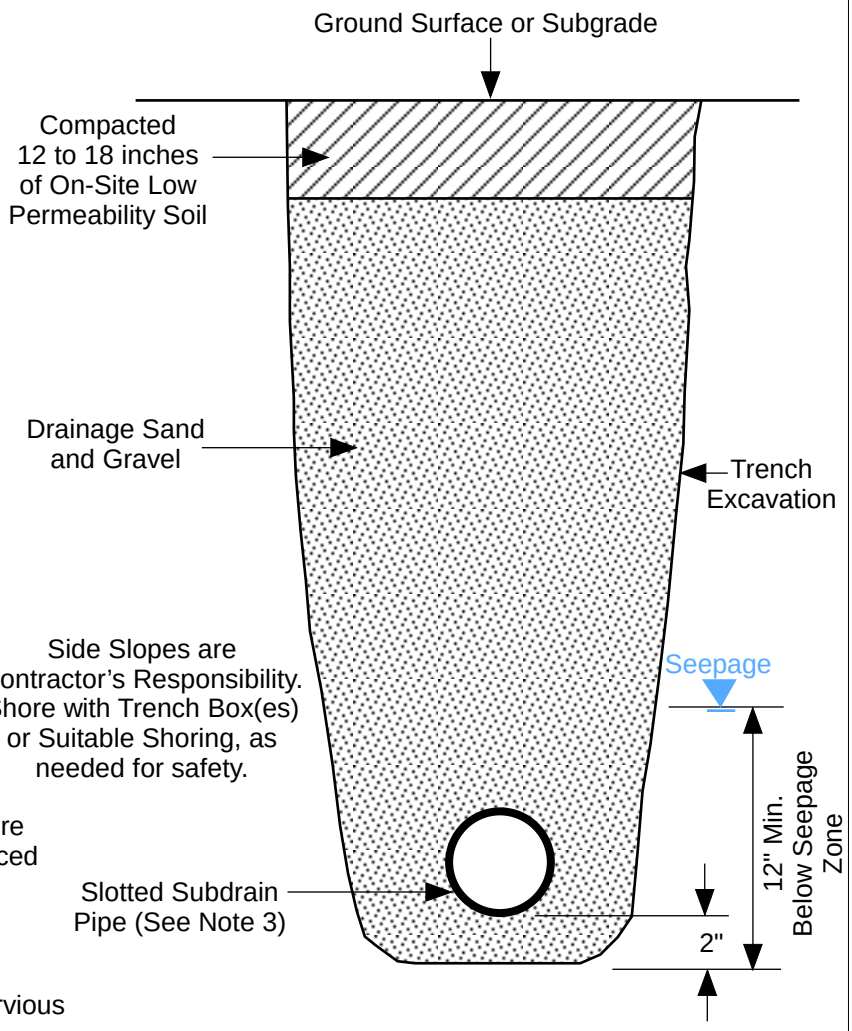
Drwn. By	MRS
Checked By	SSR
Date	12/23/2019
Proj. No.	5859.01
Plate	2

MATERIALS:

Drainage Sand and Gravel should meet the following gradation (Modified City of Seattle Mineral Aggregate Type 26):

Sieve Size	% Passing by Weight
1 - inch	100
3/4 - inch	85 to 95
1/4 - inch	30 to 60
No. 8	20 to 50
No. 50	3 to 12
No. 200 (by wet sieving)	0 to 1 (non-plastic fines)

An alternative to drainage sand and gravel is a 50-50 mixture of washed pea gravel (Mineral Aggregate Type 9) and washed sand (Mineral Aggregate Type 6).



TYPICAL CROSS SECTION

NOT - TO - SCALE

NOTES:

1. Possible caving soil conditions may require that the subdrain pipe and backfill be placed concurrently with the trench excavation.
2. Extend pipe by means of a tightline to a suitable discharge point. Where subdrain pipe changes to a tightline, provide impervious dam (concrete or clay) so as to force all water into the tightline.
3. Slotted subdrain pipe; tight joints; sloped to drain (6"/100' min. slope); provide clean-outs; min. diameter: 6".
4. Slotted pipe to have 1/8" maximum slot width.

Reference: Seattle Landslide Study

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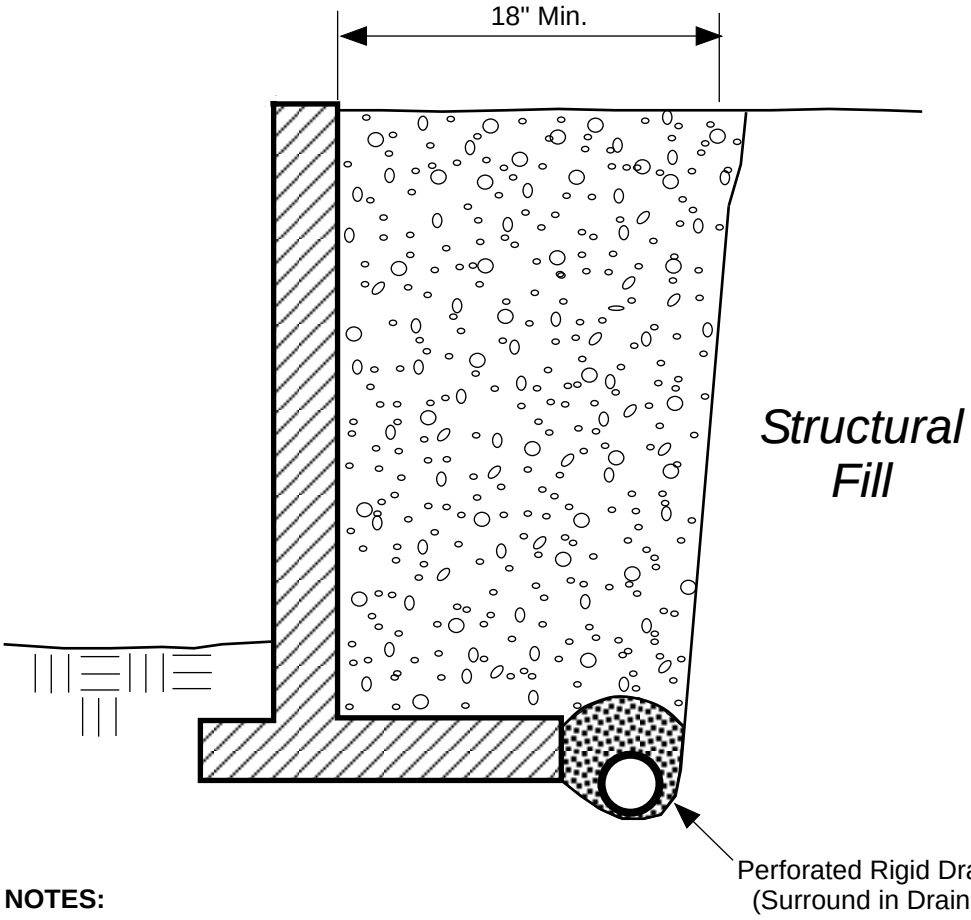
Typical Interceptor Trench Detail
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 3



NOTES:

- Free-draining Backfill should consist of soil having less than 5 percent fines. Percent passing No. 4 sieve should be 25 to 75 percent.
- Sheet Drain may be feasible in lieu of Free-draining Backfill, per ESNW recommendations.
- Drain Pipe should consist of perforated, rigid PVC Pipe surrounded with 1-inch Drain Rock.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Free-draining Structural Backfill

1-inch Drain Rock

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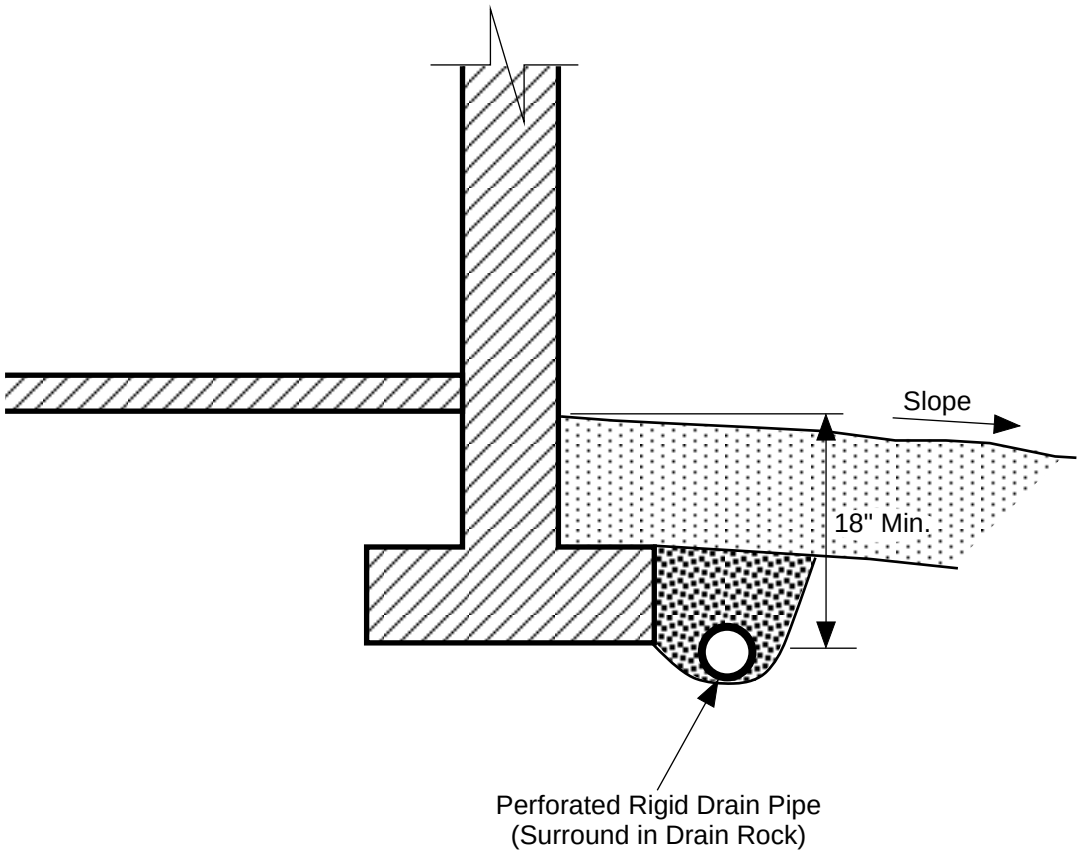
Retaining Wall Drainage Detail
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 4



NOTES:

- Do NOT tie roof downspouts to Footing Drain.
- Surface Seal to consist of 12" of less permeable, suitable soil. Slope away from building.

SCHEMATIC ONLY - NOT TO SCALE
NOT A CONSTRUCTION DRAWING

LEGEND:

Surface Seal: native soil or other low-permeability material.

1-inch Drain Rock

Earth Solutions NW LLC
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Footing Drain Detail
Kestrel Ridge
Monroe, Washington

Drwn. MRS	Date 12/24/2019	Proj. No. 5859.01
Checked SSR	Date Dec. 2019	Plate 5

Appendix A

Subsurface Exploration
Test Pit Logs

ES-5859.01

Subsurface conditions at the subject site were explored on February 2, 2018 by excavating five test pits and December 6, 2019 by excavating nine test pits using a trackhoe and operator retained by our firm. The approximate locations of the test pits are illustrated on Plate 2 of this study. The test pit logs are provided in this Appendix. The maximum exploration depth was approximately nine feet bgs.

The final logs represent the interpretations of the field logs and the results of laboratory analyses. The stratification lines on the logs represent the approximate boundaries between soil types. In actuality, the transitions may be more gradual.

Earth Solutions NW LLC

SOIL CLASSIFICATION CHART

MAJOR DIVISIONS			SYMBOLS		TYPICAL DESCRIPTIONS
			GRAPH	LETTER	
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	CLEAN GRAVELS (LITTLE OR NO FINES)		GW	WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
				GP	POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	GRAVELS WITH FINES (APPRECIABLE AMOUNT OF FINES)		GM	SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES
				GC	CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES
MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	SAND AND SANDY SOILS	CLEAN SANDS (LITTLE OR NO FINES)		SW	WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES
				SP	POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES
	MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	SANDS WITH FINES (APPRECIABLE AMOUNT OF FINES)		SM	SILTY SANDS, SAND - SILT MIXTURES
				SC	CLAYEY SANDS, SAND - CLAY MIXTURES
FINE GRAINED SOILS	SILTS AND CLAYS	LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY
				CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
				OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS	LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS
				CH	INORGANIC CLAYS OF HIGH PLASTICITY
				OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS				PT	PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS

DUAL SYMBOLS are used to indicate borderline soil classifications.

The discussion in the text of this report is necessary for a proper understanding of the nature of the material presented in the attached logs.

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-1

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 390 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 12": grass, duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown saturated TOPSOIL
		MC = 71.50%			1.0 389.0
			SM		Brown silty SAND with gravel, medium dense, wet -heavy groundwater seepage at 1'
					2.0 388.0
		MC = 37.00% Fines = 72.70%	ML		Brown sandy SILT with gravel, medium dense, wet [USDA Classification: slightly gravelly LOAM]
5		MC = 29.70%			5.0 385.0
					Test pit terminated at 5.0 feet below existing grade due to heavy seepage. Groundwater seepage encountered at 1.0 foot during excavation. No caving observed. Bottom of test pit at 5.0 feet.

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Fax: 425-449-4711

TEST PIT NUMBER TP-2

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 385 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** —

NOTES Depth of Topsoil & Sod 6": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		0.5 Dark brown highly organic TOPSOIL 384.5
		MC = 53.20%			Brown silty SAND with gravel, medium dense, moist
		MC = 25.20%			-heavy groundwater seepage from 2' to 2.5' -becomes gray, dense, weakly cemented
			SM		
5		MC = 18.40%			6.0 379.0
					Test pit terminated at 6.0 feet below existing grade. Groundwater seepage encountered from 2.0 to 2.5 feet during excavation. No caving observed. Bottom of test pit at 6.0 feet.

Earth Solutions NW
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TEST PIT NUMBER TP-3

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 385 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		Dark brown TOPSOIL, root intrusions to 2'	384.5
				0.5		
		MC = 106.10%	SM		Brown silty SAND, medium dense, wet -heavy groundwater seepage at 2'	
				3.0		382.0
		MC = 23.30%	GM		Brown silty GRAVEL with sand, dense, wet	
				4.0		381.0
					Test pit terminated at 4.0 feet below existing grade due to seepage. Groundwater seepage encountered at 2.0 feet during excavation. No caving observed. Bottom of test pit at 4.0 feet.	

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Bellevue, Washington 98005
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Fax: 425-449-4711

TEST PIT NUMBER TP-4

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 380 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Surface Conditions: grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		0.5 Dark brown highly organic TOPSOIL	379.5
		MC = 32.90%	SM		Brown silty SAND, medium dense, damp	
					-light groundwater seepage at 3'	
					-becomes gray, dense to very dense, weakly cemented	
		MC = 15.90%				
5						
		MC = 12.60% Fines = 24.00%			7.0 [USDA Classification: very gravelly sandy LOAM]	373.0
					Test pit terminated at 7.0 feet below existing grade. Groundwater seepage encountered at 3.0 feet during excavation. No caving observed. Bottom of test pit at 7.0 feet.	

Earth Solutions NW
1805 - 136th Place N.E., Suite 201
Bellevue, Washington 98005
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-5

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD

DATE STARTED 2/2/18 **COMPLETED** 2/2/18 **GROUND ELEVATION** 385 ft **TEST PIT SIZE**

EXCAVATION CONTRACTOR Client Provided **GROUND WATER LEVELS:**

EXCAVATION METHOD **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 3": grass **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION	
0			TPSL		0.3 Dark brown highly organic TOPSOIL	384.7
					Brown silty SAND, medium dense, wet	
		MC = 36.90%	SM		-heavy groundwater seepage at 2'	
					-becomes gray, dense, unweathered	
		MC = 15.20% Fines = 33.70%			4.0 [USDA Classification: gravelly fine sandy LOAM]	381.0
					Test pit terminated at 4.0 feet below existing grade. Groundwater seepage encountered at 2.0 feet during excavation. No caving observed. Bottom of test pit at 4.0 feet.	

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-101

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL
				0.5	
		MC = 5.10%	SM		Brown silty SAND with gravel, loose to medium dense, damp
					-moderate caving to BOH
				3.0	
		MC = 7.10% Fines = 2.70%	SP		Gray poorly graded SAND with gravel, medium dense, damp
					[USDA Classification: very gravelly SAND]
5					-increasing sand
		MC = 3.70%			
				7.0	
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 2.0 feet to BOH. Bottom of test pit at 7.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-102

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, shallow root intrusions
		MC = 16.50%	SM		Brown silty SAND with gravel, medium dense, damp -becomes gray -caving to BOH
5				5.0	
		MC = 3.60%	SP	7.0	Gray poorly graded SAND with gravel, medium dense, damp
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.0 feet to BOH. Bottom of test pit at 7.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-103

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 12": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 3'
				1.0	Gray silty SAND with gravel, medium dense, damp
		MC = 15.60%			-mottled texture
					-becomes gray
			SM		
5					
					-becomes dense
		MC = 20.00% Fines = 17.40%		7.5	[USDA Classification: very gravelly sandy LOAM]
					Test pit terminated at 7.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 7.5 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-104

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	TOPSOIL
					Brown silty SAND with gravel, medium dense, damp
		MC = 33.70%			
			SM		-becomes gray
5					-becomes moist
					-caving to BOH
		MC = 14.20%			
		MC = 10.90% Fines = 13.20%		7.0	[USDA Classification: loamy coarse SAND]
					Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 5.0 feet to BOH. Bottom of test pit at 7.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-105

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 3": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0					Brown silty SAND with gravel, loose to medium dense, damp
		MC = 31.90%			-becomes gray
					-becomes medium dense
			SM		
5		MC = 10.50%			
					-becomes dense
		MC = 12.50%			
					8.0
					Test pit terminated at 8.0 feet below existing grade. No groundwater encountered during excavation. No caving observed.
					Bottom of test pit at 8.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-106

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		0.5 Dark brown TOPSOIL, root intrusions to 1.5'
					Brown silty SAND with gravel, loose to medium dense, damp
		MC = 6.30%			-becomes gray, medium dense
5			SM		-slight caving to BOH
					-decrease silt content
					-becomes very dense
		MC = 6.60% Fines = 12.80%			9.0 [USDA Classification: very gravelly sandy LOAM]
					Test pit terminated at 9.0 feet below existing grade. No groundwater encountered during excavation. Caving observed from 4.5 feet to BOH. Bottom of test pit at 9.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-107

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL	0.5	Dark brown TOPSOIL, root intrusions to 1.5'
			SM		Brown silty SAND with gravel, medium dense, moist
		MC = 24.00%			-becomes wet -becomes gray
				4.0	
5			SP-SM		Gray poorly graded SAND with silt and gravel, medium dense, damp to moist
		MC = 8.50%		6.5	
					Test pit terminated at 6.5 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 6.5 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-108

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 1'
				0.5	Brown silty SAND with gravel, medium dense, moist
					-becomes wet
		MC = 24.10% Fines = 38.00%	SM		-becomes gray, dense [USDA Classification: slightly gravelly fine sandy LOAM]
5					-becomes moist -becomes very dense
		MC = 8.50%		7.0	Test pit terminated at 7.0 feet below existing grade. No groundwater encountered during excavation. No caving observed. Bottom of test pit at 7.0 feet.

Earth Solutions NW
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

TEST PIT NUMBER TP-109

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge

DATE STARTED 12/6/19 **COMPLETED** 12/6/19 **GROUND ELEVATION** _____ **TEST PIT SIZE** _____

EXCAVATION CONTRACTOR NW Excavating **GROUND WATER LEVELS:**

EXCAVATION METHOD _____ **AT TIME OF EXCAVATION** ---

LOGGED BY SES **CHECKED BY** SSR **AT END OF EXCAVATION** ---

NOTES Depth of Topsoil & Sod 6": duff **AFTER EXCAVATION** ---

DEPTH (ft)	SAMPLE TYPE NUMBER	TESTS	U.S.C.S.	GRAPHIC LOG	MATERIAL DESCRIPTION
0			TPSL		Dark brown TOPSOIL, root intrusions to 1'
				0.5	Brown silty SAND, medium dense, moist
		MC = 14.80%			-becomes wet -groundwater seepage
			SM		-becomes gray, dense
5					
		MC = 11.60%		7.5	Test pit terminated at 7.5 feet below existing grade. Groundwater seepage encountered at 2.5 feet during excavation. No caving observed. Bottom of test pit at 7.5 feet.

Appendix B

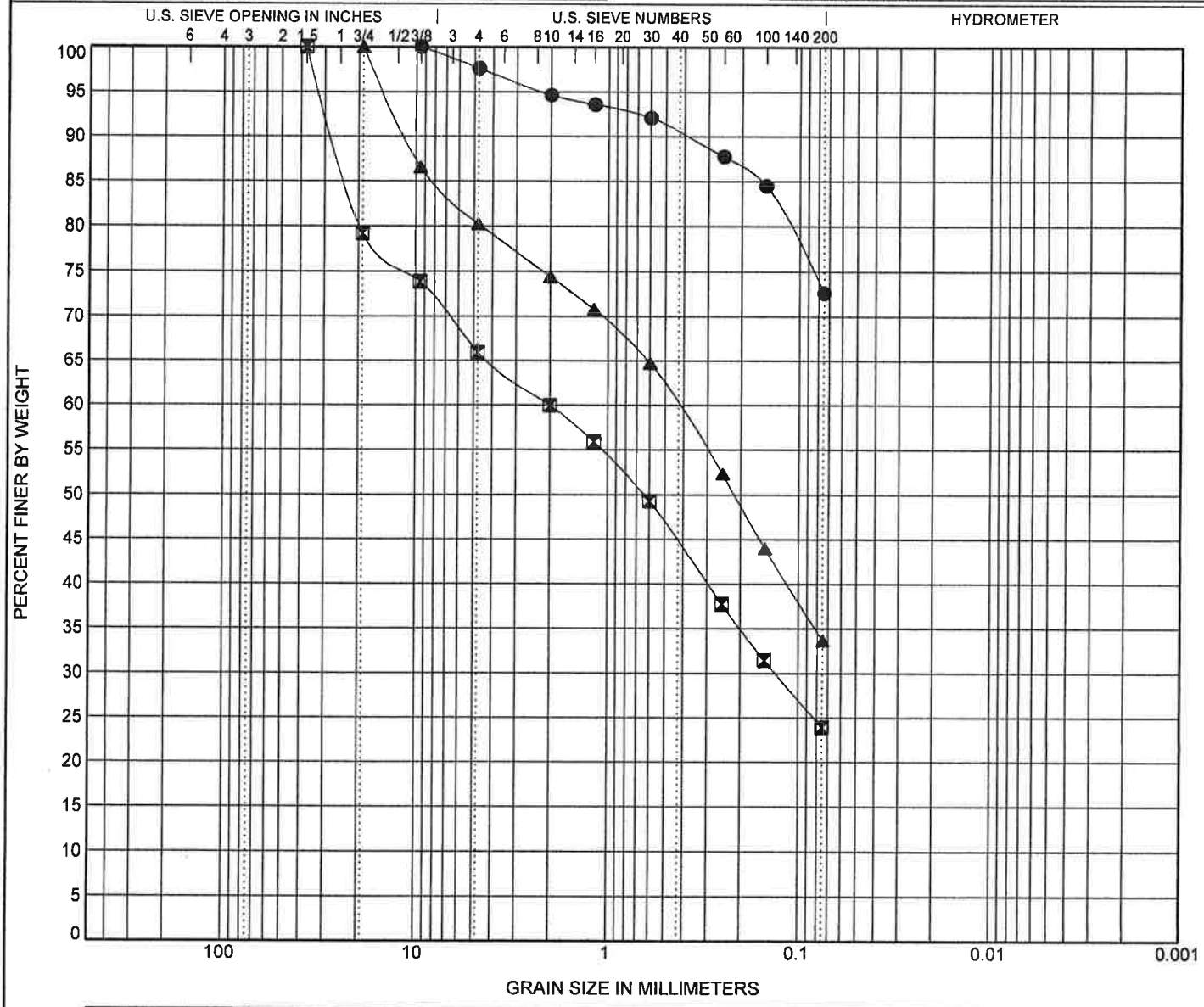
Laboratory Test Results

ES-5859.01

Earth Solutions NW, LLC
1805 - 136th PL N.E., Suite 201
Bellevue, WA 98005
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-5859 **PROJECT NAME** Chain Lake PRD



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

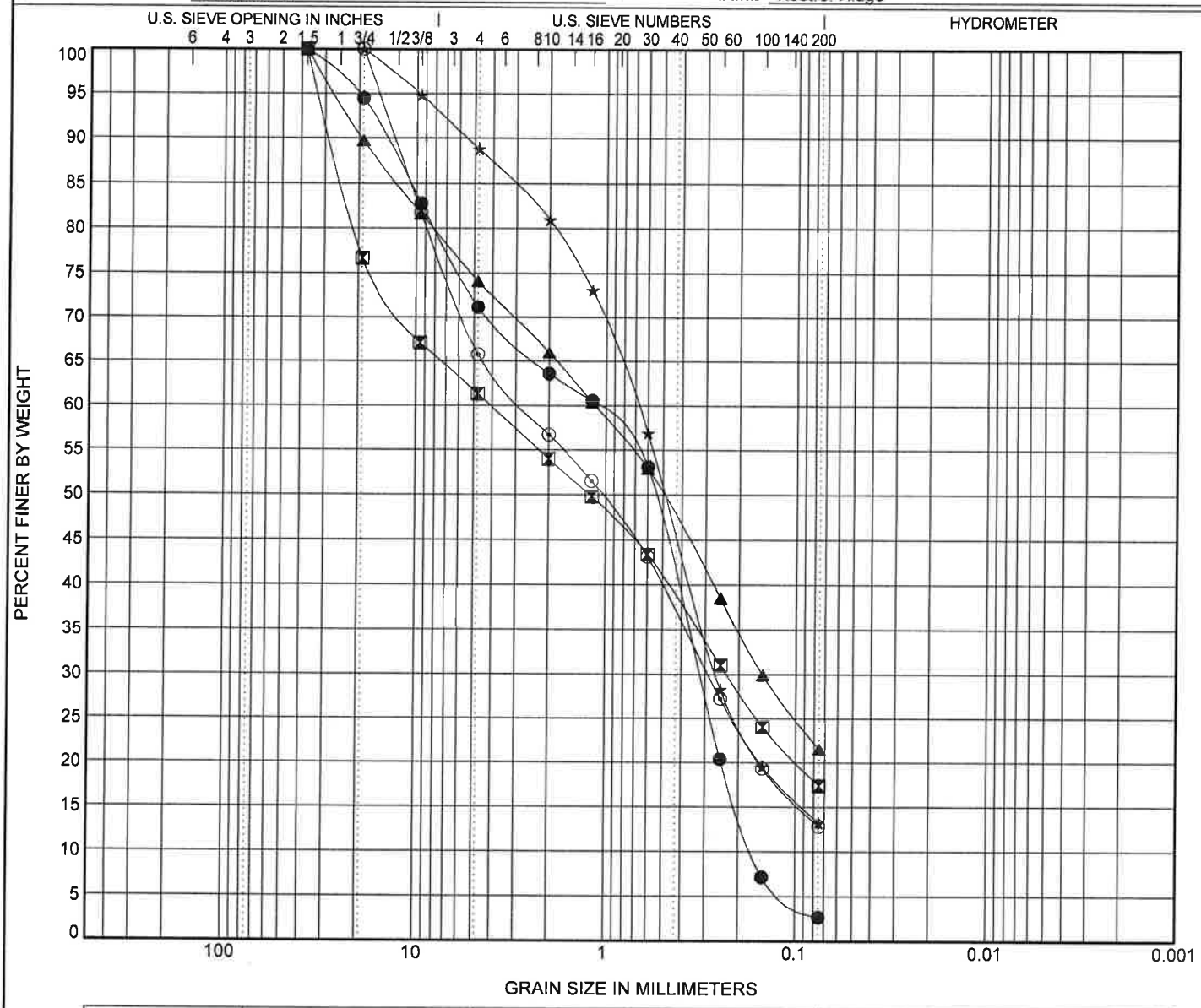
Specimen Identification		Classification	Cc	Cu
● TP-1	3.00ft.	**USDA: Brown Slightly Gravelly Loam. USCS: ML with Sand.**		
⊠ TP-4	7.00ft.	**USDA: Gray Very Gravelly Sandy Loam. USCS: SM with Gravel.**		
▲ TP-5	4.00ft.	**USDA: Gray Gravelly Fine Sandy Loam. USCS: SM with Gravel.**		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-1	3.0ft.	9.5							72.7	
⊠ TP-4	7.0ft.	37.5	2.018	0.131					24.0	
▲ TP-5	4.0ft.	19	0.429						33.7	

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	Cc	Cu
●	TP-101	4.00ft.	USDA: Brown Very Gravelly Sand. USCS: SP with Gravel.	0.56	6.71
⊠	TP-103	3.00ft.	USDA: Brown Very Gravelly Sandy Loam. USCS: SM with Gravel.		
▲	TP-103	7.50ft.	USDA: Gray Gravelly Sandy Loam. USCS: SM with Gravel.		
★	TP-104	7.00ft.	USDA: Gray Gravelly Loamy Coarse Sand. USCS: SM.		
⊙	TP-106	9.00ft.	USDA: Gray Very Gravelly Sandy Loam. USCS: SM with Gravel.		

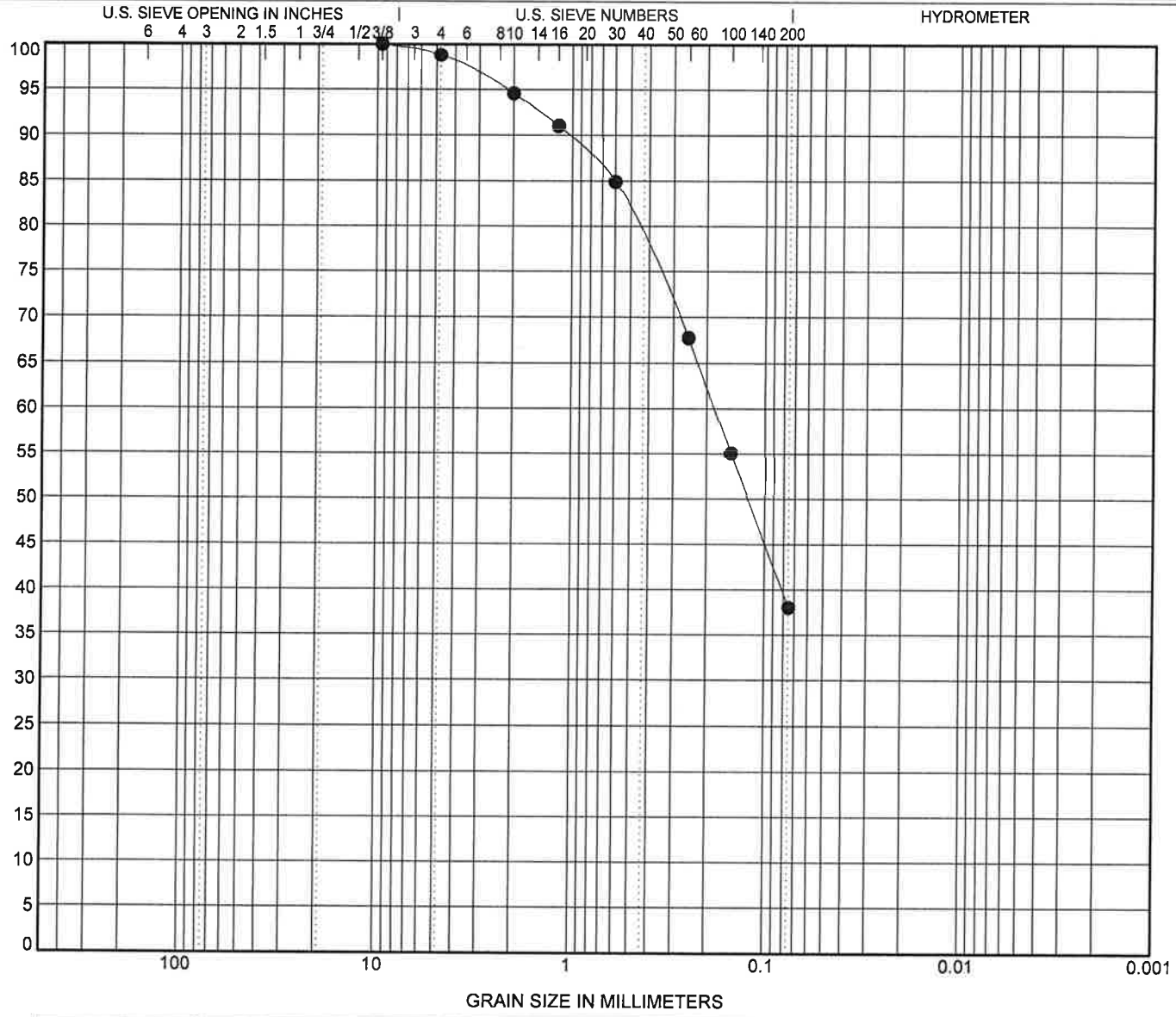
Specimen Identification			D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
●	TP-101	4.0ft.	37.5	1.124	0.323	0.168				2.7	
⊠	TP-103	3.0ft.	37.5	4.07	0.232					17.4	
▲	TP-103	7.5ft.	37.5	1.143	0.151					21.5	
★	TP-104	7.0ft.	19	0.683	0.264					13.2	
⊙	TP-106	9.0ft.	19	2.74	0.291					12.8	

GRAIN SIZE USDA ES-5859.01 KESTREL RIDGE.GPJ GINT US LAB.GDT 12/13/19

Earth Solutions NW, LLC
15365 N.E. 90th Street, Suite 100
Redmond, Washington 98052
Telephone: 425-449-4704
Fax: 425-449-4711

GRAIN SIZE DISTRIBUTION

PROJECT NUMBER ES-5859.01 **PROJECT NAME** Kestrel Ridge



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification		Classification	Cc	Cu
● TP-108	3.00ft.	**USDA: Gray Slightly Gravelly Fine Sandy Loam. USCS: SM.**		

Specimen Identification		D100	D60	D30	D10	LL	PL	PI	%Silt	%Clay
● TP-108	3.0ft.	**9.5**	**0.183**						**38.0**	

GRAIN SIZE USDA ES-5859.01 KESTREL RIDGE.GPJ GINT US LAB.GDT 12/13/19

Report Distribution

ES-5859.01

EMAIL ONLY

Taylor Development, Inc.
15 Lake Bellevue Drive, Suite 102
Bellevue, Washington 98005

Attention: Mr. Robert Fitzmaurice

CP|H
CONSULTANTS

APPENDIX B

WWMH INPUT PARAMETERS AND RESULTS

	TOTAL AREA		TOTAL IMPERVIOUS		TOTAL PERVIOUS		ROAD/PAT		LOT IMPERVIOUS		WALK		LOT LAWN		OTHER PERVIOUS		FOREST		POND	
	SF	AC	SF	AC	SF	AC	SF	AC	SF	AC	SF	AC	SF	AC	SF	AC	SF	AC	SF	AC
ON SITE	370,626	8.508	208,580	4.788	162,046	3.720	48,217	1.107	119,376	2.740	13,815	0.317	79,584	1.827	66,871	1.535	0	0.000	27172	0.624
FRONTAGE	12,894	0.296	4,193	0.096	8,701	0.200	3,049	0.070	0	0.000	1,144	0.026	0	0.000	9,809	0.225	0	0.000	0	0
UPSTREAM 1	144,837	3.325	28,837	0.662	116,000	2.663	0	0.000	28,837	0.662	0	0.000	54,458	1.250	0	0.000	61,542	1.413	0	0
UPSTREAM 2	16,483	0.378	4,800	0.110	11,683	0.268	0	0.000	4,800	0.110	0	0.000	11,683	0.268	0	0.000	0	0.000	0	0
BYPASS	14,456	0.332	12,415	0.285	2,041	0.047	0	0.000	0	0.000	12,415	0.285	0	0.000	2,041	0.047	0	0.000	0	0

WWHM2012

PROJECT REPORT

General Model Information

Project Name:	POND SSD 191220 CMT
Site Name:	Kestrel Ridge
Site Address:	
City:	Monroe, WA
Report Date:	12/24/2019
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2019/09/13
Version:	4.2.17

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

UPSTREAM 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Mod	1.413
C, Lawn, Mod	1.25
Pervious Total	2.663

Impervious Land Use	acre
ROOF TOPS FLAT	0.662
Impervious Total	0.662
Basin Total	3.325

Element Flows To:

Surface	Interflow	Groundwater

BYPASS

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	0.332
Pervious Total	0.332
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.332

Element Flows To:

Surface	Interflow	Groundwater

ON SITE

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Mod	8.51
Pervious Total	8.51

Impervious Land Use	acre
Impervious Total	0
Basin Total	8.51

Element Flows To:

Surface	Interflow	Groundwater

FRONTAGE

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	0.296
Pervious Total	0.296
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.296

Element Flows To:

Surface	Interflow	Groundwater

UPSTREAM 2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	0.268
Pervious Total	0.268

Impervious Land Use	acre
ROOF TOPS FLAT	0.11
Impervious Total	0.11
Basin Total	0.378

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

UPSTREAM 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Mod	1.413
C, Lawn, Mod	1.25
Pervious Total	2.663

Impervious Land Use	acre
ROOF TOPS FLAT	0.662
Impervious Total	0.662
Basin Total	3.325

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

BYPASS

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	0.047
Pervious Total	0.047

Impervious Land Use	acre
ROADS MOD	0.229
SIDEWALKS MOD	0.056
Impervious Total	0.285
Basin Total	0.332

Element Flows To:

Surface	Interflow	Groundwater

ON SITE

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	3.72
Pervious Total	3.72

Impervious Land Use	acre
ROADS MOD	1.107
ROOF TOPS FLAT	2.74
SIDEWALKS MOD	0.317
POND	0.624
Impervious Total	4.788
Basin Total	8.508

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

FRONTAGE

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	0.2
Pervious Total	0.2

Impervious Land Use	acre
ROADS MOD	0.07
SIDEWALKS MOD	0.026
Impervious Total	0.096
Basin Total	0.296

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

UPSTREAM 2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	0.268
Pervious Total	0.268

Impervious Land Use	acre
ROOF TOPS FLAT	0.11
Impervious Total	0.11
Basin Total	0.378

Element Flows To:

Surface	Interflow	Groundwater
SSD Table 1	SSD Table 1	

Routing Elements
Predeveloped Routing

Mitigated Routing

SSD Table 1

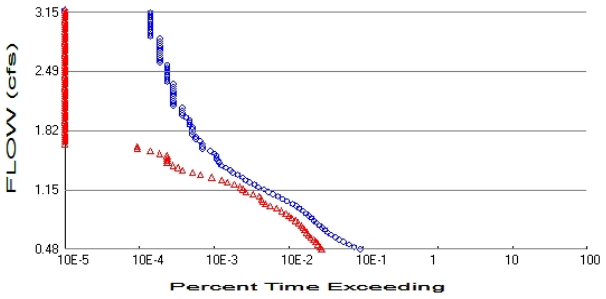
Depth: 8 ft.
Discharge Structure: 1
Riser Height: 7 ft.
Riser Diameter: 18 in.
Orifice 1 Diameter: 2.5 in. Elevation:0 ft.
Orifice 2 Diameter: 5 in. Elevation:5.5 ft.
Orifice 3 Diameter: 1 in. Elevation:6.5 ft.
Element Flows To:
Outlet 1 Outlet 2

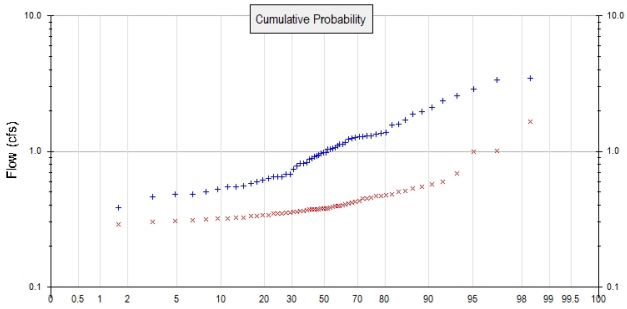
SSD Table Hydraulic Table

Stage (feet)	Area (ac.)	Volume (ac-ft.)	Outlet Struct	NotUsed	NotUsed	NotUsed	NotUsed
0.000	0.294	0.000	0.000	0.000	0.000	0.000	0.000
1.000	0.337	0.315	0.170	0.000	0.000	0.000	0.000
3.000	0.427	1.079	0.294	0.000	0.000	0.000	0.000
5.000	0.522	2.028	0.379	0.000	0.000	0.000	0.000
7.000	0.624	3.173	1.299	0.000	0.000	0.000	0.000
8.000	0.679	3.825	8.672	0.000	0.000	0.000	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 12.069
Total Impervious Area: 0.772

Mitigated Landuse Totals for POC #1
Total Pervious Area: 6.898
Total Impervious Area: 5.941

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.955665
5 year	1.516211
10 year	1.959608
25 year	2.606705
50 year	3.154931
100 year	3.76255

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.395197
5 year	0.523327
10 year	0.621171
25 year	0.760407
50 year	0.8761
100 year	1.002629

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	1.290	0.347
1950	1.381	0.389
1951	0.811	0.346
1952	0.943	0.349
1953	1.099	0.339
1954	2.878	0.469
1955	1.286	0.418
1956	0.735	0.396
1957	1.294	0.458
1958	2.572	0.596

1959	0.829	0.386
1960	1.127	0.395
1961	3.482	0.688
1962	0.974	0.375
1963	1.713	0.413
1964	0.980	0.301
1965	0.459	0.339
1966	0.480	0.276
1967	0.892	0.507
1968	1.043	0.399
1969	3.387	0.570
1970	0.673	0.313
1971	1.134	0.374
1972	1.259	0.479
1973	0.971	0.374
1974	1.597	0.428
1975	1.157	0.359
1976	0.614	0.378
1977	0.528	0.332
1978	0.593	0.313
1979	1.966	0.478
1980	0.931	0.361
1981	0.674	0.307
1982	0.627	0.426
1983	1.306	0.373
1984	0.810	0.393
1985	1.073	0.409
1986	2.097	1.005
1987	0.875	0.471
1988	0.783	0.365
1989	1.031	0.320
1990	0.651	0.381
1991	0.580	0.370
1992	0.918	0.356
1993	0.648	0.325
1994	0.484	0.378
1995	0.550	0.381
1996	1.341	0.447
1997	2.366	1.658
1998	1.051	0.375
1999	0.557	0.332
2000	1.348	0.530
2001	0.317	0.289
2002	0.500	0.352
2003	0.383	0.323
2004	1.253	0.547
2005	0.545	0.352
2006	1.882	0.504
2007	1.561	0.450
2008	1.231	0.992
2009	0.649	0.319

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	3.4816	1.6584
2	3.3873	1.0045
3	2.8783	0.9917

4	2.5720	0.6881
5	2.3659	0.5957
6	2.0970	0.5703
7	1.9657	0.5471
8	1.8825	0.5297
9	1.7134	0.5069
10	1.5967	0.5036
11	1.5607	0.4787
12	1.3814	0.4779
13	1.3482	0.4710
14	1.3414	0.4688
15	1.3060	0.4578
16	1.2939	0.4497
17	1.2901	0.4473
18	1.2863	0.4276
19	1.2587	0.4262
20	1.2531	0.4179
21	1.2309	0.4126
22	1.1568	0.4092
23	1.1335	0.3989
24	1.1266	0.3958
25	1.0986	0.3953
26	1.0734	0.3933
27	1.0506	0.3892
28	1.0426	0.3864
29	1.0307	0.3812
30	0.9804	0.3808
31	0.9744	0.3782
32	0.9710	0.3775
33	0.9433	0.3754
34	0.9311	0.3751
35	0.9176	0.3745
36	0.8924	0.3739
37	0.8753	0.3732
38	0.8286	0.3705
39	0.8111	0.3653
40	0.8099	0.3611
41	0.7826	0.3594
42	0.7350	0.3558
43	0.6743	0.3519
44	0.6734	0.3517
45	0.6513	0.3487
46	0.6493	0.3465
47	0.6484	0.3457
48	0.6269	0.3387
49	0.6139	0.3386
50	0.5931	0.3320
51	0.5803	0.3317
52	0.5569	0.3251
53	0.5504	0.3230
54	0.5447	0.3201
55	0.5278	0.3193
56	0.4995	0.3131
57	0.4842	0.3126
58	0.4800	0.3070
59	0.4594	0.3008
60	0.3827	0.2892
61	0.3166	0.2759

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.4778	1959	586	29	Pass
0.5049	1610	560	34	Pass
0.5319	1365	529	38	Pass
0.5590	1163	496	42	Pass
0.5860	1014	460	45	Pass
0.6130	906	423	46	Pass
0.6401	798	395	49	Pass
0.6671	718	372	51	Pass
0.6942	654	347	53	Pass
0.7212	603	331	54	Pass
0.7482	547	311	56	Pass
0.7753	510	288	56	Pass
0.8023	463	264	57	Pass
0.8294	430	234	54	Pass
0.8564	398	215	54	Pass
0.8835	362	196	54	Pass
0.9105	331	171	51	Pass
0.9375	295	147	49	Pass
0.9646	270	120	44	Pass
0.9916	239	103	43	Pass
1.0187	202	96	47	Pass
1.0457	175	92	52	Pass
1.0727	154	86	55	Pass
1.0998	131	71	54	Pass
1.1268	113	57	50	Pass
1.1539	99	52	52	Pass
1.1809	83	48	57	Pass
1.2080	74	40	54	Pass
1.2350	63	32	50	Pass
1.2620	56	27	48	Pass
1.2891	52	20	38	Pass
1.3161	44	14	31	Pass
1.3432	38	11	28	Pass
1.3702	35	8	22	Pass
1.3972	31	7	22	Pass
1.4243	27	6	22	Pass
1.4513	25	5	20	Pass
1.4784	24	5	20	Pass
1.5054	23	5	21	Pass
1.5324	23	5	21	Pass
1.5595	22	4	18	Pass
1.5865	19	3	15	Pass
1.6136	15	2	13	Pass
1.6406	15	2	13	Pass
1.6677	15	0	0	Pass
1.6947	14	0	0	Pass
1.7217	12	0	0	Pass
1.7488	12	0	0	Pass
1.7758	11	0	0	Pass
1.8029	11	0	0	Pass
1.8299	11	0	0	Pass
1.8569	11	0	0	Pass
1.8840	10	0	0	Pass

1.9110	10	0	0	Pass
1.9381	10	0	0	Pass
1.9651	9	0	0	Pass
1.9922	8	0	0	Pass
2.0192	8	0	0	Pass
2.0462	8	0	0	Pass
2.0733	8	0	0	Pass
2.1003	6	0	0	Pass
2.1274	6	0	0	Pass
2.1544	6	0	0	Pass
2.1814	6	0	0	Pass
2.2085	6	0	0	Pass
2.2355	6	0	0	Pass
2.2626	6	0	0	Pass
2.2896	6	0	0	Pass
2.3166	6	0	0	Pass
2.3437	6	0	0	Pass
2.3707	5	0	0	Pass
2.3978	5	0	0	Pass
2.4248	5	0	0	Pass
2.4519	5	0	0	Pass
2.4789	5	0	0	Pass
2.5059	5	0	0	Pass
2.5330	5	0	0	Pass
2.5600	5	0	0	Pass
2.5871	4	0	0	Pass
2.6141	4	0	0	Pass
2.6411	4	0	0	Pass
2.6682	4	0	0	Pass
2.6952	4	0	0	Pass
2.7223	4	0	0	Pass
2.7493	4	0	0	Pass
2.7764	4	0	0	Pass
2.8034	4	0	0	Pass
2.8304	4	0	0	Pass
2.8575	4	0	0	Pass
2.8845	3	0	0	Pass
2.9116	3	0	0	Pass
2.9386	3	0	0	Pass
2.9656	3	0	0	Pass
2.9927	3	0	0	Pass
3.0197	3	0	0	Pass
3.0468	3	0	0	Pass
3.0738	3	0	0	Pass
3.1008	3	0	0	Pass
3.1279	3	0	0	Pass
3.1549	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.5023 acre-feet
On-line facility target flow:	0.2595 cfs.
Adjusted for 15 min:	0.2595 cfs.
Off-line facility target flow:	0.1699 cfs.
Adjusted for 15 min:	0.1699 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
SSD Table 1 POC	☐	1612.58			☐	0.00			
Total Volume Infiltrated		1612.58	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

Model Default Modifications

Total of 0 changes have been made.

PERLND Changes

No PERLND changes have been made.

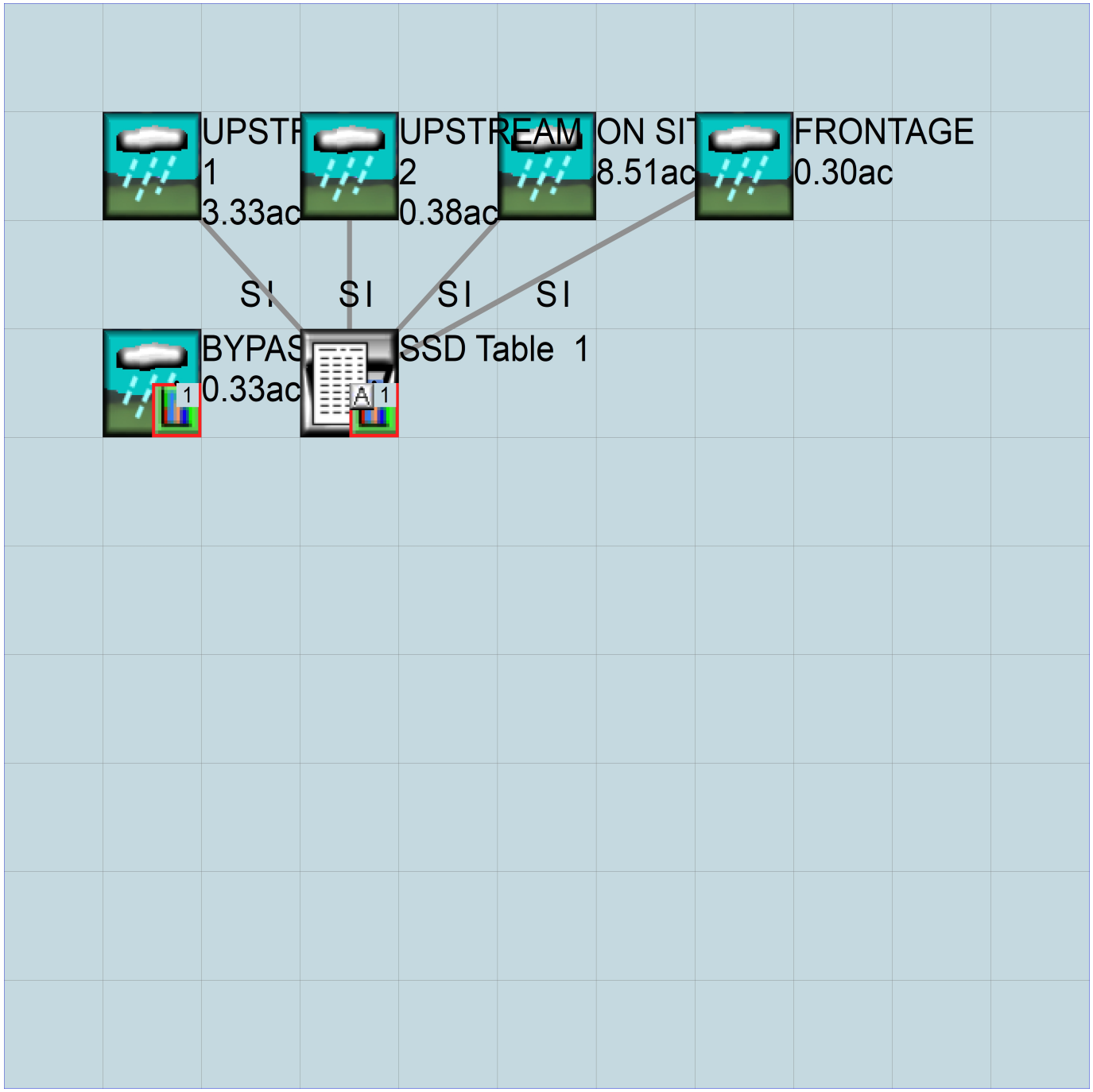
IMPLND Changes

No IMPLND changes have been made.

Appendix

Predeveloped Schematic

Mitigated Schematic



Predeveloped UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       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   POND SSD 191220 CMT.wdm
MESSU       25   PrePOND SSD 191220 CMT.MES
            27   PrePOND SSD 191220 CMT.L61
            28   PrePOND SSD 191220 CMT.L62
            30   POCPOND SSD 191220 CMT1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      PERLND      17
      IMPLND       4
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        UPSTREAM 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           ***
   11     C, Forest, Mod          1    1    1    1   27    0
   17     C, Lawn, Mod            1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   11         0    0    1    0    0    0    0    0    0    0    0    0
   17         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
```

```
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   11         0    0    0    0    0    0    0    0    0    0    0
   17         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   11              0       4.5      0.08       400       0.1       0.5     0.996
   17              0       4.5      0.03       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   11              0         0         2         2         0         0         0
   17              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   11            0.2       0.5      0.35         6       0.5       0.7
   17            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

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

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    4      ROOF TOPS/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
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    4         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
  END IWAT-PARM1

  IWAT-PARM2
```

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

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
UPSTREAM 1***
PERLND  11                       1.413     COPY   501     12
PERLND  11                       1.413     COPY   501     13
PERLND  17                        1.25     COPY   501     12
PERLND  17                        1.25     COPY   501     13
IMPLND   4                       0.662     COPY   501     15
BYPASS***
PERLND  11                       0.332     COPY   501     12
PERLND  11                       0.332     COPY   501     13
ON SITE***
PERLND  11                        8.51     COPY   501     12
PERLND  11                        8.51     COPY   501     13
FRONTAGE***
PERLND  11                       0.296     COPY   501     12
PERLND  11                       0.296     COPY   501     13
UPSTREAM 2***
PERLND  17                       0.268     COPY   501     12
PERLND  17                       0.268     COPY   501     13
IMPLND   4                        0.11     COPY   501     15

******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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
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   POND SSD 191220 CMT.wdm
MESSU       25   MitPOND SSD 191220 CMT.MES
            27   MitPOND SSD 191220 CMT.L61
            28   MitPOND SSD 191220 CMT.L62
            30   POCPOND SSD 191220 CMT1.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      11
      PERLND      17
      IMPLND       4
      IMPLND       2
      IMPLND       9
      IMPLND      14
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        SSD Table  1                MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   11     C, Forest, Mod          1    1    1    1   27    0
   17     C, Lawn, Mod            1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

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

```
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   11         0    0    1    0    0    0    0    0    0    0    0    0
   17         0    0    1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   11         0    0    0    0    0    0    0    0    0    0    0
   17         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   11              0       4.5      0.08       400       0.1       0.5     0.996
   17              0       4.5      0.03       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   11              0         0         2         2         0         0         0
   17              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   11          0.2       0.5      0.35         6       0.5       0.7
   17          0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

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

END PERLND

IMPLND
  GEN-INFO
    <PLS ><-------Name------->   Unit-systems   Printer ***
    # -  #                     User  t-series Engl Metr ***
                                     in  out           ***
    4      ROOF TOPS/FLAT         1    1    1   27    0
    2      ROADS/MOD              1    1    1   27    0
    9      SIDEWALKS/MOD          1    1    1   27    0
   14      POND                   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
    2         0    0    1    0    0    0
    9         0    0    1    0    0    0
   14         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
    2         0    0    4    0    0    0    1    9
    9         0    0    4    0    0    0    1    9
   14         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
    2         0    0    0    0    0
    9         0    0    0    0    0
   14         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
    2            400      0.05       0.1      0.08
    9            400      0.05       0.1      0.08
   14            400      0.01       0.1       0.1
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    4              0         0
    2              0         0
    9              0         0
   14              0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    4              0         0
    2              0         0
    9              0         0
   14              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
UPSTREAM 1***
PERLND  11                      1.413     RCHRES   1      2
PERLND  11                      1.413     RCHRES   1      3
PERLND  17                       1.25     RCHRES   1      2
PERLND  17                       1.25     RCHRES   1      3
IMPLND   4                      0.662     RCHRES   1      5
ON SITE***
PERLND  17                       3.72     RCHRES   1      2
PERLND  17                       3.72     RCHRES   1      3
IMPLND   2                      1.107     RCHRES   1      5
IMPLND   4                       2.74     RCHRES   1      5
IMPLND   9                      0.317     RCHRES   1      5
IMPLND  14                      0.624     RCHRES   1      5
FRONTAGE***
PERLND  17                        0.2     RCHRES   1      2
PERLND  17                        0.2     RCHRES   1      3
IMPLND   2                       0.07     RCHRES   1      5
IMPLND   9                      0.026     RCHRES   1      5
UPSTREAM 2***
PERLND  17                      0.268     RCHRES   1      2
```

```
PERLND  17                      0.268     RCHRES   1      3
IMPLND   4                       0.11     RCHRES   1      5
BYPASS***
PERLND  17                      0.047     COPY   501     12
PERLND  17                      0.047     COPY   601     12
PERLND  17                      0.047     COPY   501     13
PERLND  17                      0.047     COPY   601     13
IMPLND   2                      0.229     COPY   501     15
IMPLND   2                      0.229     COPY   601     15
IMPLND   9                      0.056     COPY   501     15
IMPLND   9                      0.056     COPY   601     15

******Routing******
PERLND  11                      1.413     COPY     1     12
PERLND  17                       1.25     COPY     1     12
IMPLND   4                      0.662     COPY     1     15
PERLND  11                      1.413     COPY     1     13
PERLND  17                       1.25     COPY     1     13
PERLND  17                       3.72     COPY     1     12
IMPLND   2                      1.107     COPY     1     15
IMPLND   4                       2.74     COPY     1     15
IMPLND   9                      0.317     COPY     1     15
IMPLND  14                      0.624     COPY     1     15
PERLND  17                       3.72     COPY     1     13
PERLND  17                        0.2     COPY     1     12
IMPLND   2                       0.07     COPY     1     15
IMPLND   9                      0.026     COPY     1     15
PERLND  17                        0.2     COPY     1     13
PERLND  17                      0.268     COPY     1     12
IMPLND   4                       0.11     COPY     1     15
PERLND  17                      0.268     COPY     1     13
RCHRES   1                          1     COPY   501     16
END SCHEMATIC

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



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

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

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

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

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

```
            *  *  *  *    *  *  *  *  *       *  *  *  *  *         ***
    1       0  1  0  0    4  0  0  0  0       0  0  0  0  0       2  2  2  2  2
  END HYDR-PARM1

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
    6    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.294000  0.000000  0.000000
  1.000000  0.337000  0.315000  0.169605
  3.000000  0.427000  1.079000  0.293765
  5.000000  0.522000  2.028000  0.379248
  7.000000  0.624000  3.173000  1.298813
  8.000000  0.679000  3.825000  8.672295
  END FTABLE  1
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2            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     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
RCHRES   1 HYDR   RO     1 1       1       WDM   1004 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1       1       WDM   1005 STAG     ENGL      REPL
END EXT TARGETS

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

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

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

  MASS-LINK       12
```

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

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

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

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


END MASS-LINK

END RUN
```

Predeveloped HSPF Message File

Mitigated HSPF Message File

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APPENDIX C

OPERATIONS AND MAINTENANCE MANUAL

V-4.6 Maintenance Standards for Drainage Facilities

The facility-specific maintenance standards contained in this section are intended to be conditions for determining if maintenance actions are required as identified through inspection. They are not intended to be measures of the facility's required condition at all times between inspections. In other words, exceedence of these conditions at any time between inspections and/or maintenance does not automatically constitute a violation of these standards. However, based upon inspection observations, the inspection and maintenance schedules shall be adjusted to minimize the length of time that a facility is in a condition that requires a maintenance action.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
General	Trash & Debris	Any trash and debris which exceed 1 cubic feet per 1,000 square feet. In general, there should be no visual evidence of dumping. If less than threshold all trash and debris will be removed as part of next scheduled maintenance.	Trash and debris cleared from site
	Poisonous Vegetation and noxious weeds	Any poisonous or nuisance vegetation which may constitute a hazard to maintenance personnel or the public. Any evidence of noxious weeds as defined by State or local regulations. (Apply requirements of adopted IPM policies for the use of herbicides).	No danger of poisonous vegetation where maintenance personnel or the public might normally be. (Coordinate with local health department) Complete eradication of noxious weeds may not be possible. Compliance with State or local eradication policies required
	Contaminants	Any evidence of oil,	No contaminants or pol-

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
	and Pollution	gasoline, contaminants or other pollutants (Coordinate removal/cleanup with local water quality response agency).	lutants present.
	Rodent Holes	Any evidence of rodent holes if facility is acting as a dam or berm, or any evidence of water piping through dam or berm via rodent holes.	Rodents destroyed and dam or berm repaired. (Coordinate with local health department; coordinate with Ecology Dam Safety Office if pond exceeds 10 acre-feet.)
	Beaver Dams	Dam results in change or function of the facility.	Facility is returned to design function. (Coordinate trapping of beavers and removal of dams with appropriate permitting agencies)
	Insects	When insects such as wasps and hornets interfere with maintenance activities.	Insects destroyed or removed from site. Apply insecticides in compliance with adopted IPM policies
	Tree Growth and Hazard Trees	Tree growth does not allow maintenance access or interferes with maintenance activity (i.e., slope mowing, silt removal, vactoring, or equipment movements). If trees are not interfering with access or maintenance, do not remove	Trees do not hinder maintenance activities. Harvested trees should be recycled into mulch or other beneficial uses (e.g., alders for firewood). Remove hazard Trees

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		If dead, diseased, or dying trees are identified (Use a certified Arborist to determine health of tree or removal requirements)	
Side Slopes of Pond	Erosion	Eroded damage over 2 inches deep where cause of damage is still present or where there is potential for continued erosion. Any erosion observed on a compacted berm embankment.	Slopes should be stabilized using appropriate erosion control measure (s); e.g.,rock reinforcement, planting of grass, compaction. If erosion is occurring on compacted berms a licensed civil engineer should be consulted to resolve source of erosion.
Storage Area	Sediment	Accumulated sediment that exceeds 10% of the designed pond depth unless otherwise specified or affects inletting or outletting condition of the facility.	Sediment cleaned out to designed pond shape and depth; pond reseeded if necessary to control erosion.
	Liner (if Applicable)	Liner is visible and has more than three 1/4-inch holes in it.	Liner repaired or replaced. Liner is fully covered.
Ponds Berms (Dikes)	Settlements	Any part of berm which has settled 4 inches lower than the design elevation If settlement is apparent, measure berm to determine amount of settlement	Dike is built back to the design elevation.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		Settling can be an indication of more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	
	Piping	Discernable water flow through pond berm. Ongoing erosion with potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	Piping eliminated. Erosion potential resolved.
Emergency Overflow/ Spillway and Berms over 4 feet in height	Tree Growth	Tree growth on emergency spillways creates blockage problems and may cause failure of the berm due to uncontrolled overtopping. Tree growth on berms over 4 feet in height may lead to piping through the berm which could lead to failure of the berm.	Trees should be removed. If root system is small (base less than 4 inches) the root system may be left in place. Otherwise the roots should be removed and the berm restored. A licensed civil engineer should be consulted for proper berm/spillway restoration.
	Piping	Discernable water flow through pond berm. Ongoing erosion with	Piping eliminated. Erosion potential resolved.

Table V-4.5.2(1) Maintenance Standards - Detention Ponds (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		potential for erosion to continue. (Recommend a Goethechnical engineer be called in to inspect and evaluate condition and recommend repair of condition.	
Emergency Overflow/Spillway	Emergency Overflow/Spillway	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil at the top of out flow path of spillway. (Rip-rap on inside slopes need not be replaced.)	Rocks and pad depth are restored to design standards.
	Erosion	See "Side Slopes of Pond"	

Table V-4.5.2(2) Maintenance Standards - 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	Sediment is removed

Table V-4.5.2(3) Maintenance Standards - Closed Detention Systems (Tanks/Vaults) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	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 (may not apply to self-locking lids).	Mechanism opens with proper tools.
	Cover Difficult to Remove	One maintenance person cannot remove lid after applying normal lifting pressure. Intent is to keep cover from sealing off access to maintenance.	Cover can be removed and reinstalled by one maintenance person.
	Ladder Rungs Unsafe	Ladder is unsafe due to missing rungs, misalignment, not securely attached to structure wall, rust, or cracks.	Ladder meets design standards. Allows maintenance person safe access.
Catch Basins	See "Catch Basins" (No. 5)	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as

Table V-4.5.2(4) Maintenance Standards - Control Structure/Flow Restrictor (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).	See "Closed Detention Systems" (No. 3).
Catch Basin	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(5) Maintenance Standards - 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%. 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. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. 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 is sit-

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
		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	ting 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. 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.	Basin replaced or repaired to design standards. 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. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See "Detention Ponds" (No. 1).	No pollution present.
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	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into	Mechanism opens with

Table V-4.5.2(5) Maintenance Standards - Catch Basins (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
	Working	frame have less than 1/2 inch of thread.	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.

Table V-4.5.2(6) Maintenance Standards - 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 are bent out of shape more than 3 inches.	Bars in place with no bends more than 3/4

Table V-4.5.2(6) Maintenance Standards - Debris Barriers (e.g., Trash Racks) (continued)

Maintenance Components	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Bars.	Bars are missing or entire barrier missing. Bars are loose and rust is causing 50% deterioration to any part of barrier.	inch. Bars in place according to design. Barrier replaced or repaired to design standards.
	Inlet/Outlet Pipe	Debris barrier missing or not attached to pipe	Barrier firmly attached to pipe

Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
External:			
Rock Pad	Missing or Moved Rock	Only one layer of rock exists above native soil in area five square feet or larger, or any exposure of native soil.	Rock pad replaced to design standards.
	Erosion	Soil erosion in or adjacent to rock pad.	Rock pad replaced to design standards.
Dispersion Trench	Pipe Plugged with Sediment	Accumulated sediment that exceeds 20% of the design depth.	Pipe cleaned/-flushed so that it matches design.
	Not Discharging Water Properly	Visual evidence of water discharging at concentrated points along trench (normal condition is a "sheet flow" of water along trench). Intent is to prevent erosion damage.	Trench redesigned or rebuilt to standards.
	Perforations Plugged.	Over 1/2 of perforations in pipe are plugged with debris and sediment.	Perforated pipe cleaned or replaced.

Table V-4.5.2(7) Maintenance Standards - Energy Dissipaters (continued)

Maintenance Components	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
	Water Flows Out Top of "Distributor" Catch Basin.	Maintenance person observes or receives credible report of water flowing out during any storm less than the design storm or its causing or appears likely to cause damage.	Facility rebuilt or redesigned to standards.
	Receiving Area Over-Saturated	Water in receiving area is causing or has potential of causing landslide problems.	No danger of landslides.
Internal:			
Manhole/Chamber	Worn or Damaged Post, Baffles, Side of Chamber	Structure dissipating flow deteriorates to 1/2 of original size or any concentrated worn spot exceeding one square foot which would make structure unsound.	Structure replaced to design standards.
	Other Defects	See "Catch Basins" (No. 5).	See "Catch Basins" (No. 5).

Table V-4.5.2(8) Maintenance Standards - Typical Biofiltration Swale

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
General	Sediment Accumulation on Grass	Sediment depth exceeds 2 inches.	Remove sediment deposits on grass treatment area of the bio-swale. When finished, swale should be level from side to side and drain freely toward outlet. There should be no areas of standing water once inflow has ceased.
	Standing Water	When water stands in the swale between storms and does not drain freely.	Any of the following may apply: remove sediment or trash blockages, improve grade from head to foot of swale, remove clogged check dams, add underdrains or convert to a wet

Table V-4.5.2(10) Maintenance Standards - Filter Strips (continued)

Maintenance Component	Defect or Problem	Condition When Maintenance is Needed	Recommended Maintenance to Correct Problem
		ation starts to take over.	
	Trash and Debris Accumulation	Trash and debris accumulated on the filter strip.	Remove trash and Debris from filter.
	Erosion/Scouring	Eroded or scoured areas due to flow channelization, or higher flows.	For ruts or bare areas less than 12 inches wide, repair the damaged area by filling with crushed gravel. The grass will creep in over the rock in time. If bare areas are large, generally greater than 12 inches wide, the filter strip should be re-graded and re-seeded. For smaller bare areas, over-seed when bare spots are evident.
	Flow spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed through entire filter width.	Level the spreader and clean so that flows are spread evenly over entire filter width.

Table V-4.5.2(11) Maintenance Standards - Wetponds

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Water level	First cell is empty, doesn't hold water.	Line the first cell to maintain at least 4 feet of water. Although the second cell may drain, the first cell must remain full to control turbulence of the incoming flow and reduce sediment resuspension.
	Trash and Debris	Accumulation that exceeds 1 CF per	Trash and debris removed from pond.

Table V-4.5.2(11) Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		1000-SF of pond area.	
	Inlet/Outlet Pipe	Inlet/Outlet pipe clogged with sediment and/or debris material.	No clogging or blockage in the inlet and outlet piping.
	Sediment Accumulation in Pond Bottom	Sediment accumulations in pond bottom that exceeds the depth of sediment zone plus 6-inches, usually in the first cell.	Sediment removed from pond bottom.
	Oil Sheen on Water	Prevalent and visible oil sheen.	Oil removed from water using oil-absorbent pads or vactor truck. Source of oil located and corrected. If chronic low levels of oil persist, plant wetland plants such as Juncus effusus (soft rush) which can uptake small concentrations of oil.
	Erosion	Erosion of the pond's side slopes and/or scouring of the pond bottom, that exceeds 6-inches, or where continued erosion is prevalent.	Slopes stabilized using proper erosion control measures and repair methods.
	Settlement of Pond Dike/Berm	Any part of these components that has settled 4-inches or lower than the design elevation, or inspector determines dike/berm is unsound.	Dike/berm is repaired to specifications.
	Internal Berm	Berm dividing cells should be level.	Berm surface is leveled so that water flows evenly over entire length of

Table V-4.5.2(11) Maintenance Standards - Wetponds (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
			berm.
	Overflow Spillway	Rock is missing and soil is exposed at top of spillway or outside slope.	Rocks replaced to specifications.

Table V-4.5.2(12) Maintenance Standards - Wetvaults

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash/Debris Accumulation	Trash and debris accumulated in vault, pipe or inlet/outlet (includes floatables and non-floatables).	Remove trash and debris from vault.
	Sediment Accumulation in Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	Remove sediment from vault.
	Damaged Pipes	Inlet/outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened or removed, especially by one person.	Pipe repaired or replaced to proper working specifications.
	Ventilation	Ventilation area blocked or plugged.	Blocking material removed or cleared from ventilation area. A specified % of the vault surface area must provide ventilation to the vault interior (see design specifications).
	Vault Structure Damage - Includes Cracks in Walls Bottom, Damage to	Maintenance/inspection personnel determine that the vault is not structurally sound. Cracks wider than 1/2-	Vault replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks

Table V-4.5.2(17) Maintenance Standards - Coalescing Plate Oil/Water Separators (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	inlet/outlet pipe.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.

Table V-4.5.2(18) Maintenance Standards - Catch Basin Inserts

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Sediment Accumulation	When sediment forms a cap over the insert media of the insert and/or unit.	No sediment cap on the insert media and its unit.
	Trash and Debris Accumulation	Trash and debris accumulates on insert unit creating a blockage/restriction.	Trash and debris removed from insert unit. Runoff freely flows into catch basin.
	Media Insert Not Removing Oil	Effluent water from media insert has a visible sheen.	Effluent water from media insert is free of oils and has no visible sheen.
	Media Insert Water Saturated	Catch basin insert is saturated with water and no longer has the capacity to absorb.	Remove and replace media insert
	Media Insert-Oil Saturated	Media oil saturated due to petroleum spill that drains into catch basin.	Remove and replace media insert.
	Media Insert Use Beyond Product Life	Media has been used beyond the typical average life of media insert product.	Remove and replace media at regular intervals, depending on insert product.

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APPENDIX D

DOWNSTREAM ANALYSIS

NORTH ↑ NTS

KESTREL RIDGE
DOWNSTREAM MAP

Photo #1: Roadside ditch adjacent to the north side of Chain Lake Road, bordering the southern boundary of the project site.

Photo #2: Concentrated flows entering the ditch from the project site.

Photo #3: Concentrated flows entering the ditch from the project site.

Photo #4: Flows entering the ditch from the property adjacent to proposed lots 40, 41, and 43.

Photo #5: Flows entering a culvert that conveys runoff under 134th Street SE.

Photo #6: Flow entering the rock lined swale.

Photo #7: Rock lined swale conveying flows to two catch basin drains.

Photo #8: Large drain at the end of the rock lined swale. Flows enter drain approximately 0.25 miles downstream from project site and are conveyed east.

Photo #9: Sensitive area tract located approximately 0.25 miles downstream of the project site where flows discharge to from rock lined swale.

Photo #10: Flows conveyed from rock lined swale, east towards a sensitive area tract.