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Preliminary Storm Drainage Report

Garibaldi PRD
CPH Project No. 0054-18-028

Monroe, WA

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PRELIMINARY STORM DRAINAGE REPORT

FOR

GARIBALDI 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 *Garibaldi 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 *Garibaldi PRD* project proposes to develop 61 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 a 13.82-acre assemblage of three developed parcels containing single-family residences and their associated structures within the Monroe city limits. Each parcel varies in area and existing conditions. The first parcel is approximately 2.2 acres and consists of mostly undeveloped land in forested conditions with a single-family home and outlying structures occupying the northwest corner of the parcel. The second parcel is approximately 2.7 acres and consists of vacant undeveloped land in forested conditions and a wetland buffer in the eastern half of the parcel. And the third parcel is approximately 8.9 acres with a single-family home, stable, barn and other outlying structures within a fenced perimeter consisting of pasture conditions. Existing access to Garibaldi PRD is provided via Chain Lake Road along the eastern boundary of the site. The site is more generally located in portions of the NE ¼ and SE ¼ of the NW ¼ of Section 31, Township 28 North, Range 7 East, W.M., Snohomish County, Washington.

The site generally descends from the northwestern property corner to the southeast with a total relief of approximately 95 feet. There is a ridgeline that starts at the western site boundary and stretches to the southeast corner of the site that creates two on-site drainage basins that do not converge within a ¼ mile downstream. The northern basin onsite area is approximately 9.15 acres and conveys runoff over pastured and partially forested area and sheet flows to an exist ditch on the west side of Chain Lake Road. The southern basin area is approximately 2.911 acres and conveys runoff over forested and partially pastured slope and sheet flows to an existing ditch along the west frontage of Chain Lake Road near the southeast corner of the subject property. The north 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. The south basin ditch conveys runoff southwesterly to a culvert inlet that discharges into a catch basin and continues in existing underground storm drainage infrastructure. 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 Garibaldi PRD project site is comprised of three adjoining parcels (Tax Parcel #'s 28073100201600, 28073100200800, and 28073100203900) with a total area of approximately 13.82 acres. It is located within the Woods Creek Drainage Basin, part of the Snohomish Watershed, WRIA 07. The site is bordered by single-family residences on all sides with access from Chain Lake Road to the east. The Eaglemont neighborhood borders the site to the west. The three existing parcels contain single-family residences and their associated structures. Each parcel varies in size and existing conditions. The first parcel is approximately 2.2 acres of mostly undeveloped land in forested conditions with a single family home and outlying structures occupying the northwest corner of the parcel. The second parcel is approximately 2.7 acres and consists of vacant undeveloped land in forested conditions and a wetland buffer in the eastern half of the parcel. And the third parcel is approximately 8.9 acres with a single family home, stable, barn and other outlying structures within a fenced perimeter consisting of pasture conditions. and has large, fenced pasture area adjacent to the frontage road.

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 detailed geotechnical engineering study will be completed prior to the final engineering design. A copy of the NRCS Web Soil Survey data is provided in Appendix A.

The site generally descends from the northwestern property corner to the southeast with a total relief of 95 feet. There is a ridgeline dividing the property into two separate basins. Approximately 2.911 acres of forested and pastured slope is located in the south basin. Surface runoff primarily sheet flows across the forested and pastured areas toward an existing ditch on the west 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.

The north basin runoff flows southeasterly and is eventually collected in a ditch along Chain lake Road north of the ridgeline. Flows are then conveyed to a culvert inlet that discharges to a shallow, vegetated channel at the east side of Chain Lake Road and flows southeasterly through vegetated wetland areas.

There is one (1) stream located within one (1) Category III wetland near the southeastern corner of the site. 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). 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 for the adjacent Eaglemont neighborhood provided by the City of Monroe. The City of Monroe's Public Works Department was contacted to inquire about any recent and/or relevant drainage complaints in the project vicinity. Minor drainage complaints were made by property owners along the north and south basin downstream paths. According to the City, these complaints are regarding sheet flow runoff entering adjacent properties. As a result of the sheet flow runoff, ponding within the ditch has been the reason for these complaints. It is understood that these complaints have been addressed by the City and/or others. The City responded and noted no significant complaints from the property owners along either quarter-mile downstream paths from the project site.

Site Visit

A site visit was completed on November 1, 2018 at 2:30 PM 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 55° and cloudy with intermittent showers. There was 0.73" of precipitation measured that day and 2.47" total precipitation over the prior week. The result of this was that the ground was fully saturated and all conveyance facilities in the area were carrying significant flows, ideal conditions to inspect a drainage system.

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. Aerial imagery from SCPDSMP shows that the properties to the north and west are developed with private drainage infrastructure improvements. The properties to the west are part of the Eaglemont subdivision and are recently developed single family subdivision lots. The properties to the north are large residential parcels consisting of homes, associated structures, and large pasture areas with driveway slopes towards the existing ditch along the west side of Chain Lake Road. Based on a site visit, the topography of adjacent properties to the west and north of the site was observed from the perspective of Chain Lake Road and Eaglemont subdivision. It was visually apparent that any sheet flow runoff that flow onto and through the site is nominal. It appears that existing landscaped topography and private drainage infrastructure almost entirely reroutes runoff southerly and westerly to the Eaglemont subdivision and northerly and easterly toward the ditch along Chain Lake Road prior to entering the project site. This was the extent of the upstream off-site analysis due to private property restrictions and poor visibility due to existing structures and vegetation.

The existing ditch on the west side of Chain Lake Road collects upstream runoff and conveys it along the project frontage to the same point of convergence as the site's North Basin. The ditch carried visible flow during the site visit and was well below its full capacity. Proposed grading and improvements will reroute any runoff along the north property boundary to the ditch along Chain Lake Road.

Downstream Analysis

Runoff sheet flows into the existing ditch on the west side of Chain Lake Road, a portion of which flows onto and through adjacent parcel nos. 2807310020-0700, -1500, and -2800 prior to the ditch. The site is divided into north and south basins that do not converge runoff within a quarter (0.25) mile downstream. See Appendix D for the Offsite Analysis Table (OAT) and downstream analysis map and photos. Refer to the map for locations of the numbered photos and structure symbols as listed in the OAT.

The north basin runoff is collected in an existing ditch on the west side of Chain Lake Road and conveys runoff to a 12" culvert inlet that directs flows easterly under the road and daylights into an open channel ditch on the east side of Chain Lake Road. The downstream path could not be followed further due to private property restrictions and dense vegetation. However, from aerial photos and the topography of the area it is believed that the runoff continues southeast as open channel flow and stream-like conveyance beyond the quarter (0.25) mile downstream threshold where a series of wetland areas and culverts convey surface water to the Skykomish river as part of the Snohomish river watershed. See Appendix D for photos and a summary table of the downstream system.

The south basin is collected in an existing ditch near the southeast corner of the site along Chain Lake Road. The ditch conveys runoff approximately 532 feet southwesterly to a 12" concrete culvert that directs flow under a private driveway. A series of 12" storm drainage pipes collects and conveys runoff along the below grade storm drainage system on the west side of Chain Lake Road to the quarter (0.25) mile downstream threshold. Runoff daylights into open channel ditch at approximate 1,340 feet downstream from the site. The downstream path appears to continue as open channel flow in the existing ditch. From aerial photos and the topography of the area it is believed that the runoff continues southerly as open channel flow and enters the existing underground storm drainage infrastructure for conveyance to the Skykomish river as part of the Snohomish river watershed. See Appendix D for photos and a summary table of the downstream system.

The downstream conveyance system appears to be properly functioning and has more than adequate capacity for its tributary drainage area. Runoff from the *Garibaldi 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.

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 below-grade detention/water quality vault for each basin is proposed in the southwest corner of the site to treat and detain runoff. Appendix B contains the WWHM model results for the proposed storm water controls and water quality facilities proposed for the project. See Figure 7 for storm vault details.

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 3 for pre-developed drainage basins.

Table 4.1 – Pre-developed Drainage Subbasins

Basin	Land Use Area (ac)				
	Forested	Grass	Pasture	Impervious	Total
South Basin	2.911	0.000	0.000	0.000	2.911
North Basin	9.154	0.000	0.000	0.000	9.154
Total Area (ac)	**12.065**	**0.000**	**0.000**	**0.000**	**12.065**

Table 4.2 – South Basin Pre-developed Peak Flows (POC 2)

Event	Flow Rate (cfs)
2-yr	0.149
10-yr	0.323
25-yr	0.446
50-yr	0.555
100-yr	0.682

Table 4.3 – North Basin Pre-developed Peak Flows (POC 1)

Event	Flow Rate (cfs)
2-yr	0.418
10-yr	0.869
25-yr	1.161
50-yr	1.410
100-yr	1.687

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

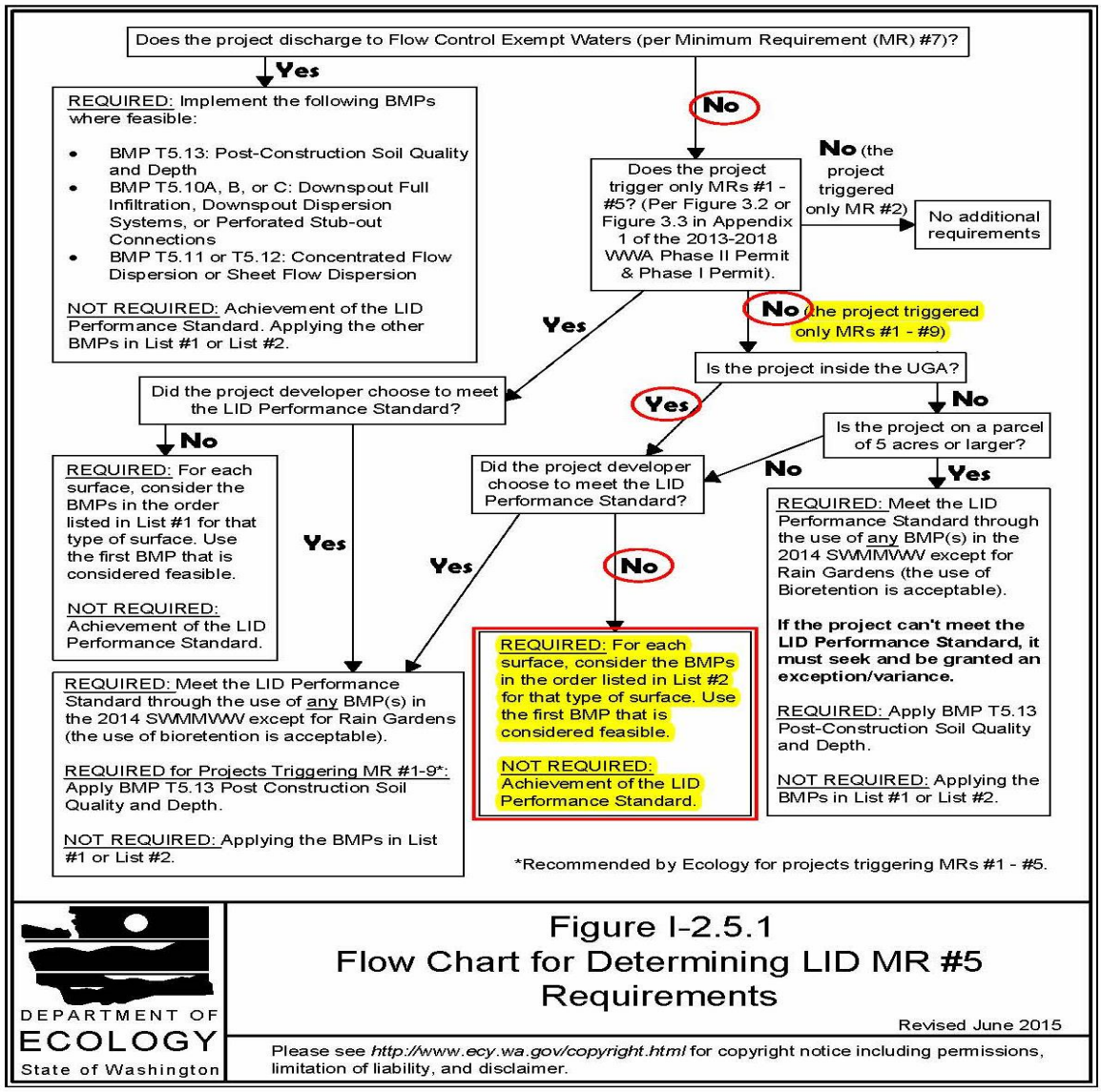

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Table I-2.5.1 On-Site Stormwater Management Requirements for Projects Triggering Minimum Requirements #1 - #9

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 *Garibaldi 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. Figure 4 indicates the locations where this BMP is feasible where the required vegetated flowpath slope and length can be accommodated. Full dispersion trenches are proposed to the maximum extent feasible. See Figure 4 for the proposed storm drainage infrastructure plan.

   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 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. Figure 4 indicates the locations where this BMP is feasible where the required vegetated flowpath slope and length can be accommodated. Full dispersion trenches are proposed to the maximum extent feasible. See Figure 4 for the proposed storm drainage infrastructure plan.

   The other dispersion BMPs are not feasible except for where indicated in the Figure 4. 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 National Resources Conservation Service (NRCS) Report is attached in Appendix A and indicates these soils are Tokul gravelly medial loam. These are till soils that are not conducive to infiltration.

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 configurations 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. Due to the existing ridgeline that divides the site, there are two sub-basins that convey site runoff to two separate detention vaults located adjacent to each other near the southeast corner of the site. The developed basins for the developed South Basin (DS1, DS2) and developed North Basin (DN1) are shown and detailed in Figure 5. There are two small sub-basins that cannot drain to the vault due to grade restrictions and are modeled in WWHM for the South Basin and North Basin as bypass areas BP1 and BP2, respectively.

Two detention/water quality vaults are proposed for this project. A single vault structure with a dividing wall creates one large detention/water quality vault (North Vault) to serve the North Basin and one small detention vault (South Vault) to serve the South Basin. The North Vault is 58' wide x 224' long with 12.5 feet of live storage on top of 4 feet of dead storage. The North Vault detention volume at the top of the flow control riser is 3.72 acre-feet. Flow control is provided by an 18-inch riser pipe with a two-orifice design used to meet the applicable standards. The South Vault is 16' wide x 58' long with 3 feet of live storage. The South Vault detention volume at the top of the flow control riser is 0.0639 acre-feet. Flow control is provided by a 12-inch riser pipe with a one-orifice design used to meet the applicable standards.

Flow control was modeled for discharging at one release flow to a discharge point at or near the natural discharge point of the North and South basins. Developed North Basin runoff will discharge flow in the wetland buffer area to convey as open channel flow to the North Basin point of convergence. The Developed South Basin will discharge flow in the existing ditch to convey as open channel flow to the South Basin point of convergence.

The developed North Basin model combines the upper Developed South Basin (DS1), Developed North Basin (DN1), and North Basin Bypass (BP2) using WWHM to match the runoff of the Predeveloped North Basin. Combined basin areas DS1, DN1, and BP2 convey runoff by means of underground storm drains. The North Vault collects runoff from pervious and impervious from the majority of the site.

The South Basin under developed conditions is much reduced in area due to the proposed final grading and storm systems design for the project. This developed area comprises the lower elevations of the site in the very southeast corner, including the offsite frontage improvement area at Chain Lake Road. This South Basin was modelled as two separate drainage subbasins, DS2 and BP1, with a single point-of-compliance (POC2) under develop site conditions. DS2 represents that portion of the basin that can be collected and conveyed to an onsite storm drainage vault and BP1 represents the remainder area that bypasses the onsite flow control and treatment facilities. The WWHM model for the South Basin resulted in a 100-year peak design flow rate of 0.534 cfs under developed site conditions compared to 0.682 cfs for pre-developed site conditions. This is a 0.148 cfs (21.7%) reduction in peak runoff rate. As such, the South Basin qualifies for the allowable 100-year peak flow rate exemption provided by SMMWW section 1-2.5.7 which states that post-project tributary area may exceed the existing conditions runoff if the runoff does not exceed 0.15 cfs at the 100-year duration using a model with a 15-minute time step.

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	Pasture	Impervious	Total
DS1	0.000	1.060	0.000	1.333	2.394
DS2	0.000	0.000	0.060	0.120	0.180
BP1	0.081	0.154	0.070	0.261	0.566
DN1	0.000	4.045	0.000	4.708	8.752
BP2	0.000	0.164	0.000	0.009	0.173
Total Area (ac)	**0.081**	**5.423**	**0.130**	**6.430**	**12.065**

Table 4.5 – South Basin Developed Peak Flows (POC 2)

Event	Flow Frequency Return Periods at Point of Compliance (cfs)
2-yr	0.194
10-yr	0.325
25-yr	0.402
50-yr	0466
100-yr	0.534

Table 4.6 – North Basin Developed Peak Flows (POC 1)

Event	Flow Frequency Return Periods at Point of Compliance (cfs)
2-yr	0.217
10-yr	0.358
25-yr	0.447
50-yr	0.523
100-yr	0.607

Conveyance System Analysis and Design

A capacity analysis of the onsite conveyance system for the project will be performed and compiled 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 wetvault for the on-site runoff. The minimum required water quality design volume for the North Vault is 15,411cf. There is 4' of dead storage below the live storage in the North Vault and the water quality design volume of 35,840cf. This water quality design volume is providing more than the volume required for the North Vault due to the restricted geometry of the vault.

The minimum required water quality design volume for the South Vault is 1,995cf. There is 4' of dead storage below the live storage in the South Vault and the water quality design volume of 3,923cf. This water quality design volume is providing more than the volume required for the North Vault due to the restricted geometry of the vault. The South Vault will convey mitigated water to the water quality treatment catch basin along the project frontage prior to discharge into the existing ditch.

Water quality treatment for the road bypass area at the entrance of the site is proposed with a proprietary media cartridge filter treatment system located in a catch basin at the new intersection of Chain Lake Road. A treatment trade is proposed at this location and the media filter facility will collect a portion of existing roadway equal to or greater than the area bypassing at the southern extent of the frontage.

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 sediment traps, and temporary interceptor trenches as shown on the Plans. Appendix F includes sizing calculations for the proposed temporary sediment traps. 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

LEGEND

- MSE RETAINING WALL
- LOCK+LOAD WALL SYSTEM
- WALL DRAIN
- EXIST. TOPOGRAPHIC CONTOUR
- PROPOSED GRADE CONTOUR
- TYPE 1 STORM DRAINAGE CATCH BASIN
- TYPE 2 STORM DRAINAGE CATCH BASIN
- SD — STORM DRAINAGE PIPE
- RD — RD — ROOF DRAIN CONNECTION

FIGURE 2 - EXISTING SITE CONDITIONS

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0 50 100
PLAN IN FEET

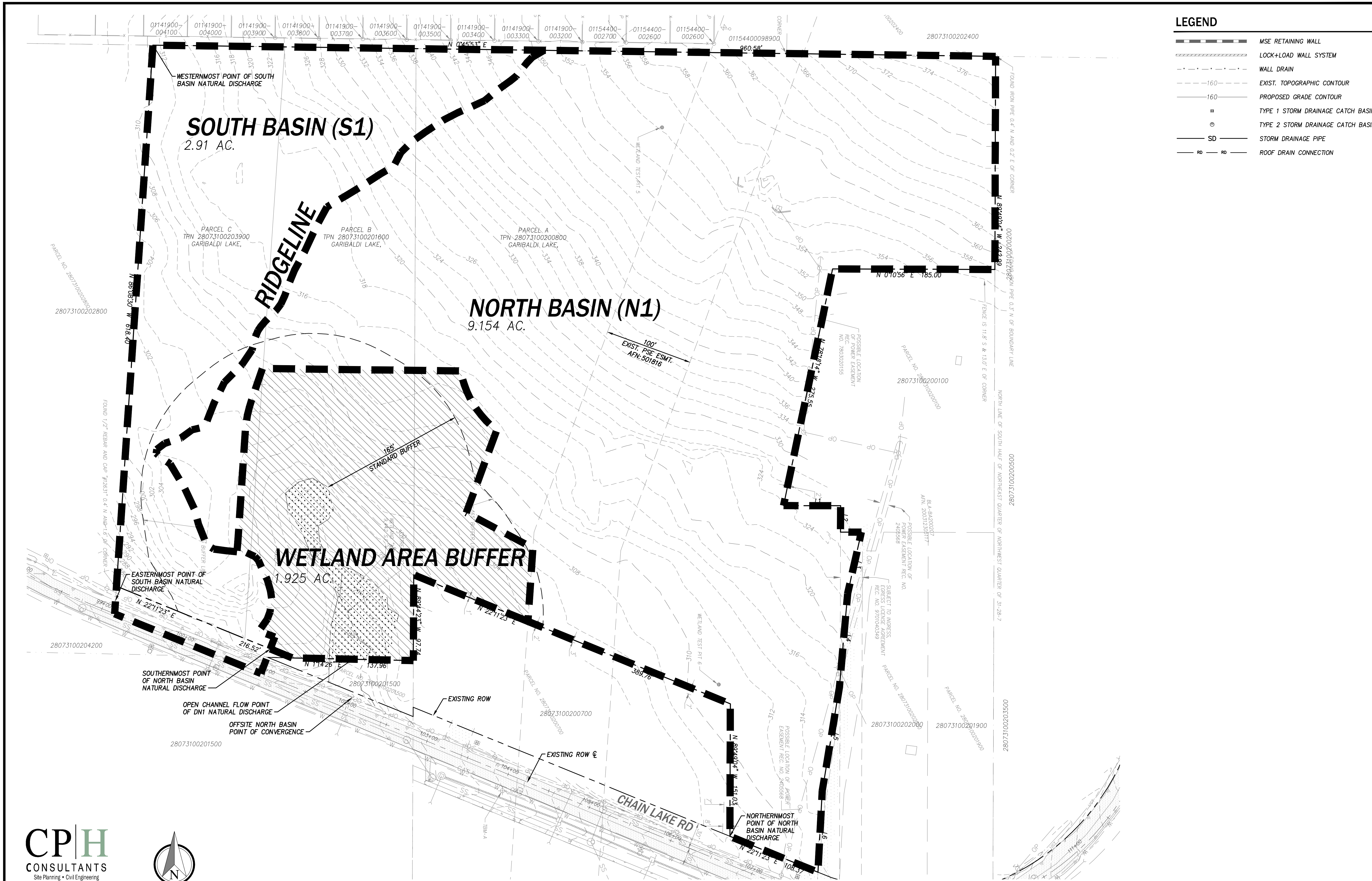

FIGURE 3 - PRE-DEVELOPED DRAINAGE BASINS

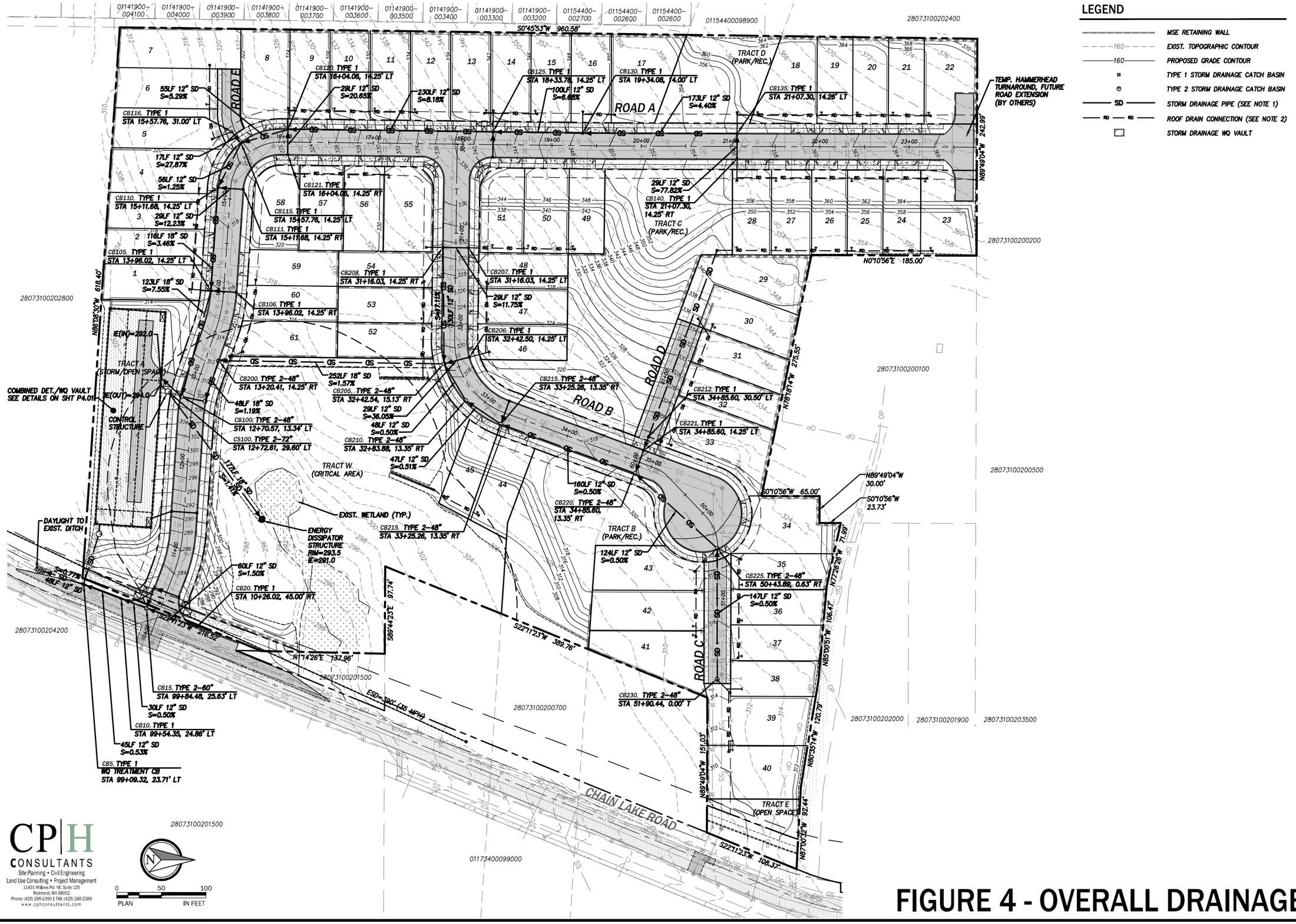

FIGURE 4 - OVERALL DRAINAGE PLAN

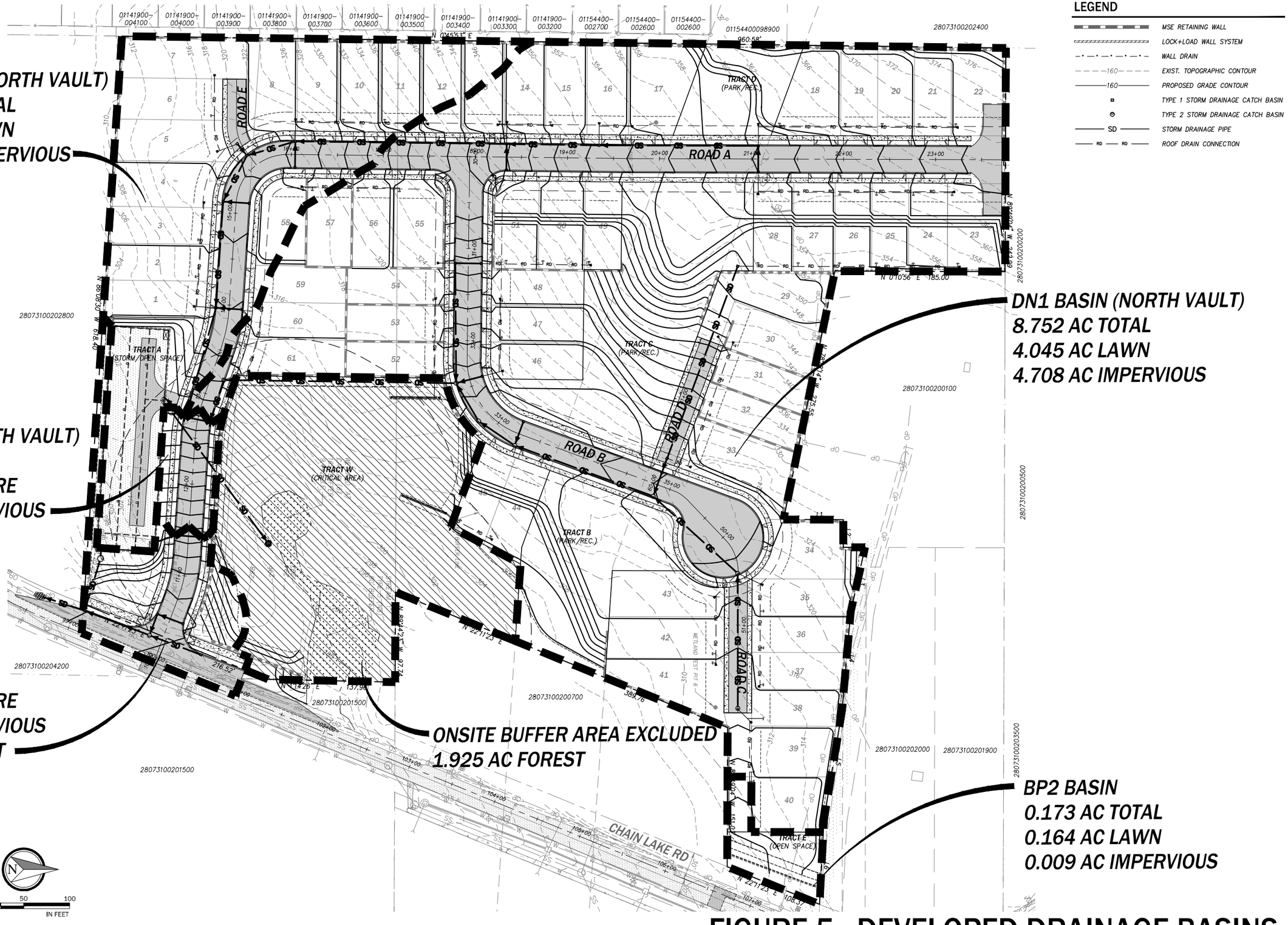

FIGURE 5 - DEVELOPED DRAINAGE BASINS

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APPENDIX A

NRCS SOILS REPORT

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Snohomish County Area, Washington

October 29, 2018

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:2,200 if printed on A portrait (8.5" x 11") 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 20, Sep 10, 2018

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

Date(s) aerial images were photographed: Mar 29, 2016—Oct 10, 2016

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
72	Tokul gravelly medial loam, 0 to 8 percent slopes	6.5	46.7%
73	Tokul gravelly medial loam, 8 to 15 percent slopes	7.4	53.3%
Totals for Area of Interest		**13.8**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Snohomish County Area, Washington

72—Tokul gravelly medial loam, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2t61k
Elevation: 160 to 1,150 feet
Mean annual precipitation: 45 to 70 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Tokul and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tokul

Setting

Landform: Till plains, hillslopes
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Volcanic ash mixed with loess over glacial till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oa - 1 to 2 inches: highly decomposed plant material
A - 2 to 6 inches: gravelly medial loam
Bs1 - 6 to 9 inches: gravelly medial loam
Bs2 - 9 to 17 inches: gravelly medial loam
Bs3 - 17 to 24 inches: gravelly medial loam
BC - 24 to 33 inches: gravelly medial fine sandy loam
2Bsm - 33 to 62 inches: cemented material

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 20 to 39 inches to cemented horizon; 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Forage suitability group: Limited Depth Soils (G002XF303WA), Limited Depth Soils (G002XN302WA)

Hydric soil rating: No

Minor Components

Barneston

Percent of map unit: 5 percent
Landform: Kames, eskers, moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Crest, interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Pastik

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Norma

Percent of map unit: 3 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

Mckenna

Percent of map unit: 2 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

73—Tokul gravelly medial loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 2t61l
Elevation: 160 to 1,150 feet
Mean annual precipitation: 45 to 70 inches
Mean annual air temperature: 46 to 52 degrees F
Frost-free period: 140 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Tokul and similar soils: 70 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Tokul

Setting

Landform: Hillslopes, till plains
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Volcanic ash mixed with loess over glacial till

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
Oa - 1 to 2 inches: highly decomposed plant material
A - 2 to 6 inches: gravelly medial loam
Bs1 - 6 to 9 inches: gravelly medial loam
Bs2 - 9 to 17 inches: gravelly medial loam
Bs3 - 17 to 24 inches: gravelly medial loam
BC - 24 to 33 inches: gravelly medial fine sandy loam
2Bsm - 33 to 62 inches: cemented material

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 20 to 39 inches to cemented horizon; 20 to 39 inches to densic material
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Forage suitability group: Limited Depth Soils (G002XF303WA)
Hydric soil rating: No

Minor Components

Vanzandt

Percent of map unit: 10 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Rinker

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Crest
Down-slope shape: Convex

Across-slope shape: Convex
Hydric soil rating: No

Pastik

Percent of map unit: 5 percent
Landform: Terraces
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: No

Barneston

Percent of map unit: 5 percent
Landform: Kames, eskers, moraines
Landform position (two-dimensional): Shoulder, footslope
Landform position (three-dimensional): Crest, base slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma

Percent of map unit: 3 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

Mckenna

Percent of map unit: 2 percent
Landform: Depressions, drainageways
Landform position (three-dimensional): Dip
Down-slope shape: Concave, linear
Across-slope shape: Concave
Hydric soil rating: Yes

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APPENDIX B

WWMH OUTPUT

WWHM2012

PROJECT REPORT

Garibaldi PRD

Preliminary Storm Drainage Analysis

CPH Project No. 0054-18-028

General Model Information

Project Name:	Vault_mjh181210_vaultX2_final
Site Name:	Garibaldi Lake, LLC
Site Address:	Prelim. PRD
City:	Monroe
Report Date:	12/10/2018
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2017/04/14
Version:	4.2.13

POC Thresholds

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

Landuse Basin Data
Predeveloped Land Use

S1+N1+BP2_predev

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	11.319
Pervious Total	11.319
Impervious Land Use	acre
Impervious Total	0
Basin Total	11.319

Element Flows To:

Surface	Interflow	Groundwater

South Basin Predev

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Forest, Steep	2.911
Pervious Total	2.911

Impervious Land Use	acre
Impervious Total	0
Basin Total	2.911

Element Flows To:

Surface	Interflow	Groundwater

Mitigated Land Use

DS1+DN1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	5.105
Pervious Total	5.105

Impervious Land Use	acre
ROADS MOD	6.041
Impervious Total	6.041
Basin Total	11.146

Element Flows To:

Surface	Interflow	Groundwater
North Vault	North Vault	

BP1

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Flat	0.154
C, Forest, Mod	0.081
C, Pasture, Mod	0.07
Pervious Total	0.305

Impervious Land Use	acre
ROADS MOD	0.2608
Impervious Total	0.2608
Basin Total	0.5658

Element Flows To:

Surface	Interflow	Groundwater

BP2

Bypass:	Yes
GroundWater:	No

Pervious Land Use	acre
C, Lawn, Mod	0.164
Pervious Total	0.164

Impervious Land Use	acre
ROADS MOD	0.009
Impervious Total	0.009
Basin Total	0.173

Element Flows To:

Surface	Interflow	Groundwater

DS2

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Steep	0.06
Pervious Total	0.06

Impervious Land Use	acre
ROADS STEEP	0.09
SIDEWALKS STEEP	0.03
Impervious Total	0.12
Basin Total	0.18

Element Flows To:

Surface	Interflow	Groundwater
South Vault	South Vault	

Mitigated Routing

North Vault

Width: 58 ft.
Length: 224 ft.
Depth: 13.5 ft.
Discharge Structure
Riser Height: 12.85 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.000 ft.
Notch Height: 0.000 ft.
Orifice 1 Diameter: 1.8 in. Elevation:0 ft.
Orifice 2 Diameter: 3.9 in. Elevation:9.8 ft.
Element Flows To:
Outlet 1 Outlet 2

Vault Hydraulic Table

Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.298	0.000	0.000	0.000
0.1500	0.298	0.044	0.034	0.000
0.3000	0.298	0.089	0.048	0.000
0.4500	0.298	0.134	0.059	0.000
0.6000	0.298	0.179	0.068	0.000
0.7500	0.298	0.223	0.076	0.000
0.9000	0.298	0.268	0.083	0.000
1.0500	0.298	0.313	0.090	0.000
1.2000	0.298	0.357	0.096	0.000
1.3500	0.298	0.402	0.102	0.000
1.5000	0.298	0.447	0.107	0.000
1.6500	0.298	0.492	0.112	0.000
1.8000	0.298	0.536	0.118	0.000
1.9500	0.298	0.581	0.122	0.000
2.1000	0.298	0.626	0.127	0.000
2.2500	0.298	0.671	0.131	0.000
2.4000	0.298	0.715	0.136	0.000
2.5500	0.298	0.760	0.140	0.000
2.7000	0.298	0.805	0.144	0.000
2.8500	0.298	0.850	0.148	0.000
3.0000	0.298	0.894	0.152	0.000
3.1500	0.298	0.939	0.156	0.000
3.3000	0.298	0.984	0.159	0.000
3.4500	0.298	1.029	0.163	0.000
3.6000	0.298	1.073	0.166	0.000
3.7500	0.298	1.118	0.170	0.000
3.9000	0.298	1.163	0.173	0.000
4.0500	0.298	1.207	0.176	0.000
4.2000	0.298	1.252	0.180	0.000
4.3500	0.298	1.297	0.183	0.000
4.5000	0.298	1.342	0.186	0.000
4.6500	0.298	1.386	0.189	0.000
4.8000	0.298	1.431	0.192	0.000
4.9500	0.298	1.476	0.195	0.000
5.1000	0.298	1.521	0.198	0.000
5.2500	0.298	1.565	0.201	0.000

5.4000	0.298	1.610	0.204	0.000
5.5500	0.298	1.655	0.207	0.000
5.7000	0.298	1.700	0.209	0.000
5.8500	0.298	1.744	0.212	0.000
6.0000	0.298	1.789	0.215	0.000
6.1500	0.298	1.834	0.218	0.000
6.3000	0.298	1.879	0.220	0.000
6.4500	0.298	1.923	0.223	0.000
6.6000	0.298	1.968	0.225	0.000
6.7500	0.298	2.013	0.228	0.000
6.9000	0.298	2.058	0.231	0.000
7.0500	0.298	2.102	0.233	0.000
7.2000	0.298	2.147	0.235	0.000
7.3500	0.298	2.192	0.238	0.000
7.5000	0.298	2.236	0.240	0.000
7.6500	0.298	2.281	0.243	0.000
7.8000	0.298	2.326	0.245	0.000
7.9500	0.298	2.371	0.247	0.000
8.1000	0.298	2.415	0.250	0.000
8.2500	0.298	2.460	0.252	0.000
8.4000	0.298	2.505	0.254	0.000
8.5500	0.298	2.550	0.257	0.000
8.7000	0.298	2.594	0.259	0.000
8.8500	0.298	2.639	0.261	0.000
9.0000	0.298	2.684	0.263	0.000
9.1500	0.298	2.729	0.266	0.000
9.3000	0.298	2.773	0.268	0.000
9.4500	0.298	2.818	0.270	0.000
9.6000	0.298	2.863	0.272	0.000
9.7500	0.298	2.908	0.274	0.000
9.9000	0.298	2.952	0.407	0.000
10.050	0.298	2.997	0.485	0.000
10.200	0.298	3.042	0.541	0.000
10.350	0.298	3.086	0.589	0.000
10.500	0.298	3.131	0.630	0.000
10.650	0.298	3.176	0.667	0.000
10.800	0.298	3.221	0.701	0.000
10.950	0.298	3.265	0.733	0.000
11.100	0.298	3.310	0.763	0.000
11.250	0.298	3.355	0.791	0.000
11.400	0.298	3.400	0.819	0.000
11.550	0.298	3.444	0.844	0.000
11.700	0.298	3.489	0.869	0.000
11.850	0.298	3.534	0.893	0.000
12.000	0.298	3.579	0.916	0.000
12.150	0.298	3.623	0.939	0.000
12.300	0.298	3.668	0.961	0.000
12.450	0.298	3.713	0.982	0.000
12.600	0.298	3.758	1.002	0.000
12.750	0.298	3.802	1.022	0.000
12.900	0.298	3.847	1.220	0.000
13.050	0.298	3.892	2.466	0.000
13.200	0.298	3.937	4.153	0.000
13.350	0.298	3.981	5.738	0.000
13.500	0.298	4.026	6.793	0.000
13.650	0.292	3.850	7.473	0.000

South Vault

Width: 58 ft.
Length: 16 ft.
Depth: 4 ft.
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 0.5 in. Elevation:0 ft.
Element Flows To:
Outlet 1 Outlet 2

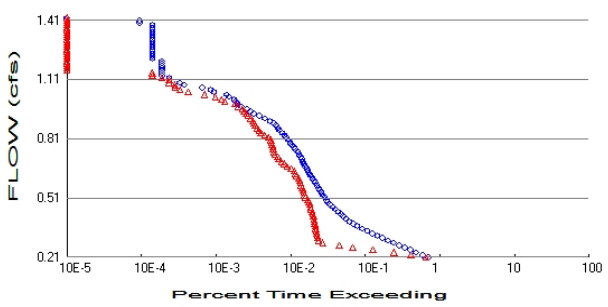
Vault Hydraulic Table

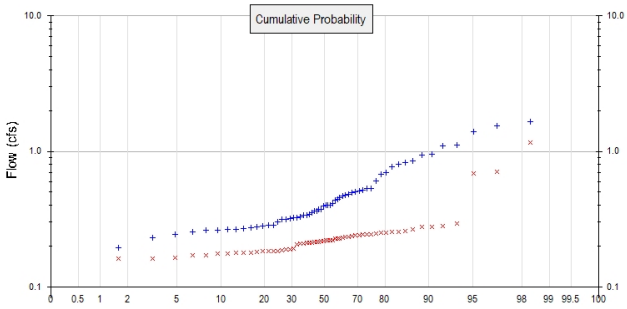
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.021	0.000	0.000	0.000
0.0444	0.021	0.000	0.001	0.000
0.0889	0.021	0.001	0.002	0.000
0.1333	0.021	0.002	0.002	0.000
0.1778	0.021	0.003	0.002	0.000
0.2222	0.021	0.004	0.003	0.000
0.2667	0.021	0.005	0.003	0.000
0.3111	0.021	0.006	0.003	0.000
0.3556	0.021	0.007	0.004	0.000
0.4000	0.021	0.008	0.004	0.000
0.4444	0.021	0.009	0.004	0.000
0.4889	0.021	0.010	0.004	0.000
0.5333	0.021	0.011	0.005	0.000
0.5778	0.021	0.012	0.005	0.000
0.6222	0.021	0.013	0.005	0.000
0.6667	0.021	0.014	0.005	0.000
0.7111	0.021	0.015	0.005	0.000
0.7556	0.021	0.016	0.005	0.000
0.8000	0.021	0.017	0.006	0.000
0.8444	0.021	0.018	0.006	0.000
0.8889	0.021	0.018	0.006	0.000
0.9333	0.021	0.019	0.006	0.000
0.9778	0.021	0.020	0.006	0.000
1.0222	0.021	0.021	0.006	0.000
1.0667	0.021	0.022	0.007	0.000
1.1111	0.021	0.023	0.007	0.000
1.1556	0.021	0.024	0.007	0.000
1.2000	0.021	0.025	0.007	0.000
1.2444	0.021	0.026	0.007	0.000
1.2889	0.021	0.027	0.007	0.000
1.3333	0.021	0.028	0.007	0.000
1.3778	0.021	0.029	0.008	0.000
1.4222	0.021	0.030	0.008	0.000
1.4667	0.021	0.031	0.008	0.000
1.5111	0.021	0.032	0.008	0.000
1.5556	0.021	0.033	0.008	0.000
1.6000	0.021	0.034	0.008	0.000
1.6444	0.021	0.035	0.008	0.000
1.6889	0.021	0.036	0.008	0.000
1.7333	0.021	0.036	0.008	0.000
1.7778	0.021	0.037	0.009	0.000
1.8222	0.021	0.038	0.009	0.000

1.8667	0.021	0.039	0.009	0.000
1.9111	0.021	0.040	0.009	0.000
1.9556	0.021	0.041	0.009	0.000
2.0000	0.021	0.042	0.009	0.000
2.0444	0.021	0.043	0.009	0.000
2.0889	0.021	0.044	0.009	0.000
2.1333	0.021	0.045	0.009	0.000
2.1778	0.021	0.046	0.010	0.000
2.2222	0.021	0.047	0.010	0.000
2.2667	0.021	0.048	0.010	0.000
2.3111	0.021	0.049	0.010	0.000
2.3556	0.021	0.050	0.010	0.000
2.4000	0.021	0.051	0.010	0.000
2.4444	0.021	0.052	0.010	0.000
2.4889	0.021	0.053	0.010	0.000
2.5333	0.021	0.054	0.010	0.000
2.5778	0.021	0.054	0.010	0.000
2.6222	0.021	0.055	0.011	0.000
2.6667	0.021	0.056	0.011	0.000
2.7111	0.021	0.057	0.011	0.000
2.7556	0.021	0.058	0.011	0.000
2.8000	0.021	0.059	0.011	0.000
2.8444	0.021	0.060	0.011	0.000
2.8889	0.021	0.061	0.011	0.000
2.9333	0.021	0.062	0.011	0.000
2.9778	0.021	0.063	0.011	0.000
3.0222	0.021	0.064	0.046	0.000
3.0667	0.021	0.065	0.194	0.000
3.1111	0.021	0.066	0.401	0.000
3.1556	0.021	0.067	0.649	0.000
3.2000	0.021	0.068	0.919	0.000
3.2444	0.021	0.069	1.195	0.000
3.2889	0.021	0.070	1.459	0.000
3.3333	0.021	0.071	1.695	0.000
3.3778	0.021	0.072	1.891	0.000
3.4222	0.021	0.072	2.041	0.000
3.4667	0.021	0.073	2.151	0.000
3.5111	0.021	0.074	2.264	0.000
3.5556	0.021	0.075	2.360	0.000
3.6000	0.021	0.076	2.452	0.000
3.6444	0.021	0.077	2.541	0.000
3.6889	0.021	0.078	2.627	0.000
3.7333	0.021	0.079	2.710	0.000
3.7778	0.021	0.080	2.790	0.000
3.8222	0.021	0.081	2.869	0.000
3.8667	0.021	0.082	2.945	0.000
3.9111	0.021	0.083	3.019	0.000
3.9556	0.021	0.084	3.092	0.000
4.0000	0.021	0.085	3.163	0.000
4.0444	0.021	0.086	3.232	0.000
4.0889	0.000	0.000	3.300	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 11.319
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 5.269
Total Impervious Area: 6.05

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.418418
5 year	0.669116
10 year	0.868602
25 year	1.161096
50 year	1.409897
100 year	1.686518

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.21745
5 year	0.296378
10 year	0.358038
25 year	0.447494
50 year	0.523133
100 year	0.607039

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.466	0.190
1950	0.473	0.215
1951	0.400	0.183
1952	0.325	0.180
1953	0.264	0.171
1954	1.655	0.209
1955	0.501	0.248
1956	0.438	0.258
1957	0.607	0.241
1958	0.528	0.243

1959	0.413	0.213
1960	0.400	0.222
1961	0.830	0.293
1962	0.402	0.185
1963	0.677	0.191
1964	0.534	0.161
1965	0.330	0.219
1966	0.194	0.179
1967	0.392	0.186
1968	0.479	0.230
1969	1.549	0.279
1970	0.273	0.184
1971	0.515	0.255
1972	0.318	0.235
1973	0.313	0.208
1974	0.846	0.214
1975	0.324	0.171
1976	0.340	0.207
1977	0.245	0.185
1978	0.286	0.175
1979	0.948	0.226
1980	0.444	0.180
1981	0.279	0.176
1982	0.362	0.240
1983	0.769	0.189
1984	0.373	0.267
1985	0.498	0.244
1986	1.120	0.703
1987	0.506	0.283
1988	0.262	0.238
1989	0.337	0.164
1990	0.354	0.234
1991	0.365	0.218
1992	0.278	0.226
1993	0.266	0.162
1994	0.253	0.220
1995	0.371	0.251
1996	0.700	0.244
1997	1.388	1.155
1998	0.232	0.178
1999	0.303	0.221
2000	0.263	0.256
2001	0.091	0.142
2002	0.345	0.222
2003	0.270	0.211
2004	0.455	0.250
2005	0.317	0.212
2006	1.092	0.277
2007	0.807	0.227
2008	0.937	0.690
2009	0.285	0.214

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.6553	1.1550
2	1.5489	0.7028
3	1.3883	0.6903

4	1.1196	0.2930
5	1.0922	0.2825
6	0.9479	0.2788
7	0.9366	0.2771
8	0.8465	0.2671
9	0.8301	0.2577
10	0.8067	0.2560
11	0.7686	0.2549
12	0.6998	0.2510
13	0.6774	0.2503
14	0.6075	0.2484
15	0.5339	0.2445
16	0.5284	0.2441
17	0.5152	0.2425
18	0.5063	0.2410
19	0.5014	0.2404
20	0.4984	0.2377
21	0.4786	0.2351
22	0.4727	0.2339
23	0.4655	0.2296
24	0.4547	0.2270
25	0.4440	0.2261
26	0.4383	0.2256
27	0.4126	0.2223
28	0.4017	0.2218
29	0.4001	0.2213
30	0.3999	0.2203
31	0.3925	0.2190
32	0.3734	0.2180
33	0.3711	0.2150
34	0.3650	0.2142
35	0.3622	0.2141
36	0.3544	0.2127
37	0.3451	0.2121
38	0.3401	0.2112
39	0.3370	0.2090
40	0.3301	0.2080
41	0.3254	0.2067
42	0.3236	0.1909
43	0.3180	0.1899
44	0.3166	0.1886
45	0.3132	0.1856
46	0.3027	0.1847
47	0.2860	0.1846
48	0.2852	0.1839
49	0.2792	0.1829
50	0.2782	0.1804
51	0.2732	0.1796
52	0.2704	0.1793
53	0.2662	0.1778
54	0.2640	0.1765
55	0.2632	0.1752
56	0.2622	0.1710
57	0.2532	0.1706
58	0.2453	0.1639
59	0.2318	0.1623
60	0.1937	0.1610
61	0.0912	0.1417

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2092	14803	13819	93	Pass
0.2213	12423	8724	70	Pass
0.2335	10288	5212	50	Pass
0.2456	8609	2701	31	Pass
0.2577	7204	1443	20	Pass
0.2698	6019	952	15	Pass
0.2820	5069	573	11	Pass
0.2941	4261	501	11	Pass
0.3062	3602	490	13	Pass
0.3184	3082	483	15	Pass
0.3305	2648	474	17	Pass
0.3426	2269	468	20	Pass
0.3547	1936	462	23	Pass
0.3669	1662	455	27	Pass
0.3790	1466	448	30	Pass
0.3911	1305	443	33	Pass
0.4033	1180	438	37	Pass
0.4154	1079	430	39	Pass
0.4275	1002	421	42	Pass
0.4396	922	412	44	Pass
0.4518	845	402	47	Pass
0.4639	783	393	50	Pass
0.4760	718	383	53	Pass
0.4882	672	376	55	Pass
0.5003	635	364	57	Pass
0.5124	610	339	55	Pass
0.5245	583	326	55	Pass
0.5367	552	320	57	Pass
0.5488	521	312	59	Pass
0.5609	499	306	61	Pass
0.5731	480	296	61	Pass
0.5852	456	288	63	Pass
0.5973	436	281	64	Pass
0.6094	416	271	65	Pass
0.6216	397	257	64	Pass
0.6337	382	246	64	Pass
0.6458	363	237	65	Pass
0.6580	349	216	61	Pass
0.6701	336	191	56	Pass
0.6822	323	176	54	Pass
0.6943	312	160	51	Pass
0.7065	299	148	49	Pass
0.7186	288	143	49	Pass
0.7307	277	131	47	Pass
0.7428	265	127	47	Pass
0.7550	245	125	51	Pass
0.7671	235	123	52	Pass
0.7792	222	120	54	Pass
0.7914	210	118	56	Pass
0.8035	197	116	58	Pass
0.8156	187	107	57	Pass
0.8277	175	96	54	Pass
0.8399	164	85	51	Pass

0.8520	152	80	52	Pass
0.8641	146	75	51	Pass
0.8763	135	72	53	Pass
0.8884	126	69	54	Pass
0.9005	112	66	58	Pass
0.9126	95	62	65	Pass
0.9248	80	57	71	Pass
0.9369	68	54	79	Pass
0.9490	61	51	83	Pass
0.9612	55	48	87	Pass
0.9733	46	42	91	Pass
0.9854	41	38	92	Pass
0.9975	39	28	71	Pass
1.0097	37	25	67	Pass
1.0218	32	21	65	Pass
1.0339	30	15	50	Pass
1.0461	20	9	45	Pass
1.0582	18	7	38	Pass
1.0703	14	6	42	Pass
1.0824	8	6	75	Pass
1.0946	7	5	71	Pass
1.1067	5	5	100	Pass
1.1188	5	4	80	Pass
1.1309	4	3	75	Pass
1.1431	4	3	75	Pass
1.1552	4	0	0	Pass
1.1673	4	0	0	Pass
1.1795	4	0	0	Pass
1.1916	4	0	0	Pass
1.2037	4	0	0	Pass
1.2158	3	0	0	Pass
1.2280	3	0	0	Pass
1.2401	3	0	0	Pass
1.2522	3	0	0	Pass
1.2644	3	0	0	Pass
1.2765	3	0	0	Pass
1.2886	3	0	0	Pass
1.3007	3	0	0	Pass
1.3129	3	0	0	Pass
1.3250	3	0	0	Pass
1.3371	3	0	0	Pass
1.3493	3	0	0	Pass
1.3614	3	0	0	Pass
1.3735	3	0	0	Pass
1.3856	3	0	0	Pass
1.3978	2	0	0	Pass
1.4099	2	0	0	Pass

Water Quality

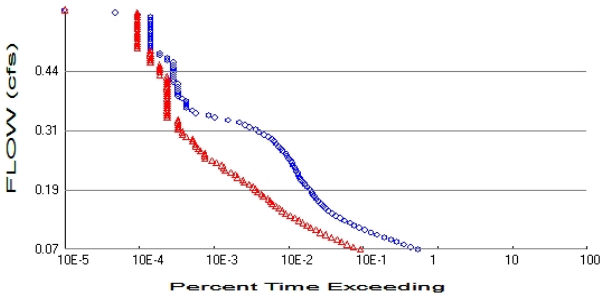
Water Quality BMP Flow and Volume for POC #1

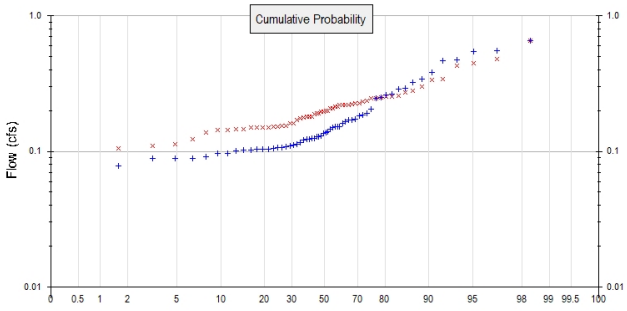
On-line facility volume:	0.3538 acre-feet
On-line facility target flow:	0.1796 cfs.
Adjusted for 15 min:	0.1796 cfs.
Off-line facility target flow:	0.1161 cfs.
Adjusted for 15 min:	0.1161 cfs.

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
North Vault POC	☐	1582.93			☐	0.00			
Total Volume Infiltrated		1582.93	0.00	0.00		0.00	0.00	0%	No Treat. Credit
Compliance with LID Standard 8% of 2-yr to 50% of 2-yr									Duration Analysis Result = Failed

POC 2





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #2
Total Pervious Area: 2.911
Total Impervious Area: 0

Mitigated Landuse Totals for POC #2
Total Pervious Area: 0.365
Total Impervious Area: 0.3808

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #2

Return Period	**Flow(cfs)**
2 year	0.149125
5 year	0.243302
10 year	0.322802
25 year	0.445635
50 year	0.55531
100 year	0.682264

Flow Frequency Return Periods for Mitigated. POC #2

Return Period	**Flow(cfs)**
2 year	0.19432
5 year	0.269063
10 year	0.324703
25 year	0.402336
50 year	0.465711
100 year	0.534025

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #2

Year	**Predeveloped**	**Mitigated**
1949	0.161	0.220
1950	0.184	0.220
1951	0.128	0.227
1952	0.122	0.178
1953	0.110	0.221
1954	0.551	0.338
1955	0.186	0.219
1956	0.153	0.113
1957	0.204	0.181
1958	0.547	0.479
1959	0.136	0.181

1960	0.145	0.198
1961	0.654	0.653
1962	0.151	0.190
1963	0.248	0.248
1964	0.172	0.151
1965	0.107	0.154
1966	0.078	0.160
1967	0.153	0.302
1968	0.190	0.174
1969	0.475	0.450
1970	0.096	0.147
1971	0.172	0.198
1972	0.124	0.272
1973	0.104	0.209
1974	0.290	0.258
1975	0.130	0.215
1976	0.108	0.149
1977	0.097	0.138
1978	0.103	0.110
1979	0.292	0.254
1980	0.138	0.209
1981	0.102	0.145
1982	0.140	0.154
1983	0.249	0.215
1984	0.124	0.189
1985	0.170	0.231
1986	0.380	0.279
1987	0.166	0.227
1988	0.103	0.196
1989	0.128	0.179
1990	0.114	0.151
1991	0.122	0.195
1992	0.105	0.190
1993	0.104	0.150
1994	0.088	0.152
1995	0.124	0.150
1996	0.265	0.236
1997	0.464	0.249
1998	0.089	0.254
1999	0.101	0.097
2000	0.088	0.426
2001	0.040	0.106
2002	0.116	0.123
2003	0.092	0.160
2004	0.149	0.340
2005	0.112	0.143
2006	0.320	0.246
2007	0.260	0.223
2008	0.342	0.171
2009	0.106	0.144

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #2

Rank	Predeveloped	Mitigated
1	0.6541	0.6530
2	0.5513	0.4794
3	0.5469	0.4497
4	0.4746	0.4257

5	0.4644	0.3400
6	0.3803	0.3377
7	0.3423	0.3018
8	0.3204	0.2790
9	0.2917	0.2718
10	0.2896	0.2579
11	0.2653	0.2543
12	0.2595	0.2540
13	0.2488	0.2490
14	0.2477	0.2476
15	0.2045	0.2460
16	0.1899	0.2357
17	0.1858	0.2313
18	0.1837	0.2274
19	0.1717	0.2269
20	0.1716	0.2226
21	0.1705	0.2205
22	0.1659	0.2198
23	0.1607	0.2196
24	0.1531	0.2187
25	0.1526	0.2150
26	0.1513	0.2146
27	0.1491	0.2090
28	0.1447	0.2089
29	0.1403	0.1984
30	0.1377	0.1978
31	0.1360	0.1961
32	0.1304	0.1950
33	0.1284	0.1901
34	0.1281	0.1900
35	0.1242	0.1894
36	0.1239	0.1815
37	0.1235	0.1808
38	0.1225	0.1793
39	0.1220	0.1783
40	0.1159	0.1742
41	0.1137	0.1714
42	0.1119	0.1602
43	0.1099	0.1601
44	0.1083	0.1544
45	0.1066	0.1541
46	0.1060	0.1518
47	0.1046	0.1514
48	0.1036	0.1506
49	0.1035	0.1496
50	0.1032	0.1495
51	0.1029	0.1490
52	0.1019	0.1466
53	0.1008	0.1452
54	0.0970	0.1440
55	0.0962	0.1435
56	0.0915	0.1381
57	0.0891	0.1233
58	0.0881	0.1134
59	0.0881	0.1096
60	0.0780	0.1056
61	0.0396	0.0973

Duration Flows

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0746	11439	1943	16	Pass
0.0794	9240	1568	16	Pass
0.0843	7471	1297	17	Pass
0.0891	5963	1084	18	Pass
0.0940	5037	956	18	Pass
0.0988	4064	796	19	Pass
0.1037	3292	668	20	Pass
0.1086	2697	571	21	Pass
0.1134	2239	494	22	Pass
0.1183	1886	421	22	Pass
0.1231	1600	375	23	Pass
0.1280	1419	332	23	Pass
0.1328	1196	291	24	Pass
0.1377	1039	258	24	Pass
0.1425	904	225	24	Pass
0.1474	813	193	23	Pass
0.1523	722	173	23	Pass
0.1571	662	158	23	Pass
0.1620	621	143	23	Pass
0.1668	579	129	22	Pass
0.1717	532	122	22	Pass
0.1765	502	113	22	Pass
0.1814	475	98	20	Pass
0.1863	449	92	20	Pass
0.1911	430	81	18	Pass
0.1960	413	76	18	Pass
0.2008	384	71	18	Pass
0.2057	349	63	18	Pass
0.2105	330	54	16	Pass
0.2154	313	52	16	Pass
0.2202	300	44	14	Pass
0.2251	285	41	14	Pass
0.2300	278	36	12	Pass
0.2348	266	30	11	Pass
0.2397	256	29	11	Pass
0.2445	245	27	11	Pass
0.2494	236	23	9	Pass
0.2542	228	20	8	Pass
0.2591	213	16	7	Pass
0.2639	203	16	7	Pass
0.2688	195	16	8	Pass
0.2737	175	14	8	Pass
0.2785	167	13	7	Pass
0.2834	155	12	7	Pass
0.2882	146	12	8	Pass
0.2931	135	11	8	Pass
0.2979	127	11	8	Pass
0.3028	113	9	7	Pass
0.3077	99	8	8	Pass
0.3125	85	8	9	Pass
0.3174	77	7	9	Pass
0.3222	64	7	10	Pass
0.3271	55	7	12	Pass
0.3319	47	7	14	Pass

0.3368	33	7	21	Pass
0.3416	22	5	22	Pass
0.3465	18	5	27	Pass
0.3514	12	5	41	Pass
0.3562	11	5	45	Pass
0.3611	9	5	55	Pass
0.3659	9	5	55	Pass
0.3708	9	5	55	Pass
0.3756	9	5	55	Pass
0.3805	8	5	62	Pass
0.3853	7	5	71	Pass
0.3902	7	5	71	Pass
0.3951	7	5	71	Pass
0.3999	7	5	71	Pass
0.4048	7	5	71	Pass
0.4096	7	5	71	Pass
0.4145	6	5	83	Pass
0.4193	6	5	83	Pass
0.4242	6	5	83	Pass
0.4291	6	4	66	Pass
0.4339	6	4	66	Pass
0.4388	6	4	66	Pass
0.4436	6	4	66	Pass
0.4485	6	4	66	Pass
0.4533	6	3	50	Pass
0.4582	5	3	60	Pass
0.4630	5	3	60	Pass
0.4679	4	3	75	Pass
0.4728	4	3	75	Pass
0.4776	3	3	100	Pass
0.4825	3	2	66	Pass
0.4873	3	2	66	Pass
0.4922	3	2	66	Pass
0.4970	3	2	66	Pass
0.5019	3	2	66	Pass
0.5067	3	2	66	Pass
0.5116	3	2	66	Pass
0.5165	3	2	66	Pass
0.5213	3	2	66	Pass
0.5262	3	2	66	Pass
0.5310	3	2	66	Pass
0.5359	3	2	66	Pass
0.5407	3	2	66	Pass
0.5456	3	2	66	Pass
0.5505	2	2	100	Pass
0.5553	1	2	200	Fail

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

Water Quality

Water Quality BMP Flow and Volume for POC #2

On-line facility volume:	0.0458 acre-feet
On-line facility target flow:	0.0502 cfs.
Adjusted for 15 min:	0.0502 cfs.
Off-line facility target flow:	0.028 cfs.
Adjusted for 15 min:	0.028 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
South Vault POC	☐	26.47			☐	0.00			
Total Volume Infiltrated		26.47	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   Vault_mjh181210_vaultX2_final.wdm
MESSU       25   PreVault_mjh181210_vaultX2_final.MES
            27   PreVault_mjh181210_vaultX2_final.L61
            28   PreVault_mjh181210_vaultX2_final.L62
            30   POCVault_mjh181210_vaultX2_final1.dat
            31   POCVault_mjh181210_vaultX2_final2.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      PERLND      12
      COPY       501
      COPY       502
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        S1+N1+BP2_predev           MAX                    1    2   30    9
    2        South Basin Predev         MAX                    1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  502         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
   12     C, Forest, Steep        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
   12         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
   12         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
   12         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
   12              0       4.5      0.08       400      0.15       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
   12              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
   12            0.2       0.3      0.35         6       0.3       0.7
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS      IFWS       LZS      AGWS      GWVS
   11              0         0         0         0       2.5         1         0
   12              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           ***
  END GEN-INFO
  *** Section IWATER***

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

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

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

  IWAT-PARM2
```

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

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
S1+N1+BP2_predev***
PERLND  11                      11.319     COPY   501     12
PERLND  11                      11.319     COPY   501     13
South Basin Predev***
PERLND  12                        2.83     COPY   502     12
PERLND  12                        2.83     COPY   502     13

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

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



<-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
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    502 FLOW     ENGL      REPL
END EXT TARGETS

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

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


END MASS-LINK

END RUN
```

Mitigated UCI File

```
RUN

GLOBAL
  WWHM4 model simulation
  START       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   Vault_mjh181210_vaultX2_final.wdm
MESSU       25   MitVault_mjh181210_vaultX2_final.MES
            27   MitVault_mjh181210_vaultX2_final.L61
            28   MitVault_mjh181210_vaultX2_final.L62
            30   POCVault_mjh181210_vaultX2_final1.dat
            31   POCVault_mjh181210_vaultX2_final2.dat
END FILES

OPN SEQUENCE
    INGRP               INDELT 00:15
      PERLND      17
      IMPLND       2
      PERLND      16
      PERLND      11
      PERLND      14
      PERLND      15
      IMPLND       3
      IMPLND      10
      RCHRES       1
      RCHRES       2
      COPY         1
      COPY       501
      COPY       601
      COPY         2
      COPY       502
      COPY       602
      DISPLY       1
      DISPLY       2
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        North Vault                MAX                    1    2   30    9
    2        South Vault                MAX                    1    2   31    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
    2         1    1
  502         1    1
  602         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           ***
   17     C, Lawn, Mod              1    1    1    1   27    0
   16     C, Lawn, Flat             1    1    1    1   27    0
   11     C, Forest, Mod            1    1    1    1   27    0
   14     C, Pasture, Mod           1    1    1    1   27    0
   15     C, Pasture, Steep         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 ***
   17         0    0    1    0    0    0    0    0    0    0    0    0
   16         0    0    1    0    0    0    0    0    0    0    0    0
   11         0    0    1    0    0    0    0    0    0    0    0    0
   14         0    0    1    0    0    0    0    0    0    0    0    0
   15         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  *********
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   16         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   14         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   15         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 ***
   17         0    0    0    0    0    0    0    0    0    0    0
   16         0    0    0    0    0    0    0    0    0    0    0
   11         0    0    0    0    0    0    0    0    0    0    0
   14         0    0    0    0    0    0    0    0    0    0    0
   15         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
   17              0       4.5      0.03       400       0.1        0.5      0.996
   16              0       4.5      0.03       400      0.05        0.5      0.996
   11              0       4.5      0.08       400       0.1        0.5      0.996
   14              0       4.5      0.06       400       0.1        0.5      0.996
   15              0       4.5      0.06       400      0.15        0.5      0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   17              0         0         2         2         0         0         0
   16              0         0         2         2         0         0         0
   11              0         0         2         2         0         0         0
   14              0         0         2         2         0         0         0
   15              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   17            0.1      0.25      0.25         6       0.5      0.25
   16            0.1      0.25      0.25         6       0.5      0.25
   11            0.2       0.5      0.35         6       0.5       0.7
   14           0.15       0.4       0.3         6       0.5       0.4
   15           0.15      0.25       0.3         6       0.3       0.4
```

```
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
               ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS       GWVS
   17             0         0         0          0       2.5          1          0
   16             0         0         0          0       2.5          1          0
   11             0         0         0          0       2.5          1          0
   14             0         0         0          0       2.5          1          0
   15             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           ***
    2      ROADS/MOD              1    1    1   27    0
    3      ROADS/STEEP            1    1    1   27    0
   10      SIDEWALKS/STEEP        1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    2         0    0    1    0    0    0
    3         0    0    1    0    0    0
   10         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    2         0    0    4    0    0    0    1    9
    3         0    0    4    0    0    0    1    9
   10         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     ***
    2         0    0    0    0    0
    3         0    0    0    0    0
   10         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    2            400      0.05       0.1      0.08
    3            400       0.1       0.1      0.05
   10            400       0.1       0.1      0.05
  END IWAT-PARM2

  IWAT-PARM3
    <PLS >      IWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN
    2             0         0
    3             0         0
   10             0         0
  END IWAT-PARM3

  IWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
    # -  # ***  RETS      SURS
    2             0         0
```

```
    3              0         0
   10              0         0
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
DS1+DN1***
PERLND  17                       5.105     RCHRES   1      2
PERLND  17                       5.105     RCHRES   1      3
IMPLND   2                       6.041     RCHRES   1      5
DS2***
PERLND  15                        0.06     RCHRES   2      2
PERLND  15                        0.06     RCHRES   2      3
IMPLND   3                        0.09     RCHRES   2      5
IMPLND  10                        0.03     RCHRES   2      5
BP1***
PERLND  16                       0.154     COPY   502     12
PERLND  16                       0.154     COPY   602     12
PERLND  16                       0.154     COPY   502     13
PERLND  16                       0.154     COPY   602     13
PERLND  11                       0.081     COPY   502     12
PERLND  11                       0.081     COPY   602     12
PERLND  11                       0.081     COPY   502     13
PERLND  11                       0.081     COPY   602     13
PERLND  14                        0.07     COPY   502     12
PERLND  14                        0.07     COPY   602     12
PERLND  14                        0.07     COPY   502     13
PERLND  14                        0.07     COPY   602     13
IMPLND   2                      0.2608     COPY   502     15
IMPLND   2                      0.2608     COPY   602     15
BP2***
PERLND  17                       0.164     COPY   501     12
PERLND  17                       0.164     COPY   601     12
PERLND  17                       0.164     COPY   501     13
PERLND  17                       0.164     COPY   601     13
IMPLND   2                       0.009     COPY   501     15
IMPLND   2                       0.009     COPY   601     15

******Routing******
PERLND  17                       5.105     COPY     1     12
IMPLND   2                       6.041     COPY     1     15
PERLND  17                       5.105     COPY     1     13
PERLND  15                        0.06     COPY     2     12
IMPLND   3                        0.09     COPY     2     15
IMPLND  10                        0.03     COPY     2     15
PERLND  15                        0.06     COPY     2     13
RCHRES   1                           1     COPY   501     16
RCHRES   2                           1     COPY   502     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
COPY   502 OUTPUT MEAN   1 1   48.4        DISPLY   2     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     North Vault             1    1    1    1   28    0    1
    2     South Vault             1    1    1    1   28    0    1
  END GEN-INFO
  *** Section RCHRES***

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

  PRINT-INFO
    <PLS > ***************** Print-flags ****************** PIVL  PYR
    # -  # HYDR ADCA CONS HEAT  SED  GQL OXRX NUTR PLNK PHCB PIVL  PYR  *********
    1         4    0    0    0    0    0    0    0    0    0    1    9
    2         4    0    0    0    0    0    0    0    0    0    1    9
  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
    2      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      0.04       0.0       0.0       0.5       0.0
    2              2      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
    2           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
   91    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.298255  0.000000  0.000000
  0.150000  0.298255  0.044738  0.034053
  0.300000  0.298255  0.089477  0.048158
  0.450000  0.298255  0.134215  0.058981
  0.600000  0.298255  0.178953  0.068105
  0.750000  0.298255  0.223691  0.076144
  0.900000  0.298255  0.268430  0.083411
  1.050000  0.298255  0.313168  0.090095
  1.200000  0.298255  0.357906  0.096315
  1.350000  0.298255  0.402645  0.102158
  1.500000  0.298255  0.447383  0.107684
  1.650000  0.298255  0.492121  0.112939
  1.800000  0.298255  0.536860  0.117961
  1.950000  0.298255  0.581598  0.122778
  2.100000  0.298255  0.626336  0.127413
  2.250000  0.298255  0.671074  0.131885
  2.400000  0.298255  0.715813  0.136210
  2.550000  0.298255  0.760551  0.140402
  2.700000  0.298255  0.805289  0.144473
```

2.850000	0.298255	0.850028	0.148432
3.000000	0.298255	0.894766	0.152288
3.150000	0.298255	0.939504	0.156048
3.300000	0.298255	0.984242	0.159721
3.450000	0.298255	1.028981	0.163310
3.600000	0.298255	1.073719	0.166823
3.750000	0.298255	1.118457	0.170263
3.900000	0.298255	1.163196	0.173635
4.050000	0.298255	1.207934	0.176942
4.200000	0.298255	1.252672	0.180189
4.350000	0.298255	1.297410	0.183378
4.500000	0.298255	1.342149	0.186513
4.650000	0.298255	1.386887	0.189596
4.800000	0.298255	1.431625	0.192630
4.950000	0.298255	1.476364	0.195617
5.100000	0.298255	1.521102	0.198559
5.250000	0.298255	1.565840	0.201457
5.400000	0.298255	1.610579	0.204315
5.550000	0.298255	1.655317	0.207133
5.700000	0.298255	1.700055	0.209914
5.850000	0.298255	1.744793	0.212658
6.000000	0.298255	1.789532	0.215367
6.150000	0.298255	1.834270	0.218043
6.300000	0.298255	1.879008	0.220686
6.450000	0.298255	1.923747	0.223297
6.600000	0.298255	1.968485	0.225879
6.750000	0.298255	2.013223	0.228431
6.900000	0.298255	2.057961	0.230955
7.050000	0.298255	2.102700	0.233452
7.200000	0.298255	2.147438	0.235923
7.350000	0.298255	2.192176	0.238368
7.500000	0.298255	2.236915	0.240788
7.650000	0.298255	2.281653	0.243184
7.800000	0.298255	2.326391	0.245556
7.950000	0.298255	2.371129	0.247906
8.100000	0.298255	2.415868	0.250234
8.250000	0.298255	2.460606	0.252540
8.400000	0.298255	2.505344	0.254826
8.550000	0.298255	2.550083	0.257091
8.700000	0.298255	2.594821	0.259336
8.850000	0.298255	2.639559	0.261562
9.000000	0.298255	2.684298	0.263770
9.150000	0.298255	2.729036	0.265959
9.300000	0.298255	2.773774	0.268130
9.450000	0.298255	2.818512	0.270284
9.600000	0.298255	2.863251	0.272420
9.750000	0.298255	2.907989	0.274540
9.900000	0.298255	2.952727	0.407167
10.05000	0.298255	2.997466	0.485107
10.20000	0.298255	3.042204	0.541851
10.35000	0.298255	3.086942	0.588966
10.50000	0.298255	3.131680	0.630236
10.65000	0.298255	3.176419	0.667469
10.80000	0.298255	3.221157	0.701696
10.95000	0.298255	3.265895	0.733571
11.10000	0.298255	3.310634	0.763539
11.25000	0.298255	3.355372	0.791921
11.40000	0.298255	3.400110	0.818956
11.55000	0.298255	3.444848	0.844828
11.70000	0.298255	3.489587	0.869682
11.85000	0.298255	3.534325	0.893635
12.00000	0.298255	3.579063	0.916783
12.15000	0.298255	3.623802	0.939208
12.30000	0.298255	3.668540	0.960975
12.45000	0.298255	3.713278	0.982143
12.60000	0.298255	3.758017	1.002761
12.75000	0.298255	3.802755	1.022872
12.90000	0.298255	3.847493	1.220364
13.05000	0.298255	3.892231	2.466182
13.20000	0.298255	3.936970	4.153192

```
13.35000  0.298255  3.981708  5.738025
13.50000  0.298255  4.026446  6.793785
END FTABLE  1
FTABLE      2
 92    4
   Depth      Area    Volume  Outflow1 Velocity  Travel Time***
    (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
0.000000  0.021304  0.000000  0.000000
0.044444  0.021304  0.000947  0.001430
0.088889  0.021304  0.001894  0.002023
0.133333  0.021304  0.002841  0.002477
0.177778  0.021304  0.003787  0.002860
0.222222  0.021304  0.004734  0.003198
0.266667  0.021304  0.005681  0.003503
0.311111  0.021304  0.006628  0.003784
0.355556  0.021304  0.007575  0.004045
0.400000  0.021304  0.008522  0.004291
0.444444  0.021304  0.009468  0.004523
0.488889  0.021304  0.010415  0.004744
0.533333  0.021304  0.011362  0.004954
0.577778  0.021304  0.012309  0.005157
0.622222  0.021304  0.013256  0.005351
0.666667  0.021304  0.014203  0.005539
0.711111  0.021304  0.015149  0.005721
0.755556  0.021304  0.016096  0.005897
0.800000  0.021304  0.017043  0.006068
0.844444  0.021304  0.017990  0.006234
0.888889  0.021304  0.018937  0.006396
0.933333  0.021304  0.019884  0.006554
0.977778  0.021304  0.020831  0.006708
1.022222  0.021304  0.021777  0.006859
1.066667  0.021304  0.022724  0.007007
1.111111  0.021304  0.023671  0.007151
1.155556  0.021304  0.024618  0.007293
1.200000  0.021304  0.025565  0.007432
1.244444  0.021304  0.026512  0.007568
1.288889  0.021304  0.027458  0.007702
1.333333  0.021304  0.028405  0.007834
1.377778  0.021304  0.029352  0.007963
1.422222  0.021304  0.030299  0.008091
1.466667  0.021304  0.031246  0.008216
1.511111  0.021304  0.032193  0.008340
1.555556  0.021304  0.033139  0.008461
1.600000  0.021304  0.034086  0.008581
1.644444  0.021304  0.035033  0.008700
1.688889  0.021304  0.035980  0.008817
1.733333  0.021304  0.036927  0.008932
1.777778  0.021304  0.037874  0.009046
1.822222  0.021304  0.038821  0.009158
1.866667  0.021304  0.039767  0.009269
1.911111  0.021304  0.040714  0.009379
1.955556  0.021304  0.041661  0.009487
2.000000  0.021304  0.042608  0.009594
2.044444  0.021304  0.043555  0.009700
2.088889  0.021304  0.044502  0.009805
2.133333  0.021304  0.045448  0.009909
2.177778  0.021304  0.046395  0.010012
2.222222  0.021304  0.047342  0.010113
2.266667  0.021304  0.048289  0.010214
2.311111  0.021304  0.049236  0.010314
2.355556  0.021304  0.050183  0.010412
2.400000  0.021304  0.051129  0.010510
2.444444  0.021304  0.052076  0.010607
2.488889  0.021304  0.053023  0.010703
2.533333  0.021304  0.053970  0.010798
2.577778  0.021304  0.054917  0.010892
2.622222  0.021304  0.055864  0.010986
2.666667  0.021304  0.056811  0.011079
2.711111  0.021304  0.057757  0.011170
2.755556  0.021304  0.058704  0.011262
```

```
  2.800000  0.021304  0.059651  0.011352
  2.844444  0.021304  0.060598  0.011442
  2.888889  0.021304  0.061545  0.011531
  2.933333  0.021304  0.062492  0.011619
  2.977778  0.021304  0.063438  0.011707
  3.022222  0.021304  0.064385  0.046941
  3.066667  0.021304  0.065332  0.194114
  3.111111  0.021304  0.066279  0.401805
  3.155556  0.021304  0.067226  0.649372
  3.200000  0.021304  0.068173  0.919812
  3.244444  0.021304  0.069119  1.195779
  3.288889  0.021304  0.070066  1.459798
  3.333333  0.021304  0.071013  1.695854
  3.377778  0.021304  0.071960  1.891739
  3.422222  0.021304  0.072907  2.041939
  3.466667  0.021304  0.073854  2.150958
  3.511111  0.021304  0.074801  2.264447
  3.555556  0.021304  0.075747  2.360388
  3.600000  0.021304  0.076694  2.452565
  3.644444  0.021304  0.077641  2.541389
  3.688889  0.021304  0.078588  2.627202
  3.733333  0.021304  0.079535  2.710290
  3.777778  0.021304  0.080482  2.790899
  3.822222  0.021304  0.081428  2.869237
  3.866667  0.021304  0.082375  2.945486
  3.911111  0.021304  0.083322  3.019806
  3.955556  0.021304  0.084269  3.092336
  4.000000  0.021304  0.085216  3.163198
  4.044444  0.021304  0.086163  3.232505
  END FTABLE  2
END FTABLES

EXT SOURCES
<-Volume-> <Member> SsysSgap<--Mult-->Tran <-Target vols> <-Grp> <-Member->  ***
<Name>   # <Name> # tem strg<-factor->strg <Name>   #   #        <Name> # #  ***
WDM      2 PREC     ENGL    1.2           PERLND   1 999 EXTNL  PREC
WDM      2 PREC     ENGL    1.2           IMPLND   1 999 EXTNL  PREC
WDM      1 EVAP     ENGL    0.76          PERLND   1 999 EXTNL  PETINP
WDM      1 EVAP     ENGL    0.76          IMPLND   1 999 EXTNL  PETINP

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
RCHRES   1 HYDR   RO     1 1        1      WDM   1000 FLOW     ENGL      REPL
RCHRES   1 HYDR   STAGE  1 1        1      WDM   1001 STAG     ENGL      REPL
COPY     1 OUTPUT MEAN   1 1     48.4      WDM    701 FLOW     ENGL      REPL
COPY   501 OUTPUT MEAN   1 1     48.4      WDM    801 FLOW     ENGL      REPL
COPY   601 OUTPUT MEAN   1 1     48.4      WDM    901 FLOW     ENGL      REPL
COPY     2 OUTPUT MEAN   1 1     48.4      WDM    702 FLOW     ENGL      REPL
COPY   502 OUTPUT MEAN   1 1     48.4      WDM    802 FLOW     ENGL      REPL
COPY   602 OUTPUT MEAN   1 1     48.4      WDM    902 FLOW     ENGL      REPL
RCHRES   2 HYDR   RO     1 1        1      WDM   1002 FLOW     ENGL      REPL
RCHRES   2 HYDR   STAGE  1 1        1      WDM   1003 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

No. 3 – Closed Detention Systems (Tanks/Vaults)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
Storage Area	Plugged Air Vents	One-half of the cross section of a vent is blocked at any point or the vent is damaged.	Vents open and functioning.
	Debris and Sediment	Accumulated sediment depth exceeds 10% of the diameter of the storage area for 1/2 length of storage vault or any point depth exceeds 15% of diameter. (Example: 72-inch storage tank would require cleaning when sediment reaches depth of 7 inches for more than 1/2 length of tank.)	All sediment and debris removed from storage area.
	Joints Between Tank/Pipe Section	Any openings or voids allowing material to be transported into facility. (Will require engineering analysis to determine structural stability).	All joint between tank/pipe sections are sealed.
	Tank Pipe Bent Out of Shape	Any part of tank/pipe is bent out of shape more than 10% of its design shape. (Review required by engineer to determine structural stability).	Tank/pipe repaired or replaced to design.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch and any evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determines that the vault is not structurally sound. Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or any evidence of soil particles entering the vault through the walls.	Vault replaced or repaired to design specifications and is structurally sound. No cracks more than 1/4-inch wide at the joint of the inlet/outlet pipe.
Manhole	Cover Not in Place	Cover is missing or only partially in place. Any open manhole requires maintenance.	Manhole is closed.
	Locking Mechanism Not Working	Mechanism cannot be opened by one maintenance person with proper tools. Bolts into frame have less than 1/2 inch of thread (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).

No. 4 – 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 securely attached to wall and outlet pipe.
		Structure is not in upright position (allow up to 10% from plumb).	Structure in correct position.
		Connections to outlet pipe are not watertight and show signs of rust.	Connections to outlet pipe are water tight; structure repaired or replaced and works as designed.
		Any holes--other than designed holes--in the structure.	Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing.	Gate is watertight and works as designed.
		Gate cannot be moved up and down by one maintenance person.	Gate moves up and down easily and is watertight.
		Chain/rod leading to gate is missing or damaged.	Chain is in place and works as designed.
		Gate is rusted over 50% of its surface area.	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).

No. 5 – Catch Basins

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

No. 5 – Catch Basins

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

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

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

No. 12 – 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 Frame and/or Top Slab	Maintenance/inspection personnel determine that the vault is not structurally sound.	Vault replaced or repairs made so that vault meets design specifications and is structurally sound.
		Cracks wider than 1/2-inch at the joint of any inlet/outlet pipe or evidence of soil particles entering through the cracks.	Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles	Baffles corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection staff.	Baffles repaired or replaced to specifications.
	Access Ladder Damage	Ladder is corroded or deteriorated, not functioning properly, not attached to structure wall, missing rungs, has cracks and/or misaligned. Confined space warning sign missing.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel. Replace sign warning of confined space entry requirements. Ladder and entry notification complies with OSHA standards.

No. 18 – Catchbasin 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 Normal 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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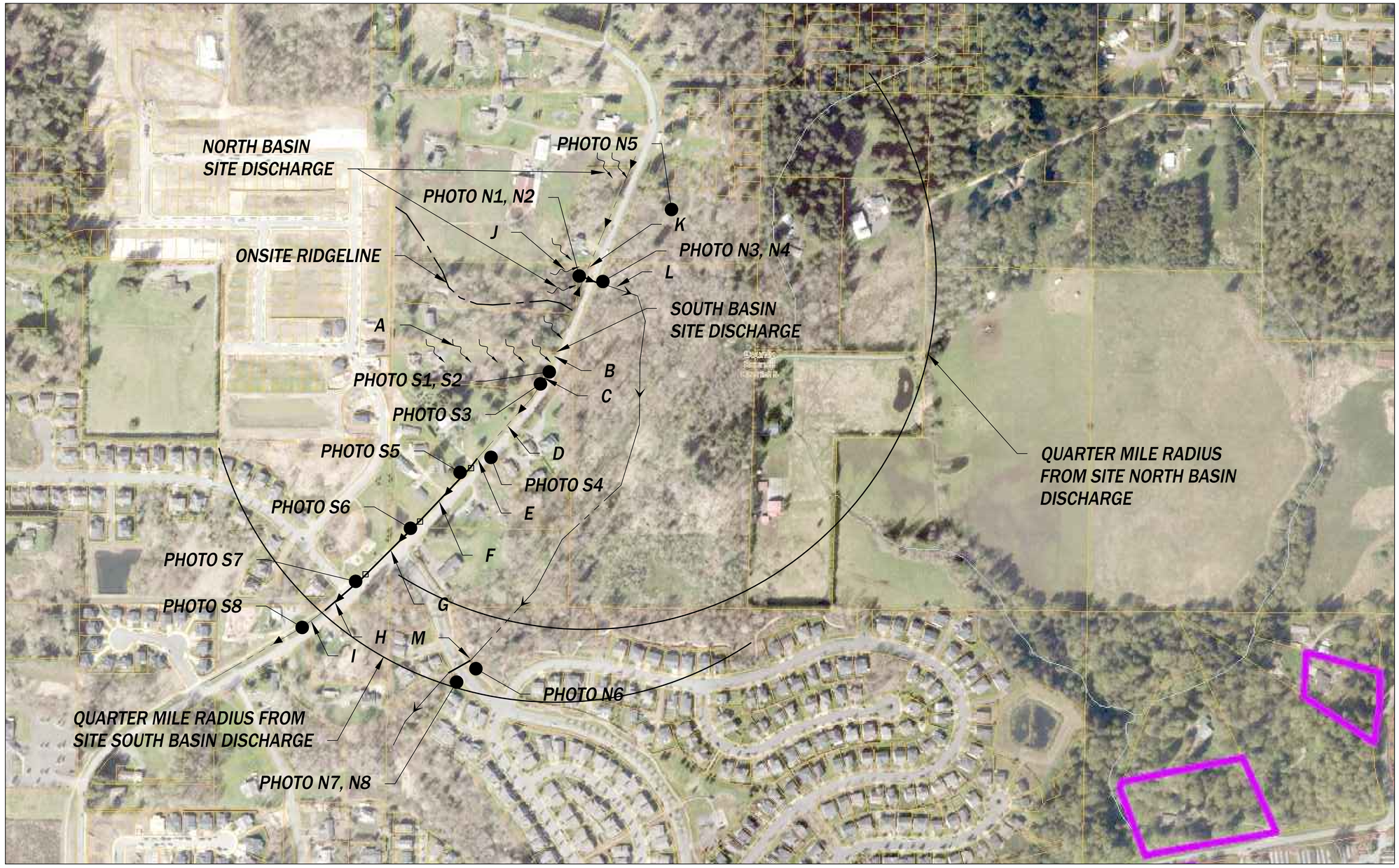
APPENDIX D

DOWNSTREAM ANALYSIS



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PLAN IN FEET

NOTE:
1. THE AERIAL OTHER MAP AND PIPE SYSTEM INFORMATION SHOWN ON THIS MAP IS FROM THE PUBLIC WEB PORTAL FOR INTERACTIVE MAPPING PROVIDED BY SNOHOMISH COUNTY. IT IS INTENDED FOR A VISUAL OF THE OFFSITE ANALYSIS PURPOSES ONLY AND DOES NOT REFLECT SURVEY ACCURACY FOR ANY OTHER PURPOSE.

DOWNSTREAM PIPE
DOWNSTREAM CB
DOWNSTREAM DITCH
STREAM/WETLAND
SHEET FLOW

DOWNSTREAM ANALYSIS MAP

P:\project\0054118028\Reports\TIR\CAD\Appendix D_Downstream Analysis Map.dwg
11/13/2018 10:18 AM ANDREW STEPHENSON

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE
SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Woods Creek **Subbasin Name:** **Subbasin Number:**

Symbol	Drainage Component Type, Name, and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems	Potential Problems	Observations of field inspector, resource reviewer, or resident
see map	Type: sheet flow, swale, stream, channel, pipe, pond; Size: diameter, surface area	drainage basin, vegetation, cover, depth, type of sensitive area, volume	%	¼ ml = 1,320 ft.	constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion		tributary area, likelihood of problem, overflow pathways, potential impacts
A	Sheet Flow	Dense Forest Vegetation	8-15%	*0 ft.	None	None	*Sheet Flow begins along full extent of site's south property boundary (0-500ft upstream of ditch); Downstream analysis begins at site's SE corner.
B	Ditch	Grass Vegetation	0-5%	0-64 ft.	None	None	
C	Culvert, Conc. 12"	Pipe end buried	0-5%	64-82 ft.	None	None	Pipe end buried, Ditch sedimentation and overgrown vegetation evident
D	Ditch	Grass Vegetation	0-5%	82-532 ft.	None	None	
E	SD Pipe, PVC 12"	Exist. SD Infrastructure	0-5%	532-554 ft.	None	None	
F	SD Pipe, PVC 12"	Exist. SD Infrastructure	0-5%	554-823 ft.	None	None	
G	SD Pipe, PVC 12"	Exist. SD Infrastructure	0-5%	823-1152 ft.	None	None	
H	SD Pipe, PVC 12"	Exist. SD Infrastructure	0-5%	1152-1320+ ft.	None	None	
I	Ditch	Pipe daylights, Grass Vegetation	0-10%	1320+ ft.	None	None	Ditch continues downstream to Woods Creek, Skykomish River

Photo S1, above: Looking north at the southeast corner of the site, runoff sheet flows southerly from on-site topographic ridge and easterly to vegetated ditch along Chain Lake Road right-of-way. The site is developed and comprised of pasture, single family homes, and outlying structures.

Photo S2, right: Looking southerly, runoff continues downstream in right-of-way ditch and enters 12" concrete culvert 64 feet from site.

Photo S3, left: Looking north, ditch continues southerly and flow through 12" concrete culvert shown in Photo #2 and daylights 22 LF south, 82 feet from site.

Photo S4, left: Looking south, a buried culvert of unidentified material conveys runoff in ditch under second driveway. Photo taken approximately 532 feet downstream.

Photo S5, right: Looking north, 12” PVC pipe ends at open grate catch basin approximately 554 feet downstream, which conveys runoff in ditch under second driveway.

Photo S6, left: Looking north, 12” PVC pipe ends at open grate catch basin approximately 823 feet downstream, which conveys runoff in existing storm drainage infrastructure.

Photo S7, left: Looking north, 12” PVC pipe ends at open grate catch basin approximately 1,152 feet downstream, which conveys runoff in existing storm drainage infrastructure.

Photo 8, right: Looking north, 12” PVC pipe daylights approximately 1344 feet downstream, beyond the 1,320 feet (1/4 mile) threshold, which ends the South Basin downstream analysis. Runoff continues downstream in ditch to Woods Creek, to the Skykomish River as part of the Snohomish River watershed.

OFF-SITE ANALYSIS DRAINAGE SYSTEM TABLE
SURFACE WATER DESIGN MANUAL, CORE REQUIREMENT #2

Basin: Woods Creek **Subbasin Name:** **Subbasin Number:**

Symbol	Drainage Component Type, Name, and Size	Drainage Component Description	Slope	Distance from site discharge	Existing Problems	Potential Problems	Observations of field inspector, resource reviewer, or resident
see map	Type: sheet flow, swale, stream, channel, pipe, pond; Size: diameter, surface area	drainage basin, vegetation, cover, depth, type of sensitive area, volume	%	¼ ml = 1,320 ft.	constrictions, under capacity, ponding, overtopping, flooding, habitat or organism destruction, scouring, bank sloughing, sedimentation, incision, other erosion		tributary area, likelihood of problem, overflow pathways, potential impacts
J	Sheet Flow	Dense grass vegetation	0-33%	50 ft. and *460 ft.	None	None	50 ft upstream to site's west discharge location, *460 ft to site's east discharge location (see downstream map)
K	Pipe, 12" PVC	Pipe extends 4.7' from daylight	3%	50-94 ft.	None	None	Pipe condition: Like New
L	Stream	Dense grass vegetation	0-3%	94 ft. - 1320+ ft.	None	None	Vegetation too dense to continue downstream
M	Culvert	No existing or potential problems visible	0-3%	1320+ ft.	None	None	Vegetation too dense to observe

Photo N1, left: Looking north, sheet flow from site's north basin flows easterly to ditch along west frontage of Chain Lake Road right-of-way and converges to a single natural discharge point as shown in photo.

Photo N2, below: Looking southerly, a close-up photo of a 12" PVC pipe culvert in great condition conveys runoff 44 LF southeasterly where runoff daylights into vegetated stream.

Photo N3, above: Runoff is conveyed through 12" PVC pipe in great condition and extends 4.7' from grade to wetland area where runoff daylights and discharges to open channel flow. Photo taken approximately 90 feet downstream.

Photo N4, right: Runoff is conveyed along an open channel at this location within a wetland area and continues downstream in densely-vegetated conditions. The downstream path could not be followed further due to private property restrictions and impenetrable vegetation. However, from the topography of the area it is believed that the runoff continues southeast as open channel flow and stream-like conveyance beyond the quarter (0.25) mile downstream threshold.

Photo N5, above: Photo taken approx. 230 LF outside the downstream path of conveyance. Runoff continues downstream within the densely-vegetated wetland area and likely turns southerly.

Photo N6, below: Photo taken past the quarter (0.25) mile threshold at approximately 1,700 feet downstream, runoff reaches a culvert downstream in densely-vegetated wetland area and enters a likely functional culvert with no visible potential problems.

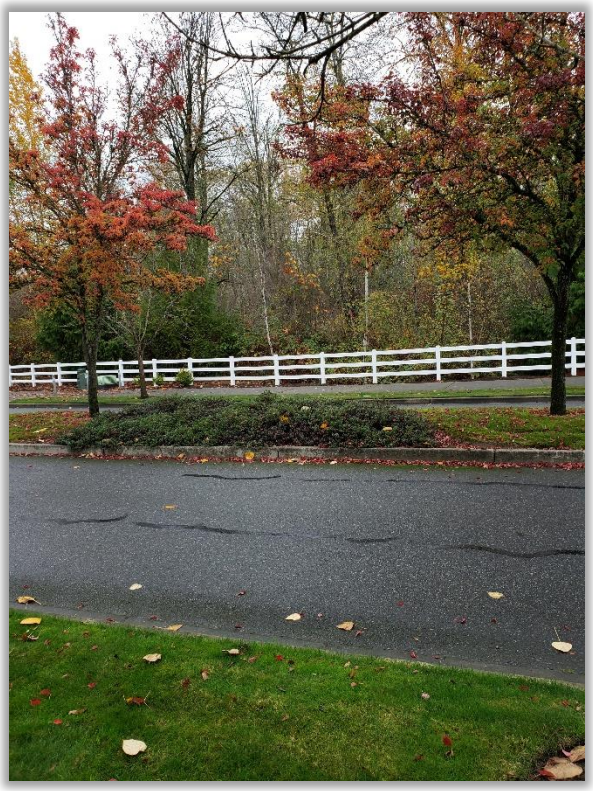

Photo N7, left: Runoff is conveyed through culvert not visible from level 1 downstream analysis and no potential problems are visible. This photo was taken beyond the quarter (0.25) mile downstream threshold.

Photo N8, right: Photo taken approximately 1,750 feet downstream, runoff daylights at end of existing culvert with no visible existing problems nor potential problems evident and continues downstream beyond the quarter (0.25) mile downstream threshold where a series of wetland areas and culverts convey surface water to the Skykomish river as part of the Snohomish river watershed.