Minor Property

Drainage Report

Presented to: City of Marysville

Minor Property

Construction Drainage Report

Prepared for

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SECTION 1: PROJECT OVERVIEW

The proposed Minor project is approximately a 3.94-acre site. The project is a single-family residential development on parcel #00590700017600 and addressed at 8512 E Sunnyside School Road, Marysville WA, 98270. The project proposes to construct 29 new single-family lots along with associated private and public utilities proposed to serve project development. The site will gain access from the adjacent Cornelius/Lacey project to the west. No frontage improvements along E Sunnyside School Rd will be required. See the Vicinity Map in Appendix 1 for visual representation of the subject property.

Existing Site

The parcel #00590700017600 is currently occupied by one single family home with associated outbuildings taking access from E Sunnyside School Rd. The central portion of the site containing the existing home consists of impervious surfaces associated with the buildings and paved driveways, while the rest of the site contains lawn and landscape. Existing topography generally descends to the north/northeast along moderate slopes, towards conveyance ditches along E Sunnyside School Rd. The project parcel is currently zoned WR-R-6-18 in the City of Marysville.

The proposed development currently straddles two stormwater threshold discharge basins (TDAs) since site runoff from developed surfaces splits to either the Northwest or southeast upon reaching the E Sunnyside School Rd conveyance system, prior to reaching the ¼ mile boundary downstream of the project site.

A Geotechnical Report has been prepared by Terra Associates on January 25, 2024 on the site. The report indicates "relatively high soil fines content, evidence of shallow perched groundwater, and the underlying presence of dense to very dense, cemented, till and till-like soils." As a result, Terra does not recommend using infiltration for stormwater control onsite.

Proposed Development

The proposed single-family project will construct 29 new single-family lots and will gain access from the adjacent Cornelius/Lacey project to the west upon its completion. Frontage improvements along E Sunnyside School Rd will not be required.

Proposed Drainage System

This project is designed to comply with the 2019 Department of Ecology Stormwater Manual for Western Washington (2019 DOE SWMMWW). Stormwater will be mitigated via two detention vaults located along the northwestern and eastern portions of the site. Prior to vault intake, Perkfilter cartridge filtration units will be used to treat stormwater runoff to meet basic water quality treatment requirements. The proposed detention vault systems will each discharge to their respective existing frontage conveyance ditches in E Sunnyside School Rd, thus maintaining the site's two natural discharge flow paths.

Onsite development will create 2.42 AC of new impervious surfaces which will be collected by either of the two detention vaults for mitigation and stormwater quality treatment. These areas are considered to be within the two Onsite Basins for stormwater modeling, which are referred to as Onsite Basin 1 and Onsite Basin 2 respectively. Upstream run-on from the property to the south will be collected and contribute to the Onsite Basin 2. Runoff from surfaces unable to be collected due to vertical constraints, approximately 0.16 AC, will be considered to bypass detention and be within the Bypass Basin(s).

Erosion/Sedimentation Control

Erosion control measures that will be utilized during construction will include a combination of silt fence, storm drain inlet protection, interceptor swales, and sediment ponds. See Section 2.0 for discussion of how SWPPP Elements are addressed.

Minimum Requirements

Per the 2019 DOE Manual, Minimum Requirements 1-9 apply to the proposed development.

Minimum Requirement #1: Preparation of Stormwater Site Plans

This report along with the preliminary plans satisfies the minimum requirement.

Minimum Requirement #2: Construction Stormwater Pollution Prevention

See Section 2 of this Report for the SWPPP BMP Elements, and the SWPPP (submitted as a separate document) for a complete discussion of erosion control BMP's and their use specific to the site.

Minimum Requirement #3: Source of Pollution
Permanent source control BMPs are not applicable for the subject site since the associated activities for the new residence do not fall within the types of facilities listed within Volume IV of the DOE Manual (Residential developments are not required to implement source control BMP's). BMPs for erosion and sedimentation control will be specified in the Construction Plans and the CSWPP.

Minimum Requirement #4: Preservation of Natural Drainage Systems and Outfalls
Flow from the site will preserve its natural drainage patterns to the north towards E Sunnyside School Rd frontage. Runoff then flows either towards King Creek to the west of the site, or to Stevens Creek to the southeast of the site.

Minimum Requirement #5: On-Site Stormwater Management
The project proposes BMP T5.13 soils to be underlain within all pervious areas that are disturbed by development. Generally, all other infiltration-related BMPs are infeasible due "relatively high soil fines content, evidence of shallow perched groundwater, and the underlying presence of dense to very dense, cemented, till and till-like soils" per Geotechnical analysis. Generally, other dispersion related BMPs are considered infeasible due to the absence of adequate flow path lengths. Please see Section 4.5 for additional discussion of Onsite Stormwater Management and Low Impact Development BMP feasibility.

Minimum Requirement #6: Runoff Treatment
Proposed new pollution generating impervious surfaces (PGIS) will exceed the 5,000 SF threshold and thus basic water quality treatment will be provided via water quality treatment structures that will treat stormwater runoff discharging from the stormwater detention vaults. Two Perkfilter cartridge filtration units are proposed for this purpose. See Section 4.0 for additional discussion regarding proposed stormwater management and water quality treatment measures.

Minimum Requirement #7: Flow Control
The project will exceed the 10,000 SF new plus replaced impervious threshold within each TDA, thus is required to provide flow control. Two concrete detention vaults will be installed in the northwestern and eastern portions of the project site, accessible via access Tracts. The vaults will discharge via point discharges at historic, mitigated rates towards existing flow paths along E Sunnyside School Rd frontage. Please see Section 4.0 for additional flow control modeling and parameters for detention sizing.

Minimum Requirement #8: Wetlands Protection
There are no critical wetland areas, streams, or associated buffers on/within close proximity to the project site.

Minimum Requirement #9: Operation and Maintenance
See Operations and Maintenance in Section 6 of this report.

SECTION 2: TEMPORARY EROSION AND SEDIMENT CONTROL DESIGN

SWPPP Design Elements

A Construction Stormwater Pollution Prevention Plan (SWPPP) will be provided prior to construction. The SWPPP report is modeled under the guidelines of I.3.4.2 MR2 of the DOE Manual. Construction SWPPP Elements #1 through #13 are addressed below.

Element #1 – Mark Clearing Limits

All clearing limits will be delineated with high visibility plastic fence and/or silt fence. See sheets ER-01 of the construction plans (to be submitted at a later date) for locations and details.

Element #2 – Establish Construction Access

Stabilized construction accesses will be installed as shown on the preliminary plans. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for locations and details.

Element #3 – Control Flow Rates

Detention of construction period runoff will be provided by means of sediment ponds on the site. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for location and details for flow and sediment control BMP's.

Element #4 – Install Sediment Controls

Silt fence, catch basin protection, and the temporary sediment pond will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for locations and details.

Element #5 – Stabilize Soils

Exposed soils will be stabilized as specified in the Grading and Erosion Control Notes with temporary and permanent seeding, mulching, and plastic covering. See sheet ER-02 of the construction plans (to be submitted at a later date) for notes.

Element #6 – Protect Slopes

Slopes are minor on the subject site. Slopes shall be protected as specified under Element #5.

Element #7 – Protect Drain Inlets

Storm drain inlet protection will be utilized to contain sediments within the project's clearing limits. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for locations and details.

Element #8 – Stabilize Channels and Outlets

Temporary channels, shall be stabilized with check dams. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for locations and details.

Element #9 – Control Pollutants

Pollutants shall be controlled as specified in Volume IV of the 2019 DOE Manual—Source Control BMPs to address potential sources of pollution which may exacerbate possible soil/groundwater contamination identified onsite.

Element #10 – Control De-Watering

There will be no de-watering as a part of this project. See sheet ER-02 of the construction plans (to be submitted at a later date) for notes.

Element #11 – Maintain BMPs

Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for the Construction Sequence and notes.

Element #12: Manage the Project

The Grading and Erosion Control Notes specify seasonal work limitations. Maintenance of the BMPs is specified within the Construction Sequence and Grading and Erosion Control Notes. See sheets ER-01 and ER-02 of the construction plans (to be submitted at a later date) for the Construction Sequence and notes.

Element #13: Protect on-site stormwater management BMPs

On-site stormwater management BMPs used for runoff from roofs and other hard surfaces are not feasible due to soil conditions and proposed project density.

SECTION 3: DOWNSTREAM ANALYSIS

Task 1. Study Area Definition and Maps

Snohomish County Bare Earth LiDAR, survey, and 2021 aerial photography were the best topographical references available for the area containing the site. The limits of the downstream analysis extend roughly 0.25 miles beyond the subject property's natural discharge location.

Task 2. Resource Review

All of the resources below have been reviewed for existing and potential issues near the project site:

Adopted Basin Plans
No Adopted Basin Plans were located that include the project site.

Drainage Basin
This site is split between two TDAs. One is in the King Creek subbasin, within the Ebey Slough watershed. The other is in the Stevens Creek Subbasin, which is tributary to Lake Stevens followed by the Snohomish River.

Floodplain / Floodway (FEMA) maps
Per FEMA Floodplain map #53061C0736F the subject property is not within a floodplain.

Critical Areas Map
There are no critical wetland areas, streams, or associated buffers on/within close proximity to the project site.

Drainage Complaints
No relevant issues were identified near the proposed site.

Road Drainage Problems
No issues were identified near the proposed site.

Soil Survey
Site soils are classified as Tokul gravelly medial loam (0 to 8 percent slopes) which is classified as Hydrologic Soil Group B. Per geotechnical analysis, site soils do not exhibit acceptable infiltration rates, which is consistent with NRCS soil mapping data.

Wetland Inventory Maps
There are no critical wetland areas, streams, or associated buffers on/within close proximity to the project site.

Migrating River Studies
Migrating River Studies are not considered applicable to the proposed development.

Section 303d List of Polluted Waters
Washington State Department of Ecology's Water Quality Assessment for Washington contains listings for King creek and Stevens Creek which the project is tributary to. Please refer to Appendix 3 for copies of applicable 303(d) listings.

Water Quality Problems
King Creek has a category 5 listing in the DOE Water Quality Assessment Review tools for temperature, while Stevens Creek does not have any listings. The development however will improve water quality tributary to the creek via basic treatment device(s).

Stormwater Compliance Plans
Not applicable to the proposed project.

Task 3. Field Inspection/Downstream Analysis
On November 27th, 2023, a Downstream Analysis was performed at the site. The weather consisted of 46ºF and clear skies. The following observations were verified during the visit.

The subject property areas consist primarily of flat to moderately sloped lawn areas surrounding the existing home, associated outbuildings, and driveways that are located in the central/southern portion of the site. There are some areas of upstream sheet flow from the property to the south due to existing topography.

Two flow paths have been identified leaving the east and west sides of the parcel that do not converge within one quarter mile of the site. As a result, the site is located within two threshold discharge areas (TDAs). Both flow paths are formed where runoff travels north towards E Sunnyside School Rd on either the west or east side of the TDA basin split (Image 1).

TDA #1 / Flowpath 1 – Overland flows traveling northwest are collected by an existing roadside ditch along E Sunnyside School Rd (Images 2 & 3). The ditch carries runoff to an existing pond/wetland area (Image 4) located on the neighboring property to the west. Overflow from the pond/wetland travels back to E Sunnyside School Rd (Image 5), crossing under the road to the north side (Image 6). Flow becomes more concentrated as it continues along the north side of E Sunnyside School Rd towards the intersection with 83rd Ave NE. Flow converges at a pipe crossing west under 83rd Ave NE (Image 9) The pipe outlets on the west side of 83rd Ave NE (Image 10), where King Creek continues beyond the quarter mile boundary.

TDA #2 / Flowpath 2 – Overland flows traveling northeast are collected by an existing roadside ditch along E Sunnyside School Rd (Images 11 & 12). The roadside ditch continues east along E Sunnyside School Rd to the eastern property corner (Image 13). E Sunnyside School Road begins to turn southeast beyond the property and the ditch continues under several driveway-culvert crossings (Image 14) until it reaches Densmore Rd. The flow crosses under Densmore Rd (Image 15) and continues southeast beyond the quarter mile buffer (Image 16), eventually joining Stevens Creek.

Task 4. Drainage System Description and Problem Descriptions
Based on the information available and all the resources available including visual inspection of the downstream flow path to the ¼-mile boundary, there is no evidence of existing or anticipated downstream drainage problems. All flows are adequately carried through natural channels to the quarter mile buffer of analysis.

Task 5. Mitigation of Existing or Potential Drainage Problems
No evidence of existing or potential problems with downstream drainage conveyance infrastructure was found. Mitigation is not required.

SECTION 4: DETENTION AND WATER QUALITY TREATMENT DESIGN

4.1 Predeveloped Site Hydrology

The pre-developed and developed conditions were modeled in WWHM for the purpose of matching historic, forested condition flow rates and durations. Based on the site location, the WWHM used the Everett Gage with a Precipitation Scale factor of 1.2. For visual representation of the listed basins, see Figure 4.0, "Predeveloped Hydrology Map".

Onsite Basin 1:

The predeveloped condition applied to the Onsite Basin 1 results in a forested land cover condition. This basin is tributary to TDA 1 and the values modeled in WWHM are as follows:

Table 1: Predeveloped Conditions: Onsite Basin 1

Onsite Basin 1	
Ground Cover	Area (acre)
Forest, mod	0.90
Forest, steep	0.18
Total	**1.08**

Onsite Basin 2:

The predeveloped condition applied to the Onsite Basin 2 results in a forested land cover condition. This basin is tributary to TDA 2 and the values modeled in WWHM are as follows:

Table 2: Predeveloped Conditions: Onsite Basin 2

Onsite Basin 2	
Ground Cover	Area (acre)
Forest, mod	2.00
Forest, steep	0.77
Total	**2.77**

Upstream Basin:

The predeveloped condition applied to the Upstream Basin results in existing land cover condition. In the developed condition, this basin will be collected alongside Onsite Basin 2. The values as modeled in WWHM are as follows:

Table 3: Predeveloped Conditions: Upstream Basin

Upstream Basin	
Ground Cover	Area (acre)
Forest, mod	0.80
Lawn, mod	0.20
Rooftops	0.12
Driveways, flat	0.23
Total	**1.35**

4.2 Developed Site Hydrology

In the developed condition, the proposed residential project will construct 29 single-family lots. Emergency and standard access drives along with associated private and public utilities are proposed to serve project development.

In compliance with the City of Marysville Design & Development Standards and the 2019 DOE Manual, all runoff from onsite developed/disturbed surfaces will be collected, treated, and discharged directly to existing/historic flow paths or will bypass detention and be mitigated within the proposed flow control system. Lots were modeled to have 65% impervious coverage.

Onsite Basin 1:

The developed Onsite Basin is 1.00 acres and includes the majority of the developed site within its TDA 1 boundaries. In the developed condition, the Onsite Basin has been modeled using WWHM with the following areas and ground cover designations:

Table 4: Developed Conditions: Onsite Basin 1

Onsite Basin 1	
Ground Cover	Area (acre)
Pasture, flat	0.40
Roads, flat	0.08
Rooftops	0.33
Driveways, flat	0.16
Sidewalks, flat	0.03
Total	**1.00**

Bypass Basin 1:

Bypass Basin 1 is 0.08 acres and is comprised of sloped landscape area adjacent to the detention vault/within Tract 999 that cannot be topographically collected into the detention system. Bypass Basin 1 was modeled using WWHM with the following areas and ground cover designations:

Table 5: Developed Conditions: Bypass Basin 1

Bypass Basin 1	
Ground Cover	Area (acre)
Pasture, mod	0.04
Pasture, steep	0.04
Total	**0.08**

Onsite Basin 2:

The developed Onsite Basin is 2.67 acres and includes the majority of the developed site within its TDA 2 boundaries. In the developed condition, the Onsite Basin has been modeled using WWHM with the following areas and ground cover designations:

Table 6: Developed Conditions: Onsite Basin 2

Onsite Basin 2	
Ground Cover	Area (acre)
Pasture, flat	0.84
Roads, flat	0.29
Rooftops	1.00
Driveways, flat	0.45
Sidewalks, flat	0.09
Total	**2.67**

Bypass Basin 2:
Bypass Basin 2 is 0.10 acres and is comprised of sloped landscape area adjacent to the detention vault/within Tract 998 and Lot 29 that cannot be topographically collected into the detention system. Bypass Basin 2 was modeled using WWHM with the following areas and ground cover designations:

Table 7: Developed Conditions: Bypass Basin 2

Bypass Basin 2	
Ground Cover	Area (acre)
Pasture, mod	0.06
Pasture, steep	0.04
Total	**0.10**

Upstream Basin:
The developed condition applied to the Upstream Basin results in existing land cover condition. In the developed condition, this basin will be collected alongside Onsite Basin 2. The values as modeled in WWHM are as follows:

Table 8: Developed Conditions: Upstream Basin

Upstream Basin	
Ground Cover	Area (acre)
Forest, mod	0.80
Lawn, mod	0.20
Rooftops	0.12
Driveways, flat	0.23
Total	**1.35**

4.3 Detention Facility Design

The proposed detention vault facilities used for mitigating developed condition flows were designed in compliance with the 2019 DOE requirements to model hydrologic conditions and detention in a continuous runoff model (WWHM2012) where the following evaluation parameters are employed:

> *"Flow duration is computed by counting the number of flow values that exceed a specified flow level. The specified flow levels used by WWHM in the flow duration*
> *analysis are listed below.*
> 1. *50% of the 2-year predevelopment peak flow.*
> 2. *100% of the 2-year predevelopment peak flow.*
> 3. *100% of the 50-year predevelopment peak flow.*
>
> *There are three criteria by which flow duration values are compared:*
> 1. *If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 50% and 100% of the 2-year predevelopment peak flow values (100 Percent Threshold) then the flow duration requirement has not been met.*
> 2. *If the postdevelopment flow duration values exceed any of the predevelopment flow levels between 100% of the 2-year and 100% of the 50-year predevelopment peak flow values more than 10 percent of the time (110 Percent Threshold) then the flow duration requirement has not been met.*
> 3. *If more than 50 percent of the flow duration levels exceed the 100 percent threshold then the flow duration requirement has not been met."*

Detention Vault Facilities
The proposed cast in place concrete detention vault facilities detains, and releases collected storm water runoff from the two Onsite Basins. The facilities are located within Tract 999 (Vault 1) and Tract 998 (Vault 2). Flows from the Onsite Basin are collected and conveyed to the detention vault via a proposed network of catch basins and storm water conveyance pipes.

Detailed WWHM output is provided in Appendix 4. A summary of the detailed statistics and inputs used for modeling the system in WWHM2012 can be found below.

Table 9.1: Detention Vault 1 Design Summary

Detention Vault 1	
Live Storage Bottom Area (modeled)	*2,200 SF*
Live Storage Bottom Area (provided)	*2,200 SF*
Number of Cells	*1*
Cell Dimensions	*22' x 100'*
Begin Live Storage Elevation	343.00'
Riser Height	6.00'
Volume (modeled)	13,200 CF
Volume (provided)	13,200 CF
Top of Riser Elevation	349.00'
Top Outside of Vault Elevation	350.50'

See table below for the flow rates and water surface elevations by storm event for detention vault 1.

Table 10.1: Flow Rates and Water Surface Elevations by Storm Event

Storm Event	Predeveloped Rate (cfs)	Mitigated Rates (cfs)
2-Year	0.0429	0.0251
10-Year	0.0895	0.0456
50-Year	0.1459	0.0719
100-Year	0.1747	0.0860

The table below is design summary for Detention Vault 2.

Table 9.2: Detention Vault 2 Design Summary

Detention Vault 2	
Live Storage Bottom Area (modeled)	*4,968 SF*
Live Storage Bottom Area (provided)	*4,968 SF*
Number of Cells	*2*
Cell Dimensions	*(23' x 140') & (23' x 76')*
Begin Live Storage Elevation	337.00'
Riser Height	6.50'
Volume (modeled)	32,292 CF
Volume (provided)	32,292 CF
Top of Riser Elevation	403.50'
Top Outside of Vault Elevation	405.00'

See table below for the flow rates and water surface elevations by storm event for the detention vault 2.

Table 10.2: Flow Rates and Water Surface Elevations by Storm Event

Storm Event	Predeveloped Rate (cfs)	Mitigated Rates (cfs)
2-Year	0.3216	0.1609
10-Year	0.6210	0.2542
50-Year	0.9733	0.3601
100-Year	1.1519	0.4127

4.4 Water Quality Treatment

Perkfilter 1 - West
Water Quality Treatment for the Onsite Basin 1 is accomplished through a Perkfilter structure located upstream of the detention vault 1. A summary of design criteria is provided below:

Table 11: Perkfilter 1 Design Summary

48" Ø Perkfilter Manhole	
Tributary Area	*1.00 AC*
Tributary Impervious Area	*0.60 AC*
Water Quality Flow Rate	0.062 cfs
2-yr unmitigated peak	0.33 cfs
Number of Cartridges	2
Cartridge Height	12"+18"
Internal Drop	2.3'
Peak Flow Rate	1.23 cfs
Peak Flow Storm Event	100-year

Perkfilter 2 - East
Water Quality Treatment for the Onsite Basin 2 is accomplished through a Perkfilter structure located upstream of the detention vault 2. A summary of design criteria is provided below:

Table 12: Perkfilter 2 Design Summary

Perkfilter Vault – 6'x8'	
Tributary Area	*4.02 AC*
Tributary Impervious Area	*2.18 AC*
Water Quality Flow Rate	0.233 cfs
2-yr unmitigated peak	1.24 cfs
Number of Cartridges	9
Cartridge Height	12"+18"
Internal Drop	2.3'
Peak Flow Rate	4.48 cfs
Peak Flow Storm Event	100-year

4.5 Onsite Stormwater Management

The project does not propose the LID performance standard and minimum requirements 1-9 are required for the project but choose to implement List #2 to evaluate low impact design. The following BMP's below are assessed for implementation:

Lawn and Landscaped Areas:

1. *Post-Construction Soil Quality and Depth*
    - BMP T5.13 soils will be applied to all permeable and landscaped areas in developed condition.
        i. **Conclusion: Infeasible**

Roofs:

1. *Downspout Full Infiltration per BMP T5.10A or Downspout Full Dispersion per BMP T5.30*
    - Infiltration is not feasible on site, which has been confirmed by testing found in the geotechnical report and thus BMP T5.10A is infeasible. Due to site specific constraints including building and fire lane location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site per BMP T5.30.
        i. **Conclusion: Infeasible**

2. *Bioretention*
    - Due to spatial constraints provided by the development footprint and infiltration infeasibility confirmed by testing in the geotechnical report, a bioretention facility cannot be designed to provide the required horizontally projected surface area.
        i. **Conclusion: Infeasible**

3. *Downspout Dispersion per BMP T5.10B.*
    - Due to site specific constraints including building and fire lane location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site.
        i. **Conclusion: Infeasible**

4. *Perforated Stub-Out Connections per BMP T5.10C.*
    - No stub-out connections will be implemented in the design as soils are not suitable for infiltration as well as the site's proximity to steep slopes.
        i. **Conclusion: Infeasible**

Other Hard Surfaces:

1. *Full Dispersion per BMP T5.30*
    - Due to site specific constraints including building and fire lane location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site.
        i. **Conclusion: Infeasible**

2. *BMP T5.15 Permeable Pavement*
    - Infiltration is not feasible on site which has been confirmed by testing found in the geotechnical report.
        i. **Conclusion: Infeasible**

3. *Bioretention*
    - Due to spatial constraints provide by the development footprint and infiltration infeasibility as confirmed by testing in the geotechnical report, a bioretention facility cannot be designed to provide the required horizontally projected surface area.
        i. **Conclusion: Infeasible**

4. *Sheet Flow Dispersion or Concentrated Flow Dispersion in accordance with BMP T5.12 or BMP T5.11*
    - Due to site specific constraints including building and fire lane location as well as the proximity of slopes and walls to the developed site improvements, there is inadequate flow path to disperse on site.
        i. **Conclusion: Infeasible**

SECTION 5: CONVEYANCE DESIGN

Conveyance Capacity Analysis

The proposed collection and conveyance systems are comprised of catch basins, storm drainage pipe and two detention vaults. Catch basins have been located such that each section of storm drainage pipe can adequately convey associated tributary area flows. Conveyance analyses have been performed for all mainline pipes and structures tributary to the proposed detention vault to ensure no catch basins overtop and cause roadway or property flooding.

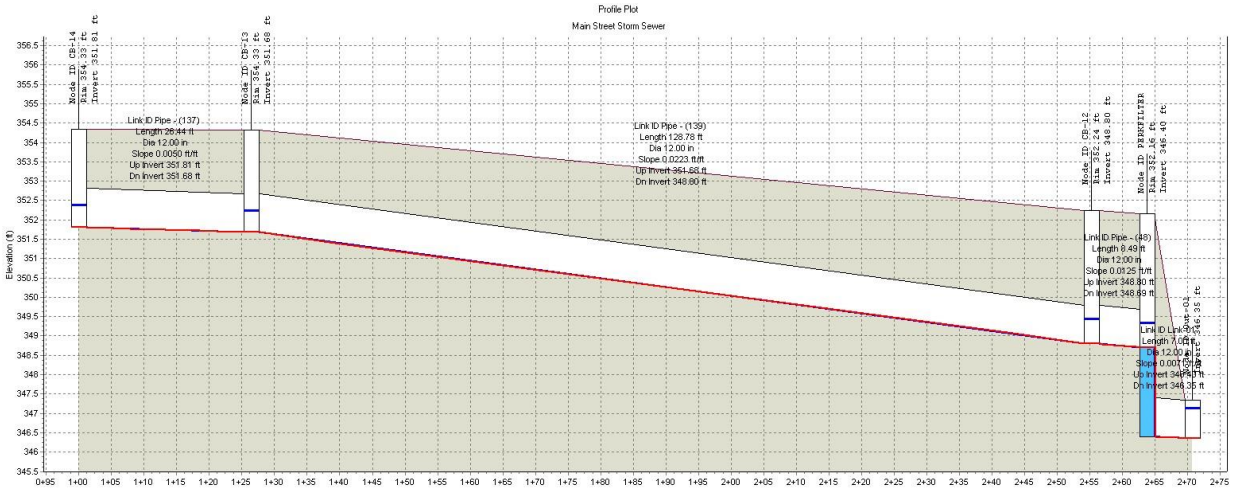
5.1 Onsite Collection and Conveyance

The onsite collection and conveyance systems were designed for the 50-year, 24-hour storm event with the Rational Method by utilizing Autodesk's Storm and Sanitary Analysis 2024. This analysis was performed to ensure that during the 50-year, 24-hour storm event, there would be no significant catch basin overtopping. The table below shows a summary of the Conveyance basin areas used in the analysis. See Appendix 5 for the Conveyance Basins Map for a visual representation of measured areas.

	BASIN	IMPERVIOUS	PERVIOUS	TOTAL (AC)
VAULT 1	1	0.33	0.13	0.46
	2	0.05	0.01	0.06
	3	0.23	0.09	0.32
VAULT 2	5	0.41	0.70	1.11
	6	0.04	0.01	0.05
	7	0.63	0.27	0.90
	8	0.36	0.13	0.49
	9	0.50	0.19	0.69

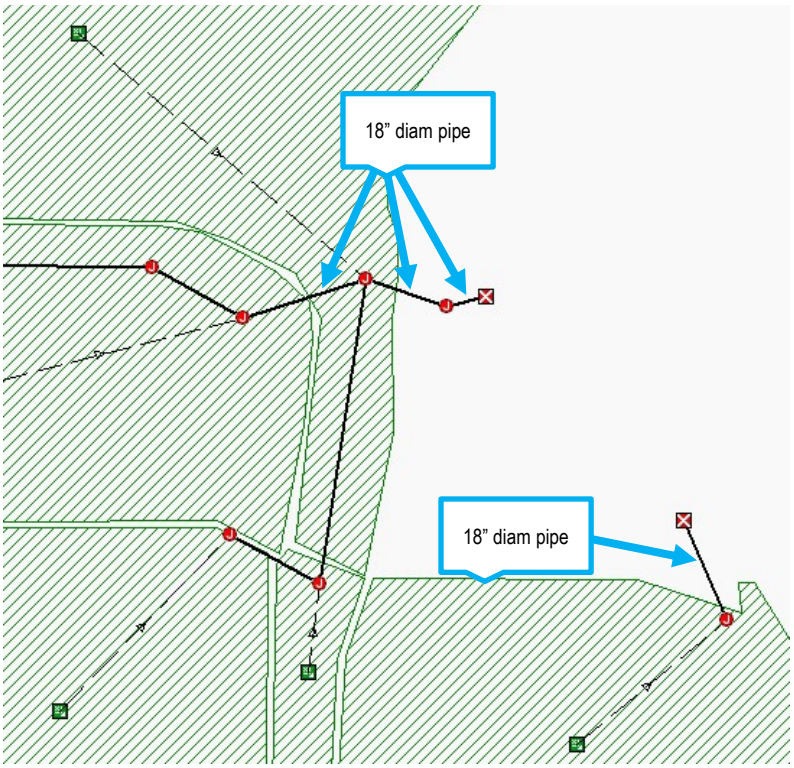
Vault 1

According to the modeling performed, the proposed single run system for Vault 1 did not have any conveyance issues upstream of the detention vault. All conveyance pipes initially sized at 12" diameter will remain as is. See Appendix 5 for the SSA model layout and SSA model results.

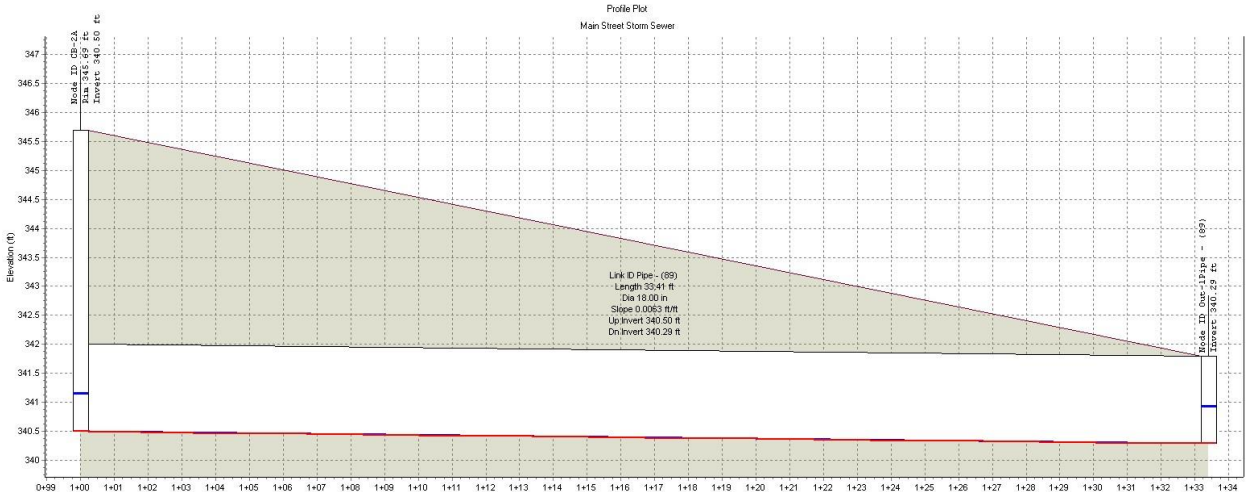


Vault 2

According to the initial modeling performed, the proposed system had several conveyance issues upstream of the detention vault. All conveyance pipes were initially sized at 12" diameter. To fix conveyance issues, four pipe runs were upsized 18" diameter which resulted in a resolution of all overtopping/flooding. See Appendix 5 for the SSA model layout with 18" upsized pipes highlighted in yellow and SSA model results.



CB-2A to VAULT INLET-1



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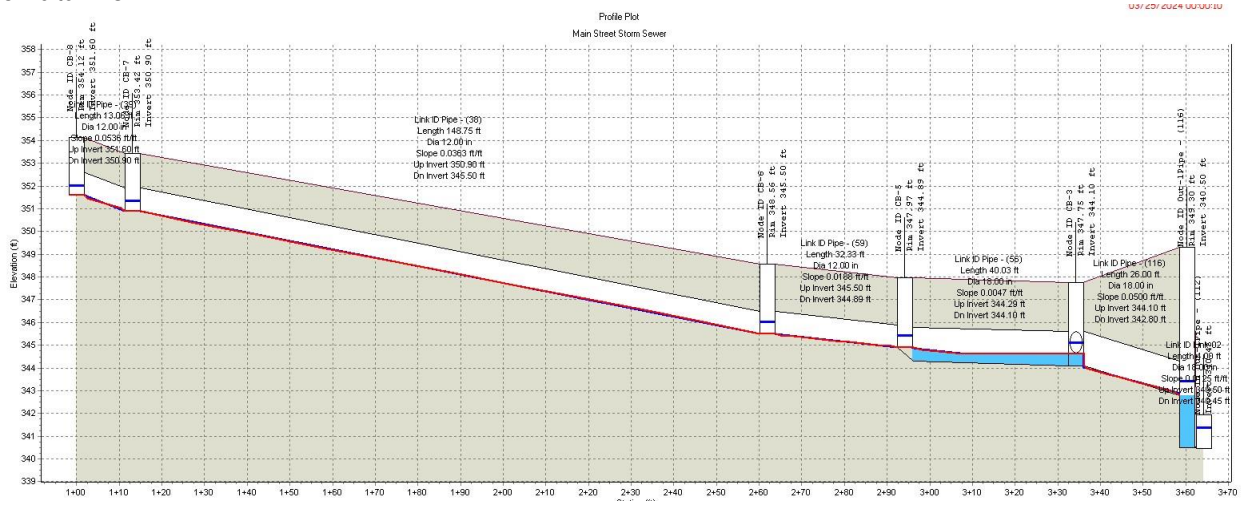
CB-8 to VAULT INLET-2



5.2 Downstream Discharge Line

The conveyance capacity analyses for each of the pipes downstream the two detention facilities were performed as a Manning's Equation evaluation of the discharge pipe with the smallest diameter, shallowest slope and largest flow capacity requirement. The pipe was analyzed against the 100-year unmitigated flow of two the proposed detention vault outfalls. Analyses confirm adequate designs. The following is a summary of the Manning's analysis performed on the pipes:

Detention Vault 1

Pipe Diameter: 12" (1.0')
Min Pipe Slope: 0.50%
100-year flow: 0.91 cfs (WWHM unmitigated – 100-yr flow)
Max Flow Depth: 0.90' (90%)
Resultant Flow Depth: 0.34'
Evaluation: System Adequate

The system is adequate because the resultant flow depth is 0.34' for the 100-year maximum pipe flow, compared to a maximum flow depth of 1.0' (90%). The results spreadsheet is located in Appendix 5.

Detention Vault 2
Pipe Diameter: 18" (1.5')
Min Pipe Slope: 0.50%
100-year flow: 3.34 cfs (WWHM unmitigated – 100-yr flow)
Max Flow Depth: 1.35' (90%)
Resultant Flow Depth: 0.57'
Evaluation: System Adequate

The system is adequate because the resultant flow depth is 0.57' for the 100-year maximum pipe flow, compared to a maximum flow depth of 1.35' (90%). The results spreadsheet is located in Appendix 5.

SECTION 6: OPERATIONS AND MAINTENANCE MANUAL

The proposed storm drainage system consists of buried pipes, catch basins, detention vaults, and perkfilter water quality treatment structures. These facilities will require periodic maintenance and inspection. Inspection and maintenance procedures are contained on the following pages.

SECTION 7: SPECIAL REPORTS AND STUDIES

The following studies were conducted in preparation of this Report:

- Geotechnical Report, Terra Associates Inc, January 25, 2024

Appendix 1: Project Overview

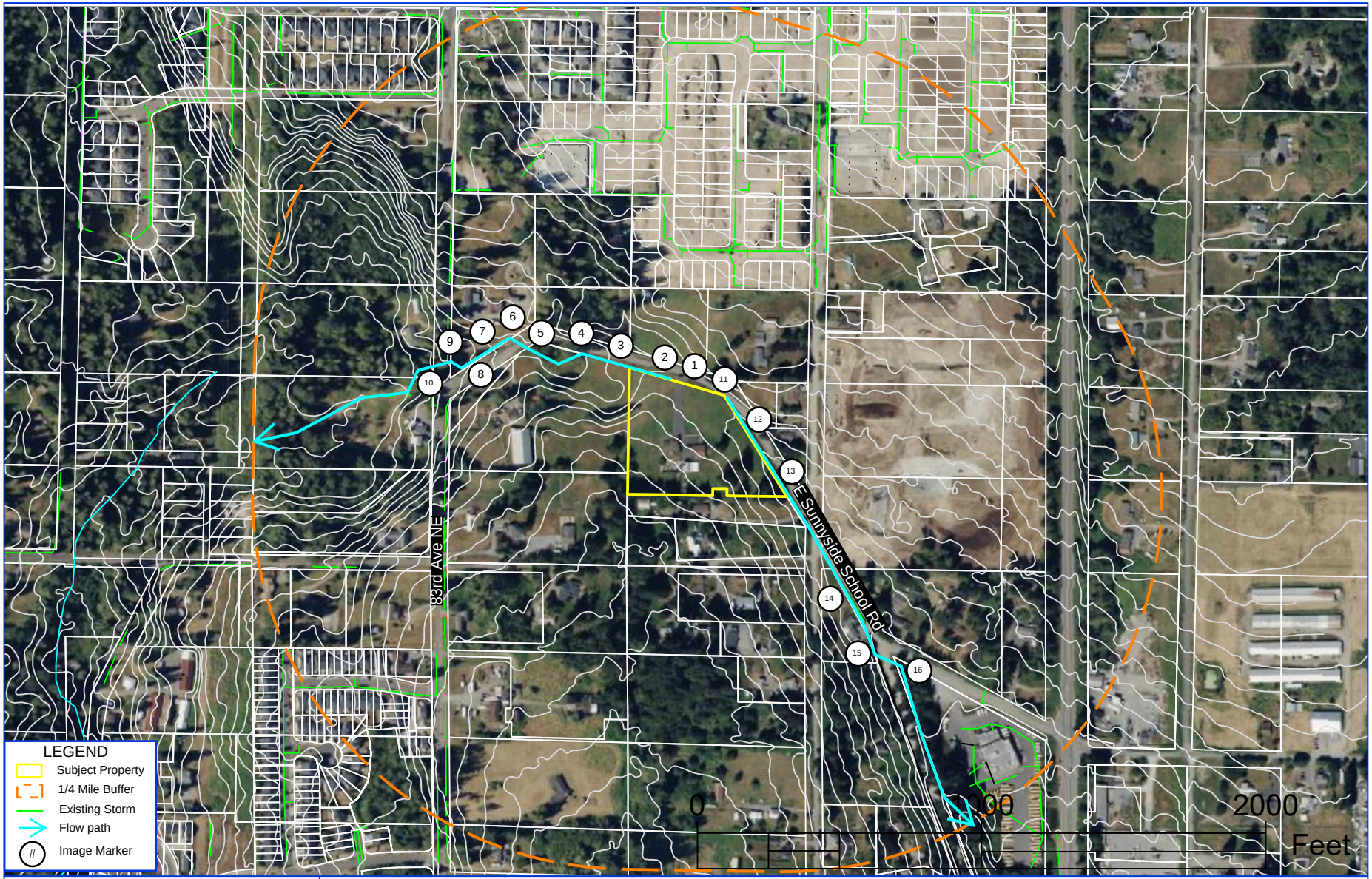
1. Vicinity Map
2. Existing Conditions Map
3. Proposed Development Map

Appendix 2: Temporary Erosion and Sediment Control Design

1. TESC Plans

Appendix 3: Downstream Analysis

1. Downstream Analysis Map
2. Downstream Analysis Site Visit Pictures
3. USDA Soils Map & Description



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MINOR PROPERTY

DOWNSTREAM ANALYSIS MAP

JOB NUMBER:	23-0011	DATE:	2-7-24
JURISDICTION:	Marysville	DRAWN BY:	CJD

C:\Users\CooperDanby\Documents\CAD-GIS\Maps\Minor Marysville\Minor Downstream Map.dwg

Downstream Analysis Photographs

Image 1: Middle of existing driveway along E Sunnyside School Rd where TDA #1 & #2 split west or east

TDA #1 – Flowpath 1

Image 2: Facing west along E Sunnyside School Rd where Flowpath 1 continues in a roadside ditch

Image 3: Northwest property corner where runoff sheet flows west down existing slopes

Image 4: Property west of project site along E Sunnyside School Rd where runoff enters existing pond/wetland

Image 5: west of existing pond/wetland where overflow runoff continues back to cross under E Sunnyside School Rd

Image 6: north side of E Sunnyside School Rd where channelized flow continues west

Image 7: north side of E Sunnyside School Rd where channelized flow continues west

Image 8: Intersection of E Sunnyside School Rd and 83rd Ave NE

Image 9: Intersection of E Sunnyside School Rd and 83rd Ave NE where flow crosses west under 83rd via culvert

Image 10: Culvert outlet west of 83rd where King Creek continues to quarter mile boundary

TDA #2 – Flowpath 2

Image 11: Facing east along E Sunnyside School Rd where Flowpath 2 continues in a roadside ditch

Image 12: Facing southeast along E Sunnyside School Rd where Flowpath 2 continues in a roadside ditch

Image 13: east property corner along E Sunnyside School Rd where Flowpath 2 continues

Image 14: along E Sunnyside School Rd where Flowpath 2 continues

Image 15: near intersection of E Sunnyside School Rd and Densmore Rd, flow crosses east under Densmore Rd

Image 16: east side of Densmore Rd, flow continues southeast beyond quarter mile boundary

Map Scale: 1:1,620 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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 25, Aug 29, 2023

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

Date(s) aerial images were photographed: Aug 14, 2022—Sep 1, 2022

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	6.0	100.0%
Totals for Area of Interest		**6.0**	**100.0%**

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: 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: 0 to 8 percent
Depth to restrictive feature: 20 to 39 inches to densic material; 20 to 39 inches to cemented horizon
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 supply, 0 to 60 inches: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: B
Ecological site: F002XA005WA - Puget Lowlands Moist Forest
Forage suitability group: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XF303WA)
Other vegetative classification: Limited Depth Soils (G002XN302WA), Limited Depth Soils (G002XF303WA)
Hydric soil rating: No

Minor Components

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

Barneston

Percent of map unit: 5 percent
Landform: Moraines, eskers, kames
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norma

Percent of map unit: 3 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

Mckenna

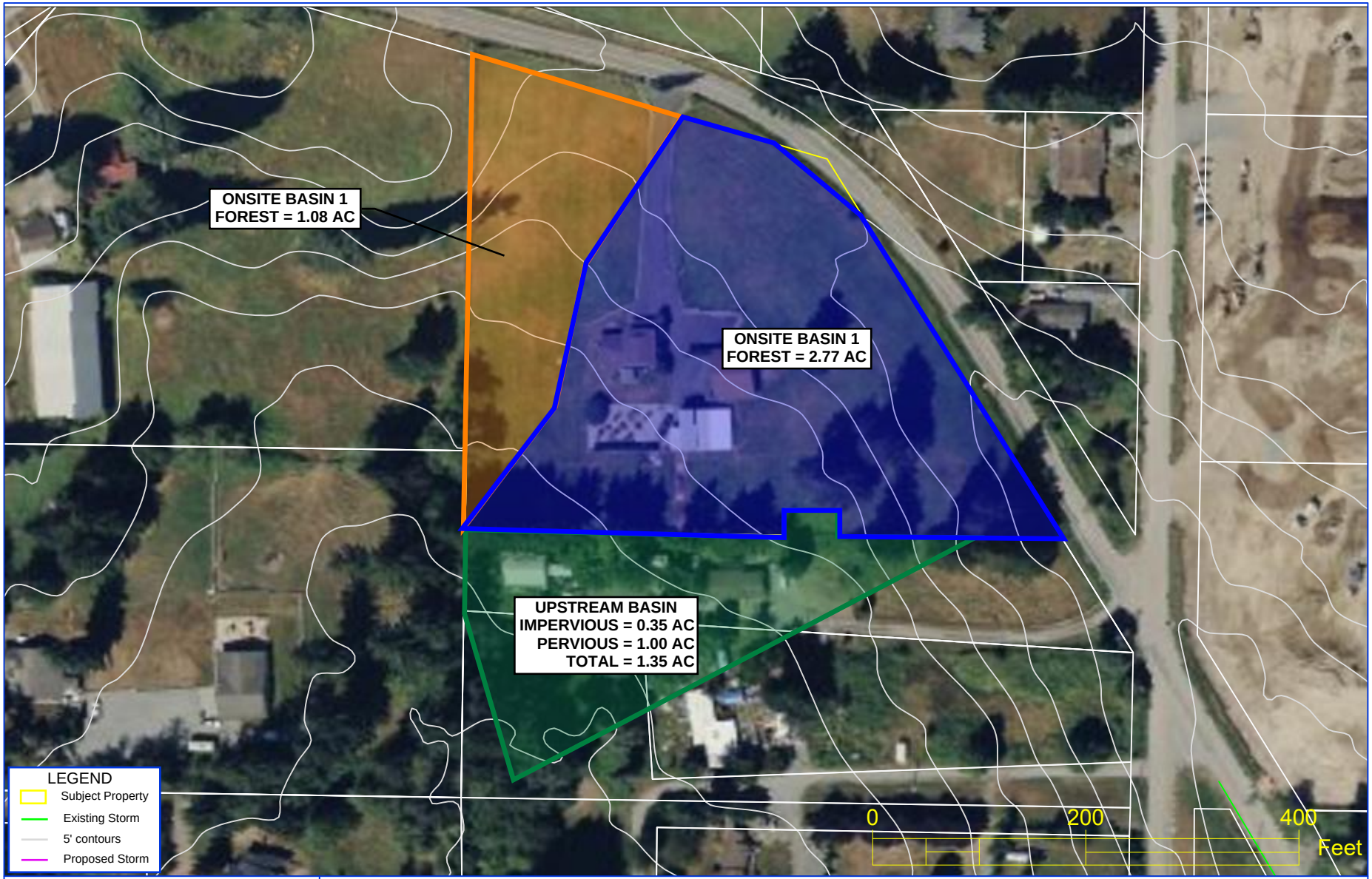
Percent of map unit: 2 percent
Landform: Drainageways, depressions
Landform position (three-dimensional): Dip
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

Data Source Information

Soil Survey Area: Snohomish County Area, Washington
Survey Area Data: Version 25, Aug 29, 2023

Appendix 4: Detention and Water Quality Design Analysis

1. Predeveloped Hydrology Map
2. Developed Hydrology Map
3. WWHM2012 Output – Detention Vault 1
4. WWHM2012 Output – Detention Vault 2
5. Perkfilter 1 Detail
6. Perkfilter 2 Detail
7. Water Quality Design Data Sheet



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PREDEVELOPED HYDROLOGY MAP

JOB NUMBER:	23-0011	DATE:	2-7-24
JURISDICTION:	Marysville	DRAWN BY:	CJD

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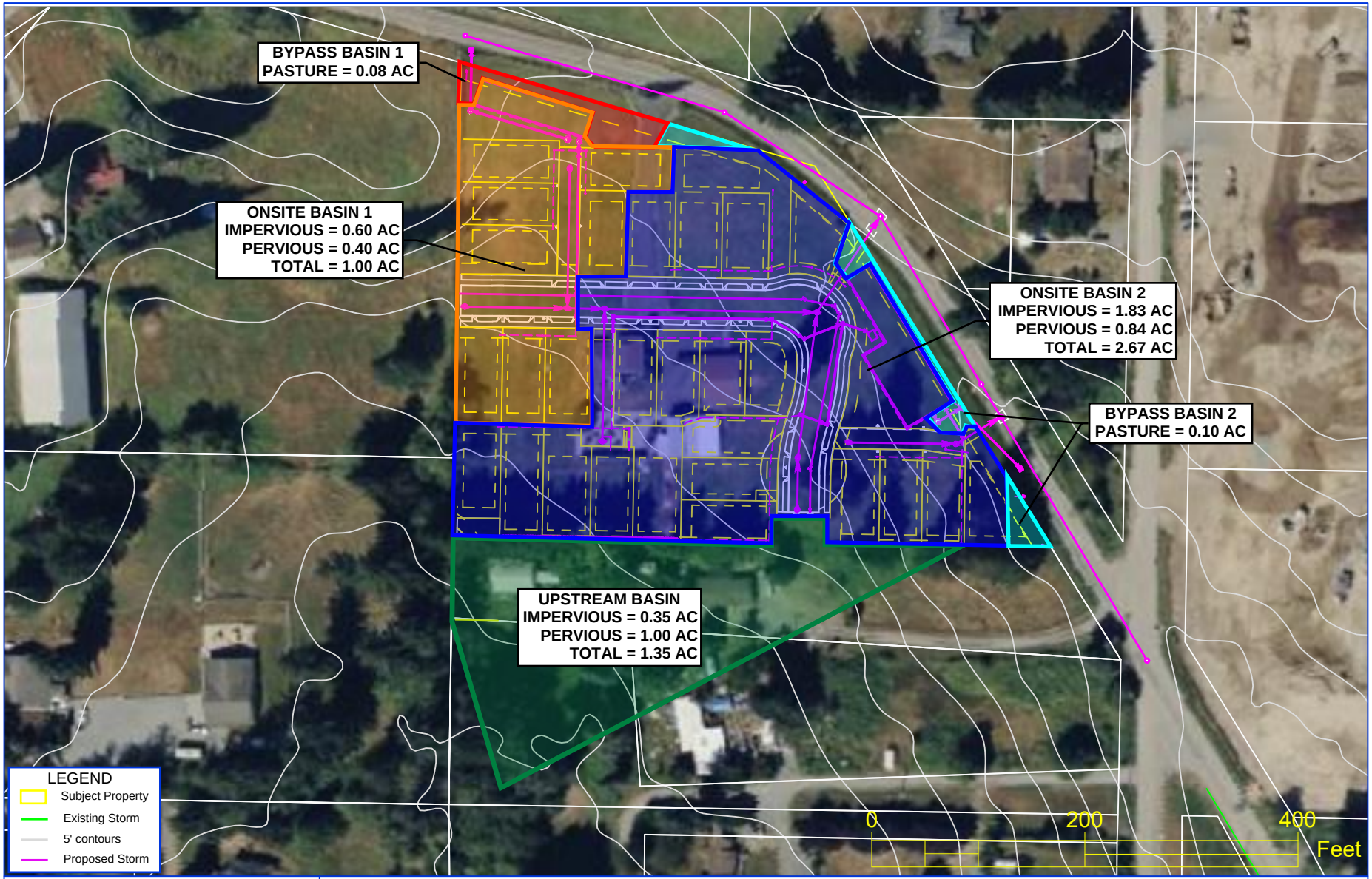

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MINOR PROPERTY

DEVELOPED HYDROLOGY MAP

JOB NUMBER:	23-0011	DATE:	2-7-24
JURISDICTION:	Marysville	DRAWN BY:	CJD

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WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: Minor West Vault
Site Name:
Site Address:
City:

Report Date:	3/12/2024
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	0.9
C, Forest, Steep	0.18
Pervious Total	1.08
Impervious Land Use	acre
Impervious Total	0
Basin Total	1.08

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.4
Pervious Total	0.4

Impervious Land Use	acre
ROADS FLAT	0.08
ROOF TOPS FLAT	0.33
DRIVEWAYS FLAT	0.16
SIDEWALKS FLAT	0.03
Impervious Total	0.6
Basin Total	1

Basin 2

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Steep	0.04
C, Pasture, Mod	0.04
Pervious Total	0.08
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.08

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

Width: 100 ft.
Length: 22 ft.
Depth: 7 ft.
Discharge Structure
Riser Height: 6 ft.
Riser Diameter: 12 in.
Orifice 1 Diameter: 0.688 in. Elevation:0 ft.
Orifice 2 Diameter: 1.156 in. Elevation:3.55 ft.
Orifice 3 Diameter: 0.563 in. Elevation:5.25 ft.
Element Flows To:
Outlet 1 Outlet 2

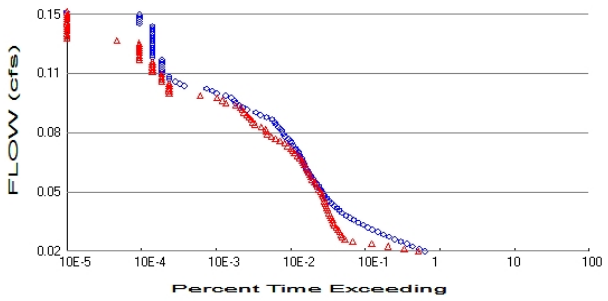
Vault Hydraulic Table

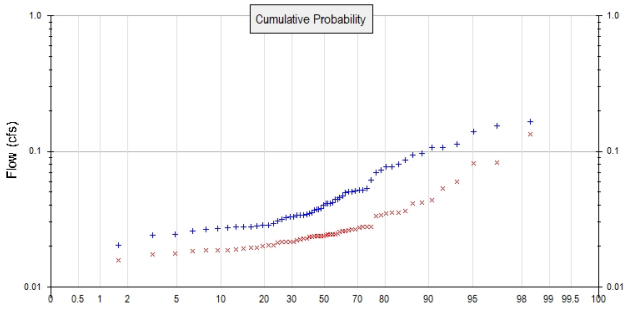
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.050	0.000	0.000	0.000
0.0778	0.050	0.003	0.003	0.000
0.1556	0.050	0.007	0.005	0.000
0.2333	0.050	0.011	0.006	0.000
0.3111	0.050	0.015	0.007	0.000
0.3889	0.050	0.019	0.008	0.000
0.4667	0.050	0.023	0.008	0.000
0.5444	0.050	0.027	0.009	0.000
0.6222	0.050	0.031	0.010	0.000
0.7000	0.050	0.035	0.010	0.000
0.7778	0.050	0.039	0.011	0.000
0.8556	0.050	0.043	0.011	0.000
0.9333	0.050	0.047	0.012	0.000
1.0111	0.050	0.051	0.012	0.000
1.0889	0.050	0.055	0.013	0.000
1.1667	0.050	0.058	0.013	0.000
1.2444	0.050	0.062	0.014	0.000
1.3222	0.050	0.066	0.014	0.000
1.4000	0.050	0.070	0.015	0.000
1.4778	0.050	0.074	0.015	0.000
1.5556	0.050	0.078	0.016	0.000
1.6333	0.050	0.082	0.016	0.000
1.7111	0.050	0.086	0.016	0.000
1.7889	0.050	0.090	0.017	0.000
1.8667	0.050	0.094	0.017	0.000
1.9444	0.050	0.098	0.017	0.000
2.0222	0.050	0.102	0.018	0.000
2.1000	0.050	0.106	0.018	0.000
2.1778	0.050	0.110	0.018	0.000
2.2556	0.050	0.113	0.019	0.000
2.3333	0.050	0.117	0.019	0.000
2.4111	0.050	0.121	0.019	0.000
2.4889	0.050	0.125	0.020	0.000
2.5667	0.050	0.129	0.020	0.000
2.6444	0.050	0.133	0.020	0.000
2.7222	0.050	0.137	0.021	0.000
2.8000	0.050	0.141	0.021	0.000
2.8778	0.050	0.145	0.021	0.000

2.9556	0.050	0.149	0.022	0.000
3.0333	0.050	0.153	0.022	0.000
3.1111	0.050	0.157	0.022	0.000
3.1889	0.050	0.161	0.022	0.000
3.2667	0.050	0.165	0.023	0.000
3.3444	0.050	0.168	0.023	0.000
3.4222	0.050	0.172	0.023	0.000
3.5000	0.050	0.176	0.024	0.000
3.5778	0.050	0.180	0.030	0.000
3.6556	0.050	0.184	0.036	0.000
3.7333	0.050	0.188	0.040	0.000
3.8111	0.050	0.192	0.043	0.000
3.8889	0.050	0.196	0.046	0.000
3.9667	0.050	0.200	0.049	0.000
4.0444	0.050	0.204	0.051	0.000
4.1222	0.050	0.208	0.053	0.000
4.2000	0.050	0.212	0.055	0.000
4.2778	0.050	0.216	0.057	0.000
4.3556	0.050	0.220	0.059	0.000
4.4333	0.050	0.223	0.061	0.000
4.5111	0.050	0.227	0.062	0.000
4.5889	0.050	0.231	0.064	0.000
4.6667	0.050	0.235	0.066	0.000
4.7444	0.050	0.239	0.067	0.000
4.8222	0.050	0.243	0.069	0.000
4.9000	0.050	0.247	0.070	0.000
4.9778	0.050	0.251	0.072	0.000
5.0556	0.050	0.255	0.073	0.000
5.1333	0.050	0.259	0.074	0.000
5.2111	0.050	0.263	0.076	0.000
5.2889	0.050	0.267	0.079	0.000
5.3667	0.050	0.271	0.081	0.000
5.4444	0.050	0.275	0.083	0.000
5.5222	0.050	0.278	0.085	0.000
5.6000	0.050	0.282	0.087	0.000
5.6778	0.050	0.286	0.089	0.000
5.7556	0.050	0.290	0.090	0.000
5.8333	0.050	0.294	0.092	0.000
5.9111	0.050	0.298	0.093	0.000
5.9889	0.050	0.302	0.095	0.000
6.0667	0.050	0.306	0.279	0.000
6.1444	0.050	0.310	0.671	0.000
6.2222	0.050	0.314	1.145	0.000
6.3000	0.050	0.318	1.610	0.000
6.3778	0.050	0.322	1.981	0.000
6.4556	0.050	0.326	2.218	0.000
6.5333	0.050	0.330	2.405	0.000
6.6111	0.050	0.333	2.568	0.000
6.6889	0.050	0.337	2.721	0.000
6.7667	0.050	0.341	2.866	0.000
6.8444	0.050	0.345	3.004	0.000
6.9222	0.050	0.349	3.136	0.000
7.0000	0.050	0.353	3.262	0.000
7.0778	0.050	0.357	3.383	0.000
7.1556	0.000	0.000	3.500	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 1.08
Total Impervious Area: 0

Mitigated Landuse Totals for POC #1
Total Pervious Area: 0.48
Total Impervious Area: 0.6

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.042903
5 year	0.068847
10 year	0.089544
25 year	0.119954
50 year	0.145867
100 year	0.174716

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.025093
5 year	0.036383
10 year	0.045643
25 year	0.059644
50 year	0.071934
100 year	0.085989

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.047	0.021
1950	0.049	0.023
1951	0.040	0.019
1952	0.034	0.018
1953	0.028	0.017
1954	0.167	0.033
1955	0.052	0.027
1956	0.045	0.035
1957	0.061	0.028
1958	0.077	0.037

1959	0.041	0.024
1960	0.041	0.025
1961	0.107	0.053
1962	0.042	0.021
1963	0.070	0.024
1964	0.053	0.020
1965	0.033	0.024
1966	0.020	0.019
1967	0.041	0.021
1968	0.050	0.026
1969	0.153	0.041
1970	0.028	0.020
1971	0.052	0.027
1972	0.033	0.023
1973	0.031	0.022
1974	0.086	0.024
1975	0.034	0.019
1976	0.034	0.022
1977	0.025	0.019
1978	0.029	0.019
1979	0.094	0.026
1980	0.044	0.020
1981	0.029	0.020
1982	0.038	0.027
1983	0.077	0.024
1984	0.037	0.042
1985	0.050	0.025
1986	0.113	0.081
1987	0.051	0.059
1988	0.027	0.024
1989	0.034	0.016
1990	0.035	0.026
1991	0.037	0.024
1992	0.028	0.024
1993	0.028	0.018
1994	0.026	0.023
1995	0.037	0.035
1996	0.073	0.028
1997	0.140	0.133
1998	0.024	0.019
1999	0.030	0.024
2000	0.027	0.035
2001	0.010	0.015
2002	0.035	0.024
2003	0.027	0.021
2004	0.046	0.043
2005	0.032	0.024
2006	0.107	0.034
2007	0.081	0.028
2008	0.096	0.083
2009	0.028	0.022

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.1667	0.1330
2	0.1533	0.0828
3	0.1399	0.0812

4	0.1132	0.0594
5	0.1074	0.0530
6	0.1072	0.0433
7	0.0961	0.0420
8	0.0939	0.0415
9	0.0857	0.0365
10	0.0807	0.0354
11	0.0769	0.0351
12	0.0768	0.0346
13	0.0725	0.0338
14	0.0696	0.0334
15	0.0613	0.0278
16	0.0534	0.0277
17	0.0519	0.0277
18	0.0517	0.0273
19	0.0508	0.0265
20	0.0505	0.0265
21	0.0501	0.0262
22	0.0493	0.0257
23	0.0469	0.0257
24	0.0456	0.0253
25	0.0446	0.0248
26	0.0441	0.0244
27	0.0416	0.0244
28	0.0410	0.0243
29	0.0410	0.0243
30	0.0409	0.0239
31	0.0400	0.0238
32	0.0377	0.0238
33	0.0375	0.0237
34	0.0373	0.0235
35	0.0368	0.0235
36	0.0353	0.0235
37	0.0348	0.0232
38	0.0341	0.0227
39	0.0340	0.0226
40	0.0336	0.0224
41	0.0336	0.0222
42	0.0330	0.0216
43	0.0330	0.0215
44	0.0322	0.0214
45	0.0314	0.0214
46	0.0305	0.0211
47	0.0293	0.0202
48	0.0287	0.0202
49	0.0285	0.0200
50	0.0280	0.0195
51	0.0278	0.0193
52	0.0278	0.0191
53	0.0276	0.0188
54	0.0273	0.0187
55	0.0269	0.0186
56	0.0265	0.0185
57	0.0257	0.0184
58	0.0245	0.0176
59	0.0240	0.0174
60	0.0204	0.0158
61	0.0095	0.0152

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0215	13490	10917	80	Pass
0.0227	11214	7048	62	Pass
0.0240	9263	4318	46	Pass
0.0252	7679	2599	33	Pass
0.0265	6352	1451	22	Pass
0.0277	5268	1140	21	Pass
0.0290	4470	1047	23	Pass
0.0302	3769	1001	26	Pass
0.0315	3140	966	30	Pass
0.0328	2674	925	34	Pass
0.0340	2314	871	37	Pass
0.0353	1990	809	40	Pass
0.0365	1713	789	46	Pass
0.0378	1497	774	51	Pass
0.0390	1332	749	56	Pass
0.0403	1171	725	61	Pass
0.0416	1036	698	67	Pass
0.0428	953	672	70	Pass
0.0441	887	655	73	Pass
0.0453	813	640	78	Pass
0.0466	754	623	82	Pass
0.0478	703	609	86	Pass
0.0491	651	594	91	Pass
0.0504	609	578	94	Pass
0.0516	586	560	95	Pass
0.0529	565	535	94	Pass
0.0541	540	502	92	Pass
0.0554	511	484	94	Pass
0.0566	478	467	97	Pass
0.0579	454	445	98	Pass
0.0592	430	418	97	Pass
0.0604	405	397	98	Pass
0.0617	384	383	99	Pass
0.0629	366	369	100	Pass
0.0642	353	356	100	Pass
0.0654	340	342	100	Pass
0.0667	327	328	100	Pass
0.0680	315	315	100	Pass
0.0692	307	301	98	Pass
0.0705	298	285	95	Pass
0.0717	285	263	92	Pass
0.0730	274	239	87	Pass
0.0742	260	226	86	Pass
0.0755	247	213	86	Pass
0.0767	233	195	83	Pass
0.0780	218	178	81	Pass
0.0793	211	154	72	Pass
0.0805	197	134	68	Pass
0.0818	180	118	65	Pass
0.0830	172	103	59	Pass
0.0843	164	101	61	Pass
0.0855	155	99	63	Pass
0.0868	144	86	59	Pass

0.0881	137	71	51	Pass
0.0893	130	66	50	Pass
0.0906	120	63	52	Pass
0.0918	101	59	58	Pass
0.0931	84	55	65	Pass
0.0943	73	51	69	Pass
0.0956	55	48	87	Pass
0.0969	49	45	91	Pass
0.0981	43	39	90	Pass
0.0994	39	29	74	Pass
0.1006	38	26	68	Pass
0.1019	34	22	64	Pass
0.1031	29	13	44	Pass
0.1044	22	5	22	Pass
0.1057	19	5	26	Pass
0.1069	16	5	31	Pass
0.1082	8	5	62	Pass
0.1094	7	5	71	Pass
0.1107	6	4	66	Pass
0.1119	5	4	80	Pass
0.1132	5	4	80	Pass
0.1144	4	4	100	Pass
0.1157	4	3	75	Pass
0.1170	4	3	75	Pass
0.1182	4	3	75	Pass
0.1195	4	3	75	Pass
0.1207	4	3	75	Pass
0.1220	4	2	50	Pass
0.1232	3	2	66	Pass
0.1245	3	2	66	Pass
0.1258	3	2	66	Pass
0.1270	3	2	66	Pass
0.1283	3	2	66	Pass
0.1295	3	2	66	Pass
0.1308	3	2	66	Pass
0.1320	3	1	33	Pass
0.1333	3	0	0	Pass
0.1346	3	0	0	Pass
0.1358	3	0	0	Pass
0.1371	3	0	0	Pass
0.1383	3	0	0	Pass
0.1396	3	0	0	Pass
0.1408	2	0	0	Pass
0.1421	2	0	0	Pass
0.1434	2	0	0	Pass
0.1446	2	0	0	Pass
0.1459	2	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.0833 acre-feet
On-line facility target flow:	0.1103 cfs.
Adjusted for 15 min:	0.1103 cfs.
Off-line facility target flow:	0.0623 cfs.
Adjusted for 15 min:	0.0623 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
Vault 1 POC	☐	133.23			☐	0.00			
Total Volume Infiltrated		133.23	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 = Passed

Model Default Modifications

Total of 0 changes have been made.

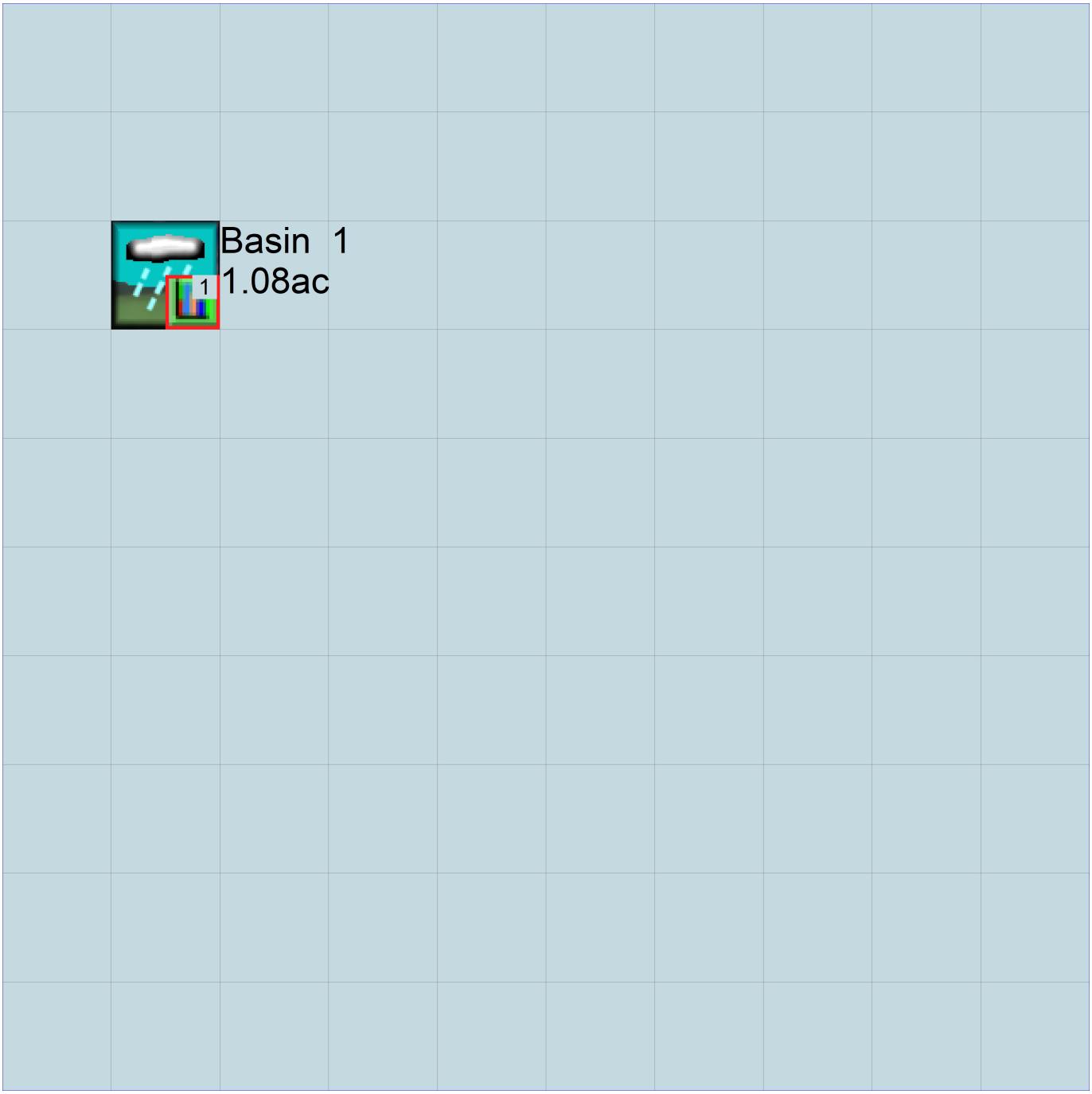
PERLND Changes

No PERLND changes have been made.

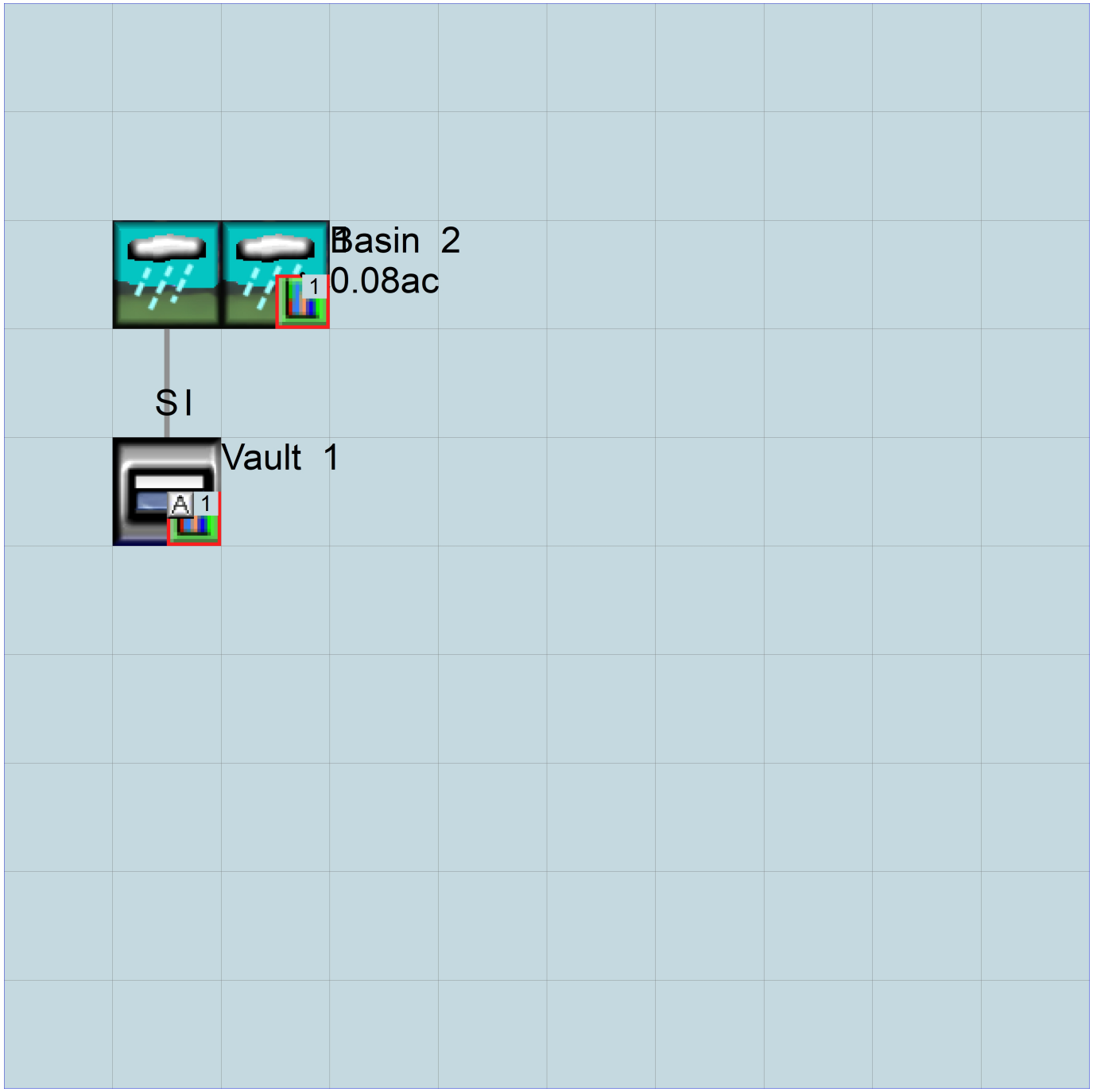
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



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   Minor West Vault.wdm
MESSU       25   PreMinor West Vault.MES
            27   PreMinor West Vault.L61
            28   PreMinor West Vault.L62
            30   POCMinor West Vault1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      PERLND      12
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                   MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                       in  out           ***
   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#   ***
Basin  1***
PERLND  11                         0.9     COPY   501     12
PERLND  11                         0.9     COPY   501     13
PERLND  12                        0.18     COPY   501     12
PERLND  12                        0.18     COPY   501     13

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

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



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

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

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

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

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

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

```
SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

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

END EXT SOURCES

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

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

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


END MASS-LINK

END RUN
```

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   Minor West Vault.wdm
MESSU       25   MitMinor West Vault.MES
            27   MitMinor West Vault.L61
            28   MitMinor West Vault.L62
            30   POCMinor West Vault1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      13
      IMPLND       1
      IMPLND       4
      IMPLND       5
      IMPLND       8
      PERLND      15
      PERLND      14
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Vault  1                    MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out           ***
   13     C, Pasture, Flat        1    1    1    1   27    0
   15     C, Pasture, Steep       1    1    1    1   27    0
   14     C, Pasture, Mod         1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***
```

```
  ACTIVITY
    <PLS > ************* Active Sections ****************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   13         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
   14         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  *********
   13         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
   14         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 ***
   13         0    0    0    0    0    0    0    0    0    0    0
   15         0    0    0    0    0    0    0    0    0    0    0
   14         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
   13              0       4.5      0.06       400      0.05        0.5      0.996
   15              0       4.5      0.06       400      0.15        0.5      0.996
   14              0       4.5      0.06       400       0.1        0.5      0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   13              0         0         2         2         0         0         0
   15              0         0         2         2         0         0         0
   14              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   13           0.15       0.4       0.3         6       0.5       0.4
   15           0.15      0.25       0.3         6       0.3       0.4
   14           0.15       0.4       0.3         6       0.5       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
   13              0         0         0         0       2.5          1         0
   15              0         0         0         0       2.5          1         0
   14              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             ***
    1      ROADS/FLAT             1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    5      DRIVEWAYS/FLAT         1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***
```

```
  ACTIVITY
    <PLS > ************* Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    4         0    0    1    0    0    0
    5         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    4    1    9
    4         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
    5         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1           400      0.01       0.1        0.1
    4           400      0.01       0.1        0.1
    5           400      0.01       0.1        0.1
    8           400      0.01       0.1        0.1
  END IWAT-PARM2

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

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

END IMPLND

SCHEMATIC
<-Source->                 <--Area-->     <-Target->   MBLK   ***
<Name>   #                 <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  13                        0.4     RCHRES   1      2
PERLND  13                        0.4     RCHRES   1      3
IMPLND   1                       0.08     RCHRES   1      5
IMPLND   4                       0.33     RCHRES   1      5
IMPLND   5                       0.16     RCHRES   1      5
IMPLND   8                       0.03     RCHRES   1      5
Basin  2***
PERLND  15                       0.04     COPY   501     12
PERLND  15                       0.04     COPY   601     12
PERLND  15                       0.04     COPY   501     13
```

```
PERLND  15                        0.04     COPY   601     13
PERLND  14                        0.04     COPY   501     12
PERLND  14                        0.04     COPY   601     12
PERLND  14                        0.04     COPY   501     13
PERLND  14                        0.04     COPY   601     13

******Routing******
PERLND  13                         0.4     COPY     1     12
IMPLND   1                        0.08     COPY     1     15
IMPLND   4                        0.33     COPY     1     15
IMPLND   5                        0.16     COPY     1     15
IMPLND   8                        0.03     COPY     1     15
PERLND  13                         0.4     COPY     1     13
RCHRES   1                           1     COPY   501     16
END SCHEMATIC

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



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

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

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

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

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

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

```
SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.050505  0.000000  0.000000
  0.077778  0.050505  0.003928  0.003577
  0.155556  0.050505  0.007856  0.005059
  0.233333  0.050505  0.011785  0.006196
  0.311111  0.050505  0.015713  0.007154
  0.388889  0.050505  0.019641  0.007999
  0.466667  0.050505  0.023569  0.008762
  0.544444  0.050505  0.027497  0.009464
  0.622222  0.050505  0.031425  0.010118
  0.700000  0.050505  0.035354  0.010731
  0.777778  0.050505  0.039282  0.011312
  0.855556  0.050505  0.043210  0.011864
  0.933333  0.050505  0.047138  0.012391
  1.011111  0.050505  0.051066  0.012897
  1.088889  0.050505  0.054994  0.013384
  1.166667  0.050505  0.058923  0.013854
  1.244444  0.050505  0.062851  0.014308
  1.322222  0.050505  0.066779  0.014749
  1.400000  0.050505  0.070707  0.015176
  1.477778  0.050505  0.074635  0.015592
  1.555556  0.050505  0.078563  0.015997
  1.633333  0.050505  0.082492  0.016392
  1.711111  0.050505  0.086420  0.016778
  1.788889  0.050505  0.090348  0.017155
  1.866667  0.050505  0.094276  0.017524
  1.944444  0.050505  0.098204  0.017886
  2.022222  0.050505  0.102132  0.018240
  2.100000  0.050505  0.106061  0.018587
  2.177778  0.050505  0.109989  0.018928
  2.255556  0.050505  0.113917  0.019263
  2.333333  0.050505  0.117845  0.019593
  2.411111  0.050505  0.121773  0.019916
  2.488889  0.050505  0.125701  0.020235
  2.566667  0.050505  0.129630  0.020549
  2.644444  0.050505  0.133558  0.020858
  2.722222  0.050505  0.137486  0.021162
  2.800000  0.050505  0.141414  0.021463
  2.877778  0.050505  0.145342  0.021759
  2.955556  0.050505  0.149270  0.022051
  3.033333  0.050505  0.153199  0.022339
  3.111111  0.050505  0.157127  0.022624
  3.188889  0.050505  0.161055  0.022905
  3.266667  0.050505  0.164983  0.023182
  3.344444  0.050505  0.168911  0.023457
  3.422222  0.050505  0.172840  0.023728
  3.500000  0.050505  0.176768  0.023996
  3.577778  0.050505  0.180696  0.030308
  3.655556  0.050505  0.184624  0.036310
  3.733333  0.050505  0.188552  0.040317
  3.811111  0.050505  0.192480  0.043578
  3.888889  0.050505  0.196409  0.046414
  3.966667  0.050505  0.200337  0.048964
  4.044444  0.050505  0.204265  0.051306
  4.122222  0.050505  0.208193  0.053486
  4.200000  0.050505  0.212121  0.055536
  4.277778  0.050505  0.216049  0.057479
  4.355556  0.050505  0.219978  0.059331
  4.433333  0.050505  0.223906  0.061104
  4.511111  0.050505  0.227834  0.062810
  4.588889  0.050505  0.231762  0.064455
  4.666667  0.050505  0.235690  0.066046
  4.744444  0.050505  0.239618  0.067588
  4.822222  0.050505  0.243547  0.069087
```

```
  4.900000  0.050505  0.247475  0.070545
  4.977778  0.050505  0.251403  0.071967
  5.055556  0.050505  0.255331  0.073355
  5.133333  0.050505  0.259259  0.074711
  5.211111  0.050505  0.263187  0.076038
  5.288889  0.050505  0.267116  0.079032
  5.366667  0.050505  0.271044  0.081545
  5.444444  0.050505  0.274972  0.083649
  5.522222  0.050505  0.278900  0.085571
  5.600000  0.050505  0.282828  0.087377
  5.677778  0.050505  0.286756  0.089099
  5.755556  0.050505  0.290685  0.090756
  5.833333  0.050505  0.294613  0.092358
  5.911111  0.050505  0.298541  0.093913
  5.988889  0.050505  0.302469  0.095427
  6.066667  0.050505  0.306397  0.279140
  6.144444  0.050505  0.310325  0.670994
  6.222222  0.050505  0.314254  1.145797
  6.300000  0.050505  0.318182  1.610827
  6.377778  0.050505  0.322110  1.981788
  6.455556  0.050505  0.326038  2.218085
  6.533333  0.050505  0.329966  2.405339
  6.611111  0.050505  0.333895  2.568651
  6.688889  0.050505  0.337823  2.721920
  6.766667  0.050505  0.341751  2.866807
  6.844444  0.050505  0.345679  3.004558
  6.922222  0.050505  0.349607  3.136137
  7.000000  0.050505  0.353535  3.262310
  7.077778  0.050505  0.357464  3.383696
  END FTABLE  1
END FTABLES

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

END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
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
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
```

WWHM2012

PROJECT REPORT

General Model Information

WWHM2012 Project Name: Minor East w_Upstream
Site Name:
Site Address:
City:

Report Date:	3/26/2024
Gage:	Everett
Data Start:	1948/10/01
Data End:	2009/09/30
Timestep:	15 Minute
Precip Scale:	1.200
Version Date:	2023/01/27
Version:	4.2.19

POC Thresholds

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

Landuse Basin Data

Predeveloped Land Use

Basin 1

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Forest, Mod	2
C, Forest, Steep	0.77
Pervious Total	2.77
Impervious Land Use	acre
Impervious Total	0
Basin Total	2.77

Upstream

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Mod	0.2
C, Forest, Mod	0.8
Pervious Total	1
Impervious Land Use	acre
ROOF TOPS FLAT	0.12
DRIVEWAYS FLAT	0.23
Impervious Total	0.35
Basin Total	1.35

Mitigated Land Use

Basin 1

Bypass:	No
GroundWater:	No

Pervious Land Use	acre
C, Pasture, Flat	0.84
Pervious Total	0.84

Impervious Land Use	acre
ROADS FLAT	0.29
ROOF TOPS FLAT	1
DRIVEWAYS FLAT	0.45
SIDEWALKS FLAT	0.09
Impervious Total	1.83
Basin Total	2.67

Bypass

Bypass:	Yes
GroundWater:	No
Pervious Land Use	acre
C, Pasture, Mod	0.06
C, Pasture, Steep	0.04
Pervious Total	0.1
Impervious Land Use	acre
Impervious Total	0
Basin Total	0.1

Upstream

Bypass:	No
GroundWater:	No
Pervious Land Use	acre
C, Lawn, Mod	0.2
C, Forest, Mod	0.8
Pervious Total	1
Impervious Land Use	acre
ROOF TOPS FLAT	0.12
DRIVEWAYS FLAT	0.23
Impervious Total	0.35
Basin Total	1.35

Routing Elements
Predeveloped Routing

Mitigated Routing

Vault 1

Width: 108 ft.
Length: 46 ft.
Depth: 7.5 ft.
Discharge Structure
Riser Height: 6.5 ft.
Riser Diameter: 18 in.
Notch Type: Rectangular
Notch Width: 0.100 ft.
Notch Height: 0.800 ft.
Orifice 1 Diameter: 1.938 in. Elevation:0 ft.
Orifice 2 Diameter: 1.656 in. Elevation:3 ft.
Orifice 3 Diameter: 2.000 in. Elevation:6 ft.
Element Flows To:
Outlet 1 Outlet 2

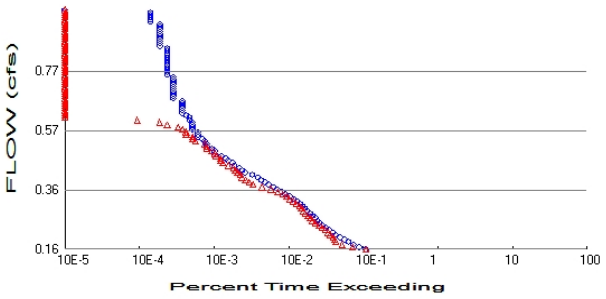
Vault Hydraulic Table

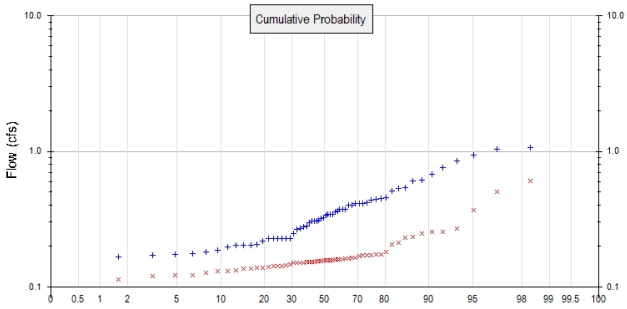
Stage(feet)	Area(ac.)	Volume(ac-ft.)	Discharge(cfs)	Infilt(cfs)
0.0000	0.114	0.000	0.000	0.000
0.0833	0.114	0.009	0.029	0.000
0.1667	0.114	0.019	0.041	0.000
0.2500	0.114	0.028	0.050	0.000
0.3333	0.114	0.038	0.058	0.000
0.4167	0.114	0.047	0.065	0.000
0.5000	0.114	0.057	0.072	0.000
0.5833	0.114	0.066	0.077	0.000
0.6667	0.114	0.076	0.083	0.000
0.7500	0.114	0.085	0.088	0.000
0.8333	0.114	0.095	0.093	0.000
0.9167	0.114	0.104	0.097	0.000
1.0000	0.114	0.114	0.101	0.000
1.0833	0.114	0.123	0.106	0.000
1.1667	0.114	0.133	0.110	0.000
1.2500	0.114	0.142	0.113	0.000
1.3333	0.114	0.152	0.117	0.000
1.4167	0.114	0.161	0.121	0.000
1.5000	0.114	0.171	0.124	0.000
1.5833	0.114	0.180	0.128	0.000
1.6667	0.114	0.190	0.131	0.000
1.7500	0.114	0.199	0.134	0.000
1.8333	0.114	0.209	0.137	0.000
1.9167	0.114	0.218	0.141	0.000
2.0000	0.114	0.228	0.144	0.000
2.0833	0.114	0.237	0.147	0.000
2.1667	0.114	0.247	0.149	0.000
2.2500	0.114	0.256	0.152	0.000
2.3333	0.114	0.266	0.155	0.000
2.4167	0.114	0.275	0.158	0.000
2.5000	0.114	0.285	0.161	0.000
2.5833	0.114	0.294	0.163	0.000
2.6667	0.114	0.304	0.166	0.000
2.7500	0.114	0.313	0.168	0.000
2.8333	0.114	0.323	0.171	0.000

2.9167	0.114	0.332	0.174	0.000
3.0000	0.114	0.342	0.176	0.000
3.0833	0.114	0.351	0.200	0.000
3.1667	0.114	0.361	0.211	0.000
3.2500	0.114	0.370	0.220	0.000
3.3333	0.114	0.380	0.229	0.000
3.4167	0.114	0.389	0.236	0.000
3.5000	0.114	0.399	0.243	0.000
3.5833	0.114	0.408	0.249	0.000
3.6667	0.114	0.418	0.255	0.000
3.7500	0.114	0.427	0.261	0.000
3.8333	0.114	0.437	0.267	0.000
3.9167	0.114	0.446	0.272	0.000
4.0000	0.114	0.456	0.278	0.000
4.0833	0.114	0.465	0.283	0.000
4.1667	0.114	0.475	0.288	0.000
4.2500	0.114	0.484	0.293	0.000
4.3333	0.114	0.494	0.298	0.000
4.4167	0.114	0.503	0.302	0.000
4.5000	0.114	0.513	0.307	0.000
4.5833	0.114	0.522	0.311	0.000
4.6667	0.114	0.532	0.316	0.000
4.7500	0.114	0.541	0.320	0.000
4.8333	0.114	0.551	0.324	0.000
4.9167	0.114	0.560	0.328	0.000
5.0000	0.114	0.570	0.333	0.000
5.0833	0.114	0.579	0.337	0.000
5.1667	0.114	0.589	0.341	0.000
5.2500	0.114	0.598	0.345	0.000
5.3333	0.114	0.608	0.349	0.000
5.4167	0.114	0.617	0.352	0.000
5.5000	0.114	0.627	0.356	0.000
5.5833	0.114	0.636	0.360	0.000
5.6667	0.114	0.646	0.364	0.000
5.7500	0.114	0.655	0.371	0.000
5.8333	0.114	0.665	0.387	0.000
5.9167	0.114	0.674	0.407	0.000
6.0000	0.114	0.684	0.429	0.000
6.0833	0.114	0.693	0.486	0.000
6.1667	0.114	0.703	0.526	0.000
6.2500	0.114	0.712	0.564	0.000
6.3333	0.114	0.722	0.601	0.000
6.4167	0.114	0.731	0.638	0.000
6.5000	0.114	0.741	0.675	0.000
6.5833	0.114	0.750	1.067	0.000
6.6667	0.114	0.760	1.768	0.000
6.7500	0.114	0.769	2.641	0.000
6.8333	0.114	0.779	3.593	0.000
6.9167	0.114	0.788	4.531	0.000
7.0000	0.114	0.798	5.366	0.000
7.0833	0.114	0.807	6.028	0.000
7.1667	0.114	0.817	6.496	0.000
7.2500	0.114	0.826	6.820	0.000
7.3333	0.114	0.836	7.225	0.000
7.4167	0.114	0.845	7.548	0.000
7.5000	0.114	0.855	7.856	0.000
7.5833	0.114	0.864	8.152	0.000
7.6667	0.000	0.000	8.437	0.000

Analysis Results

POC 1





\+ Predeveloped x Mitigated

Predeveloped Landuse Totals for POC #1
Total Pervious Area: 3.77
Total Impervious Area: 0.35

Mitigated Landuse Totals for POC #1
Total Pervious Area: 1.94
Total Impervious Area: 2.18

Flow Frequency Method: Log Pearson Type III 17B

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.3216
5 year	0.489468
10 year	0.621004
25 year	0.811994
50 year	0.973321
100 year	1.151877

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.160859
5 year	0.21374
10 year	0.25423
25 year	0.311982
50 year	0.360068
100 year	0.412746

Annual Peaks

Annual Peaks for Predeveloped and Mitigated. POC #1

Year	**Predeveloped**	**Mitigated**
1949	0.412	0.151
1950	0.443	0.159
1951	0.268	0.150
1952	0.309	0.127
1953	0.365	0.121
1954	0.936	0.156
1955	0.412	0.171
1956	0.247	0.173
1957	0.412	0.213
1958	0.851	0.159

1959	0.280	0.158
1960	0.358	0.174
1961	1.066	0.171
1962	0.317	0.155
1963	0.541	0.156
1964	0.308	0.150
1965	0.167	0.152
1966	0.182	0.122
1967	0.375	0.160
1968	0.344	0.234
1969	1.032	0.141
1970	0.228	0.131
1971	0.372	0.157
1972	0.399	0.161
1973	0.323	0.137
1974	0.529	0.139
1975	0.374	0.131
1976	0.203	0.163
1977	0.187	0.142
1978	0.217	0.121
1979	0.615	0.206
1980	0.304	0.143
1981	0.227	0.147
1982	0.229	0.248
1983	0.418	0.151
1984	0.267	0.172
1985	0.343	0.181
1986	0.673	0.366
1987	0.296	0.256
1988	0.276	0.157
1989	0.336	0.112
1990	0.226	0.158
1991	0.206	0.164
1992	0.304	0.136
1993	0.227	0.138
1994	0.171	0.153
1995	0.198	0.168
1996	0.446	0.231
1997	0.755	0.606
1998	0.341	0.133
1999	0.204	0.153
2000	0.453	0.161
2001	0.136	0.113
2002	0.177	0.156
2003	0.173	0.142
2004	0.398	0.253
2005	0.202	0.158
2006	0.602	0.269
2007	0.507	0.154
2008	0.436	0.503
2009	0.228	0.145

Ranked Annual Peaks

Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	1.0661	0.6064
2	1.0323	0.5027
3	0.9355	0.3663

4	0.8509	0.2686
5	0.7550	0.2559
6	0.6734	0.2529
7	0.6154	0.2475
8	0.6022	0.2338
9	0.5411	0.2311
10	0.5293	0.2128
11	0.5072	0.2063
12	0.4530	0.1806
13	0.4465	0.1740
14	0.4427	0.1726
15	0.4358	0.1723
16	0.4180	0.1712
17	0.4124	0.1709
18	0.4123	0.1678
19	0.4123	0.1643
20	0.3990	0.1633
21	0.3981	0.1607
22	0.3750	0.1607
23	0.3736	0.1599
24	0.3721	0.1588
25	0.3648	0.1585
26	0.3577	0.1584
27	0.3440	0.1578
28	0.3432	0.1576
29	0.3410	0.1571
30	0.3360	0.1571
31	0.3228	0.1563
32	0.3172	0.1557
33	0.3091	0.1555
34	0.3082	0.1548
35	0.3044	0.1538
36	0.3040	0.1533
37	0.2959	0.1531
38	0.2798	0.1522
39	0.2757	0.1509
40	0.2681	0.1506
41	0.2673	0.1504
42	0.2471	0.1498
43	0.2287	0.1471
44	0.2284	0.1451
45	0.2282	0.1432
46	0.2270	0.1421
47	0.2268	0.1420
48	0.2265	0.1409
49	0.2172	0.1391
50	0.2063	0.1378
51	0.2039	0.1372
52	0.2032	0.1358
53	0.2023	0.1333
54	0.1976	0.1314
55	0.1870	0.1310
56	0.1819	0.1272
57	0.1769	0.1223
58	0.1733	0.1209
59	0.1709	0.1206
60	0.1668	0.1135
61	0.1359	0.1125

Duration Flows

The Facility PASSED

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1608	2329	2306	99	Pass
0.1690	1894	1537	81	Pass
0.1772	1583	1105	69	Pass
0.1854	1356	916	67	Pass
0.1936	1201	878	73	Pass
0.2018	1048	841	80	Pass
0.2100	914	769	84	Pass
0.2183	829	716	86	Pass
0.2265	737	660	89	Pass
0.2347	660	593	89	Pass
0.2429	600	552	92	Pass
0.2511	554	483	87	Pass
0.2593	519	446	85	Pass
0.2675	484	417	86	Pass
0.2757	446	387	86	Pass
0.2839	416	356	85	Pass
0.2921	377	335	88	Pass
0.3003	352	316	89	Pass
0.3085	329	297	90	Pass
0.3167	305	269	88	Pass
0.3249	276	245	88	Pass
0.3332	247	219	88	Pass
0.3414	219	199	90	Pass
0.3496	190	177	93	Pass
0.3578	173	151	87	Pass
0.3660	150	124	82	Pass
0.3742	134	94	70	Pass
0.3824	114	71	62	Pass
0.3906	102	63	61	Pass
0.3988	91	56	61	Pass
0.4070	82	51	62	Pass
0.4152	69	48	69	Pass
0.4234	55	44	80	Pass
0.4316	51	41	80	Pass
0.4398	46	39	84	Pass
0.4481	40	33	82	Pass
0.4563	38	28	73	Pass
0.4645	33	26	78	Pass
0.4727	31	26	83	Pass
0.4809	27	23	85	Pass
0.4891	22	22	100	Pass
0.4973	22	20	90	Pass
0.5055	20	17	85	Pass
0.5137	17	17	100	Pass
0.5219	17	16	94	Pass
0.5301	16	12	75	Pass
0.5383	15	11	73	Pass
0.5465	13	11	84	Pass
0.5547	13	9	69	Pass
0.5630	13	9	69	Pass
0.5712	11	8	72	Pass
0.5794	11	7	63	Pass
0.5876	11	5	45	Pass

0.5958	11	4	36	Pass
0.6040	10	2	20	Pass
0.6122	10	0	0	Pass
0.6204	9	0	0	Pass
0.6286	8	0	0	Pass
0.6368	8	0	0	Pass
0.6450	8	0	0	Pass
0.6532	8	0	0	Pass
0.6614	8	0	0	Pass
0.6697	8	0	0	Pass
0.6779	6	0	0	Pass
0.6861	6	0	0	Pass
0.6943	6	0	0	Pass
0.7025	6	0	0	Pass
0.7107	6	0	0	Pass
0.7189	6	0	0	Pass
0.7271	6	0	0	Pass
0.7353	6	0	0	Pass
0.7435	6	0	0	Pass
0.7517	6	0	0	Pass
0.7599	5	0	0	Pass
0.7681	5	0	0	Pass
0.7763	5	0	0	Pass
0.7846	5	0	0	Pass
0.7928	5	0	0	Pass
0.8010	5	0	0	Pass
0.8092	5	0	0	Pass
0.8174	5	0	0	Pass
0.8256	5	0	0	Pass
0.8338	5	0	0	Pass
0.8420	5	0	0	Pass
0.8502	5	0	0	Pass
0.8584	4	0	0	Pass
0.8666	4	0	0	Pass
0.8748	4	0	0	Pass
0.8830	4	0	0	Pass
0.8912	4	0	0	Pass
0.8995	4	0	0	Pass
0.9077	4	0	0	Pass
0.9159	4	0	0	Pass
0.9241	4	0	0	Pass
0.9323	4	0	0	Pass
0.9405	3	0	0	Pass
0.9487	3	0	0	Pass
0.9569	3	0	0	Pass
0.9651	3	0	0	Pass
0.9733	3	0	0	Pass

Water Quality

Water Quality BMP Flow and Volume for POC #1

On-line facility volume:	0.313 acre-feet
On-line facility target flow:	0.4129 cfs.
Adjusted for 15 min:	0.4129 cfs.
Off-line facility target flow:	0.2332 cfs.
Adjusted for 15 min:	0.2332 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
Vault 1 POC	☐	505.37			☐	0.00			
Total Volume Infiltrated		505.37	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 = Passed

Model Default Modifications

Total of 0 changes have been made.

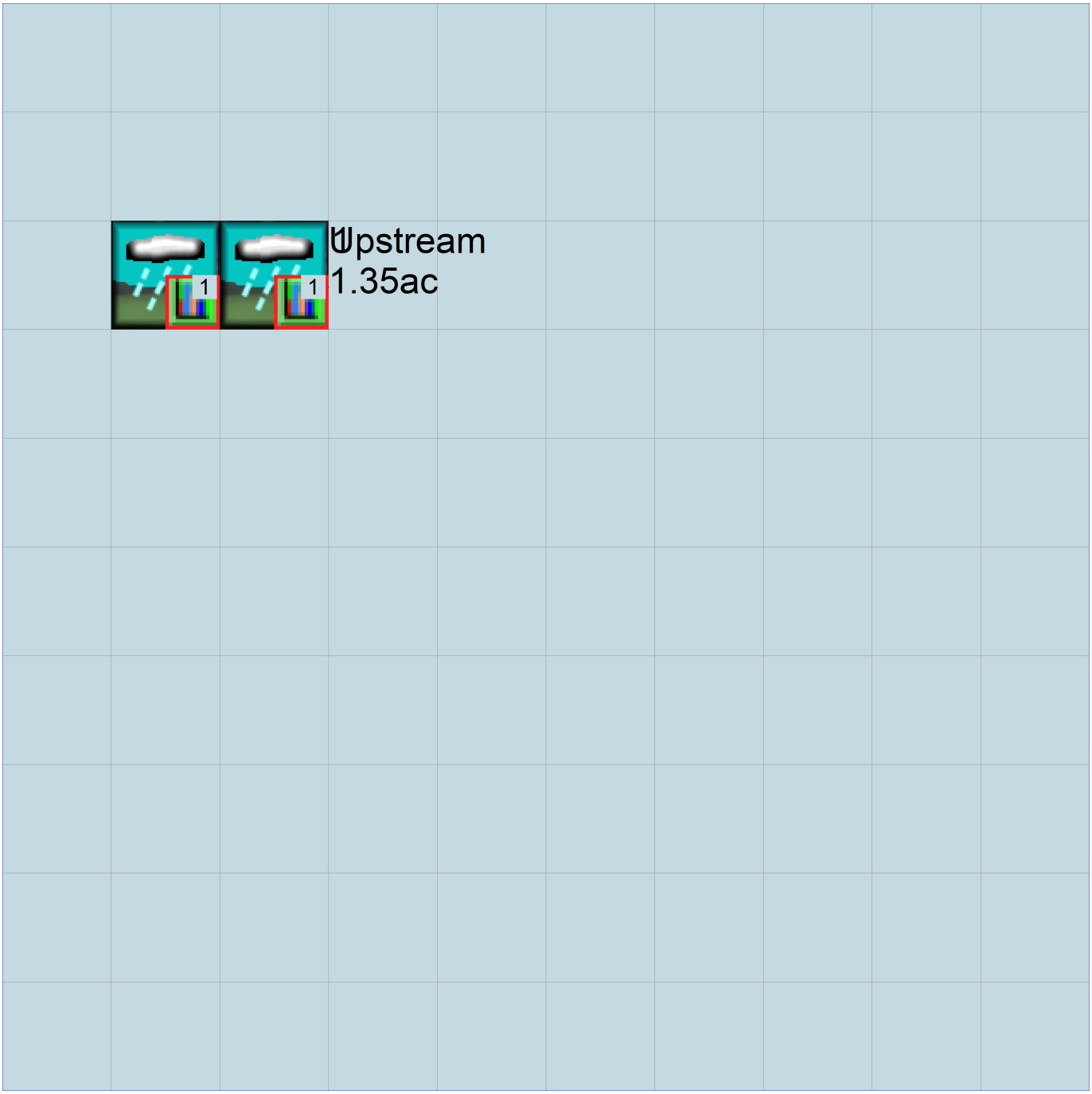
PERLND Changes

No PERLND changes have been made.

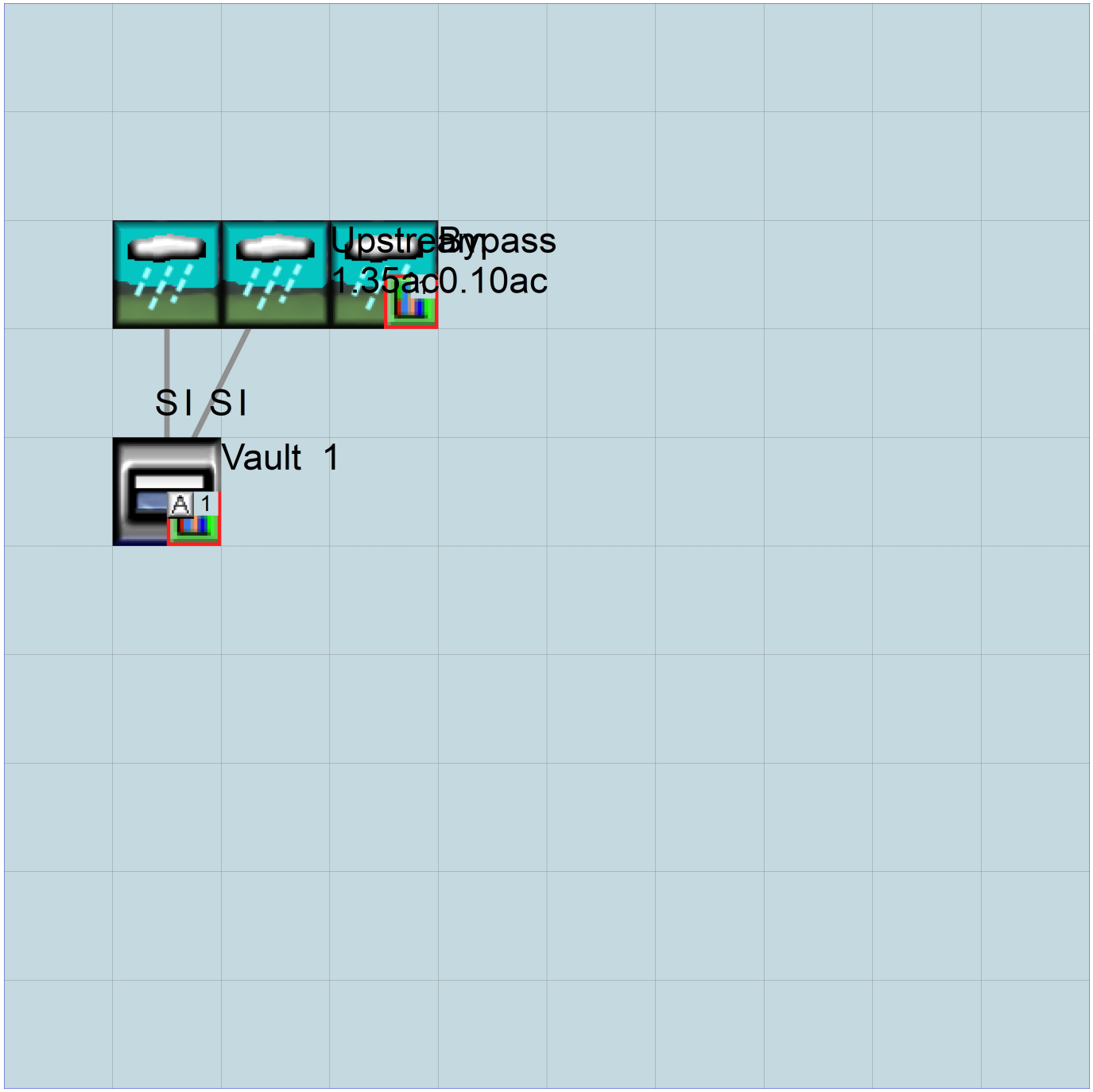
IMPLND Changes

No IMPLND changes have been made.

Appendix
Predeveloped Schematic



Mitigated Schematic



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   Minor East w_Upstream.wdm
MESSU       25   PreMinor East w_Upstream.MES
            27   PreMinor East w_Upstream.L61
            28   PreMinor East w_Upstream.L62
            30   POCMinor East w_Upstream1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      11
      PERLND      12
      PERLND      17
      IMPLND       4
      IMPLND       5
      COPY       501
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title---------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Basin  1                  MAX                    1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   11     C, Forest, Mod          1    1    1    1   27    0
   12     C, Forest, Steep        1    1    1    1   27    0
   17     C, Lawn, Mod            1    1    1    1   27    0
  END GEN-INFO
  *** Section PWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
   11         0    0    1    0    0    0    0    0    0    0    0    0
   12         0    0    1    0    0    0    0    0    0    0    0    0
   17         0    0    1    0    0    0    0    0    0    0    0    0
```

```
  END ACTIVITY

  PRINT-INFO
    <PLS > ***************** Print-flags **************************** PIVL  PYR
    # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
   11         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   12         0    0    4    0    0    0    0    0    0    0    0    0    1    9
   17         0    0    4    0    0    0    0    0    0    0    0    0    1    9
  END PRINT-INFO

  PWAT-PARM1
    <PLS >  PWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
   11         0    0    0    0    0    0    0    0    0    0    0
   12         0    0    0    0    0    0    0    0    0    0    0
   17         0    0    0    0    0    0    0    0    0    0    0
  END PWAT-PARM1

  PWAT-PARM2
    <PLS >      PWATER input info: Part 2         ***
    # -  # ***FOREST      LZSN    INFILT      LSUR     SLSUR     KVARY     AGWRC
   11              0       4.5      0.08       400       0.1       0.5     0.996
   12              0       4.5      0.08       400      0.15       0.5     0.996
   17              0       4.5      0.03       400       0.1       0.5     0.996
  END PWAT-PARM2

  PWAT-PARM3
    <PLS >      PWATER input info: Part 3         ***
    # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
   11              0         0         2         2         0         0         0
   12              0         0         2         2         0         0         0
   17              0         0         2         2         0         0         0
  END PWAT-PARM3
  PWAT-PARM4
    <PLS >     PWATER input info: Part 4                              ***
    # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
   11            0.2       0.5      0.35         6       0.5       0.7
   12            0.2       0.3      0.35         6       0.3       0.7
   17            0.1      0.25      0.25         6       0.5      0.25
  END PWAT-PARM4

  PWAT-STATE1
    <PLS > *** Initial conditions at start of simulation
             ran from 1990 to end of 1992 (pat 1-11-95) RUN 21 ***
    # -  # ***  CEPS      SURS       UZS       IFWS       LZS       AGWS      GWVS
   11              0         0         0         0       2.5          1         0
   12              0         0         0         0       2.5          1         0
   17              0         0         0         0       2.5          1         0
  END PWAT-STATE1

END PERLND

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

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

  PRINT-INFO
```

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

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    4         0    0    0    0    0
    5         0    0    0    0    0
  END IWAT-PARM1

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

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

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

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  11                          2     COPY   501     12
PERLND  11                          2     COPY   501     13
PERLND  12                       0.77     COPY   501     12
PERLND  12                       0.77     COPY   501     13
Upstream***
PERLND  17                        0.2     COPY   501     12
PERLND  17                        0.2     COPY   501     13
PERLND  11                        0.8     COPY   501     12
PERLND  11                        0.8     COPY   501     13
IMPLND   4                       0.12     COPY   501     15
IMPLND   5                       0.23     COPY   501     15

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

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



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

RCHRES
  GEN-INFO
    RCHRES       Name        Nexits   Unit Systems   Printer                ***
    # -  #<----------------><---> User T-series  Engl Metr LKFG             ***
```

```
                                          in  out                          ***
  END GEN-INFO
  *** Section RCHRES***

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

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
END FTABLES

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

END EXT SOURCES

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

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

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

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

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   Minor East w_Upstream.wdm
MESSU       25   MitMinor East w_Upstream.MES
            27   MitMinor East w_Upstream.L61
            28   MitMinor East w_Upstream.L62
            30   POCMinor East w_Upstream1.dat
END FILES

OPN SEQUENCE
    INGRP              INDELT 00:15
      PERLND      13
      IMPLND       1
      IMPLND       4
      IMPLND       5
      IMPLND       8
      PERLND      14
      PERLND      15
      PERLND      17
      PERLND      11
      RCHRES       1
      COPY         1
      COPY       501
      COPY       601
      DISPLY       1
    END INGRP
END OPN SEQUENCE
DISPLY
  DISPLY-INFO1
    # -  #<----------Title----------->***TRAN PIVL DIG1 FIL1  PYR DIG2 FIL2 YRND
    1        Vault  1                   MAX                     1    2   30    9
  END DISPLY-INFO1
END DISPLY
COPY
  TIMESERIES
    # -  #  NPT  NMN ***
    1         1    1
  501         1    1
  601         1    1
  END TIMESERIES
END COPY
GENER
  OPCODE
    #    # OPCD ***
  END OPCODE
  PARM
    #    #         K ***
  END PARM
END GENER
PERLND
  GEN-INFO
    <PLS ><-------Name------->NBLKS   Unit-systems   Printer ***
    # -  #                          User  t-series Engl Metr ***
                                          in  out            ***
   13     C, Pasture, Flat        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
   17     C, Lawn, Mod            1    1    1    1   27    0
```

```
 11     C, Forest, Mod          1    1    1    1   27    0
END GEN-INFO
*** Section PWATER***

ACTIVITY
  <PLS > ************ Active Sections ******************************
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC ***
 13         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
 17         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
END ACTIVITY

PRINT-INFO
  <PLS > ***************** Print-flags **************************** PIVL  PYR
  # -  # ATMP SNOW PWAT  SED  PST  PWG PQAL MSTL PEST NITR PHOS TRAC  *********
 13         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
 17         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
END PRINT-INFO

PWAT-PARM1
  <PLS >  PWATER variable monthly parameter value flags  ***
  # -  # CSNO RTOP UZFG  VCS  VUZ  VNN VIFW VIRC  VLE INFC  HWT ***
 13         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
 17         0    0    0    0    0    0    0    0    0    0    0
 11         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
 13              0       4.5      0.06       400      0.05       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
 17              0       4.5      0.03       400       0.1       0.5     0.996
 11              0       4.5      0.08       400       0.1       0.5     0.996
END PWAT-PARM2

PWAT-PARM3
  <PLS >      PWATER input info: Part 3          ***
  # -  # ***PETMAX    PETMIN    INFEXP    INFILD    DEEPFR    BASETP    AGWETP
 13              0         0         2         2         0         0         0
 14              0         0         2         2         0         0         0
 15              0         0         2         2         0         0         0
 17              0         0         2         2         0         0         0
 11              0         0         2         2         0         0         0
END PWAT-PARM3
PWAT-PARM4
  <PLS >     PWATER input info: Part 4                              ***
  # -  #     CEPSC      UZSN      NSUR     INTFW       IRC     LZETP ***
 13          0.15       0.4       0.3         6       0.5       0.4
 14          0.15       0.4       0.3         6       0.5       0.4
 15          0.15      0.25       0.3         6       0.3       0.4
 17           0.1      0.25      0.25         6       0.5      0.25
 11           0.2       0.5      0.35         6       0.5       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
 13              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
```

```
   17             0         0         0         0       2.5         1         0
   11             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           ***
    1      ROADS/FLAT             1    1    1   27    0
    4      ROOF TOPS/FLAT         1    1    1   27    0
    5      DRIVEWAYS/FLAT         1    1    1   27    0
    8      SIDEWALKS/FLAT         1    1    1   27    0
  END GEN-INFO
  *** Section IWATER***

  ACTIVITY
    <PLS > ************ Active Sections ******************************
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL   ***
    1         0    0    1    0    0    0
    4         0    0    1    0    0    0
    5         0    0    1    0    0    0
    8         0    0    1    0    0    0
  END ACTIVITY

  PRINT-INFO
    <ILS > ******** Print-flags ******** PIVL  PYR
    # -  # ATMP SNOW IWAT  SLD  IWG IQAL    *********
    1         0    0    4    0    0    4    1    9
    4         0    0    4    0    0    0    1    9
    5         0    0    4    0    0    0    1    9
    8         0    0    4    0    0    0    1    9
  END PRINT-INFO

  IWAT-PARM1
    <PLS >  IWATER variable monthly parameter value flags  ***
    # -  # CSNO RTOP  VRS  VNN RTLI     ***
    1         0    0    0    0    0
    4         0    0    0    0    0
    5         0    0    0    0    0
    8         0    0    0    0    0
  END IWAT-PARM1

  IWAT-PARM2
    <PLS >      IWATER input info: Part 2         ***
    # -  # ***  LSUR     SLSUR      NSUR     RETSC
    1            400      0.01       0.1       0.1
    4            400      0.01       0.1       0.1
    5            400      0.01       0.1       0.1
    8            400      0.01       0.1       0.1
  END IWAT-PARM2

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

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

```
  END IWAT-STATE1

END IMPLND

SCHEMATIC
<-Source->                  <--Area-->     <-Target->   MBLK   ***
<Name>   #                  <-factor->     <Name>   #   Tbl#   ***
Basin  1***
PERLND  13                       0.84     RCHRES   1      2
PERLND  13                       0.84     RCHRES   1      3
IMPLND   1                       0.29     RCHRES   1      5
IMPLND   4                          1     RCHRES   1      5
IMPLND   5                       0.45     RCHRES   1      5
IMPLND   8                       0.09     RCHRES   1      5
Upstream***
PERLND  17                        0.2     RCHRES   1      2
PERLND  17                        0.2     RCHRES   1      3
PERLND  11                        0.8     RCHRES   1      2
PERLND  11                        0.8     RCHRES   1      3
IMPLND   4                       0.12     RCHRES   1      5
IMPLND   5                       0.23     RCHRES   1      5
Bypass***
PERLND  14                       0.06     COPY   501     12
PERLND  14                       0.06     COPY   601     12
PERLND  14                       0.06     COPY   501     13
PERLND  14                       0.06     COPY   601     13
PERLND  15                       0.04     COPY   501     12
PERLND  15                       0.04     COPY   601     12
PERLND  15                       0.04     COPY   501     13
PERLND  15                       0.04     COPY   601     13

******Routing******
PERLND  13                       0.84     COPY     1     12
IMPLND   1                       0.29     COPY     1     15
IMPLND   4                          1     COPY     1     15
IMPLND   5                       0.45     COPY     1     15
IMPLND   8                       0.09     COPY     1     15
PERLND  13                       0.84     COPY     1     13
PERLND  17                        0.2     COPY     1     12
PERLND  11                        0.8     COPY     1     12
IMPLND   4                       0.12     COPY     1     15
IMPLND   5                       0.23     COPY     1     15
PERLND  17                        0.2     COPY     1     13
PERLND  11                        0.8     COPY     1     13
RCHRES   1                          1     COPY   501     16
END SCHEMATIC

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



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

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

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

```
    1         1    0    0    0    0    0    0    0    0    0
  END ACTIVITY

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

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

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

SPEC-ACTIONS
END SPEC-ACTIONS
FTABLES
  FTABLE      1
   92    4
     Depth      Area    Volume  Outflow1 Velocity  Travel Time***
      (ft)   (acres) (acre-ft)   (cfs)   (ft/sec)    (Minutes)***
  0.000000  0.114050  0.000000  0.000000
  0.083333  0.114050  0.009504  0.029407
  0.166667  0.114050  0.019008  0.041588
  0.250000  0.114050  0.028512  0.050935
  0.333333  0.114050  0.038017  0.058814
  0.416667  0.114050  0.047521  0.065756
  0.500000  0.114050  0.057025  0.072032
  0.583333  0.114050  0.066529  0.077804
  0.666667  0.114050  0.076033  0.083176
  0.750000  0.114050  0.085537  0.088221
  0.833333  0.114050  0.095041  0.092993
  0.916667  0.114050  0.104545  0.097532
  1.000000  0.114050  0.114050  0.101869
  1.083333  0.114050  0.123554  0.106029
  1.166667  0.114050  0.133058  0.110031
  1.250000  0.114050  0.142562  0.113893
  1.333333  0.114050  0.152066  0.117628
  1.416667  0.114050  0.161570  0.121248
  1.500000  0.114050  0.171074  0.124764
  1.583333  0.114050  0.180579  0.128182
  1.666667  0.114050  0.190083  0.131512
  1.750000  0.114050  0.199587  0.134760
  1.833333  0.114050  0.209091  0.137931
  1.916667  0.114050  0.218595  0.141031
  2.000000  0.114050  0.228099  0.144065
  2.083333  0.114050  0.237603  0.147035
  2.166667  0.114050  0.247107  0.149947
  2.250000  0.114050  0.256612  0.152804
  2.333333  0.114050  0.266116  0.155608
  2.416667  0.114050  0.275620  0.158362
  2.500000  0.114050  0.285124  0.161069
  2.583333  0.114050  0.294628  0.163732
```

```
  2.666667  0.114050  0.304132  0.166351
  2.750000  0.114050  0.313636  0.168931
  2.833333  0.114050  0.323140  0.171471
  2.916667  0.114050  0.332645  0.173974
  3.000000  0.114050  0.342149  0.176442
  3.083333  0.114050  0.351653  0.200365
  3.166667  0.114050  0.361157  0.211668
  3.250000  0.114050  0.370661  0.220867
  3.333333  0.114050  0.380165  0.228965
  3.416667  0.114050  0.389669  0.236348
  3.500000  0.114050  0.399174  0.243217
  3.583333  0.114050  0.408678  0.249690
  3.666667  0.114050  0.418182  0.255845
  3.750000  0.114050  0.427686  0.261736
  3.833333  0.114050  0.437190  0.267403
  3.916667  0.114050  0.446694  0.272876
  4.000000  0.114050  0.456198  0.278179
  4.083333  0.114050  0.465702  0.283330
  4.166667  0.114050  0.475207  0.288344
  4.250000  0.114050  0.484711  0.293236
  4.333333  0.114050  0.494215  0.298014
  4.416667  0.114050  0.503719  0.302689
  4.500000  0.114050  0.513223  0.307268
  4.583333  0.114050  0.522727  0.311758
  4.666667  0.114050  0.532231  0.316165
  4.750000  0.114050  0.541736  0.320494
  4.833333  0.114050  0.551240  0.324751
  4.916667  0.114050  0.560744  0.328938
  5.000000  0.114050  0.570248  0.333061
  5.083333  0.114050  0.579752  0.337122
  5.166667  0.114050  0.589256  0.341125
  5.250000  0.114050  0.598760  0.345072
  5.333333  0.114050  0.608264  0.348966
  5.416667  0.114050  0.617769  0.352810
  5.500000  0.114050  0.627273  0.356605
  5.583333  0.114050  0.636777  0.360354
  5.666667  0.114050  0.646281  0.364058
  5.750000  0.114050  0.655785  0.371405
  5.833333  0.114050  0.665289  0.387120
  5.916667  0.114050  0.674793  0.407049
  6.000000  0.114050  0.684298  0.429897
  6.083333  0.114050  0.693802  0.486276
  6.166667  0.114050  0.703306  0.526002
  6.250000  0.114050  0.712810  0.564033
  6.333333  0.114050  0.722314  0.601523
  6.416667  0.114050  0.731818  0.638785
  6.500000  0.114050  0.741322  0.675888
  6.583333  0.114050  0.750826  1.067637
  6.666667  0.114050  0.760331  1.768617
  6.750000  0.114050  0.769835  2.641403
  6.833333  0.114050  0.779339  3.593799
  6.916667  0.114050  0.788843  4.531930
  7.000000  0.114050  0.798347  5.366192
  7.083333  0.114050  0.807851  6.028618
  7.166667  0.114050  0.817355  6.496551
  7.250000  0.114050  0.826860  6.820942
  7.333333  0.114050  0.836364  7.225527
  7.416667  0.114050  0.845868  7.548185
  7.500000  0.114050  0.855372  7.856654
  7.583333  0.114050  0.864876  8.152668
  END FTABLE  1
END FTABLES

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

```
END EXT SOURCES

EXT TARGETS
<-Volume-> <-Grp> <-Member-><--Mult-->Tran <-Volume-> <Member> Tsys Tgap Amd ***
<Name>   #        <Name> # #<-factor->strg <Name>   # <Name>    tem strg strg***
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
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
```

Disclaimer

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SITE SPECIFIC DATA	
Structure ID	-
Treatment Flow Rate (gpm/cfs)	-
Peak Flow Rate (cfs)	-
Cartridge Quantity	-
Rim Elevation	-

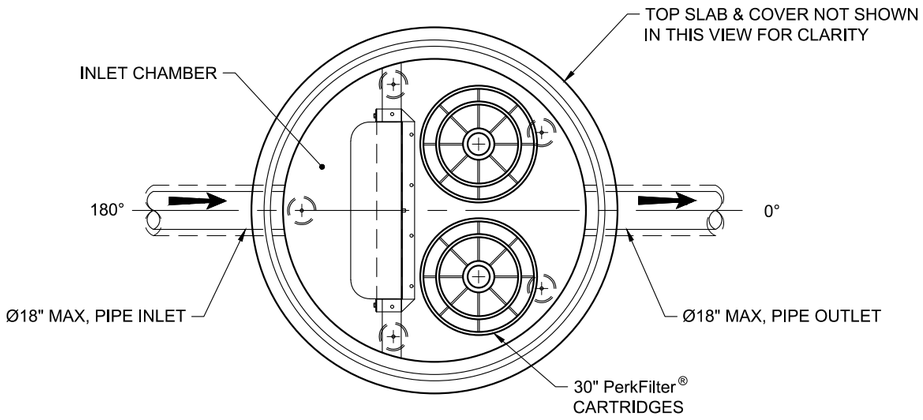
Pipe Data	Pipe Location	Pipe Size	Pipe Type	Invert Elevation
Inlet	-	-	-	-
Outlet	-	-	-	-

Notes:
-

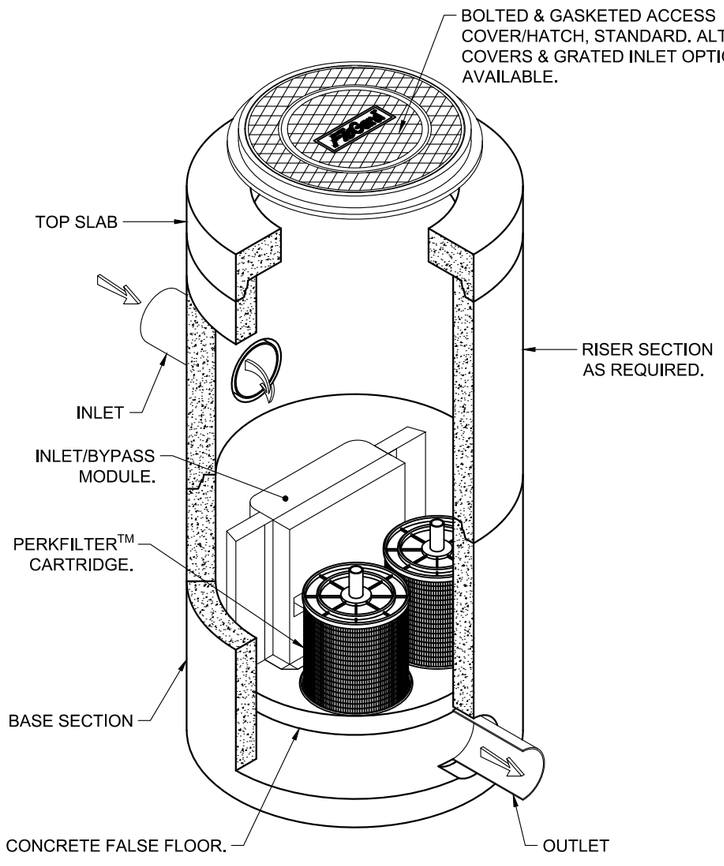
PERFORMANCE SPECIFICATIONS	
Peak Treatment Capacities: [1]	
Max. Cartridge Quantity	2
NJDEP 80% Removal, 75 micron	68 gpm / 0.151 cfs
WA Ecology GULD - Basic & Phosphorus	34 gpm / 0.075 cfs
Max. Bypass Capacity	3.62 cfs

1. Contact Oldcastle for alternative treatment and peak flow capacities.

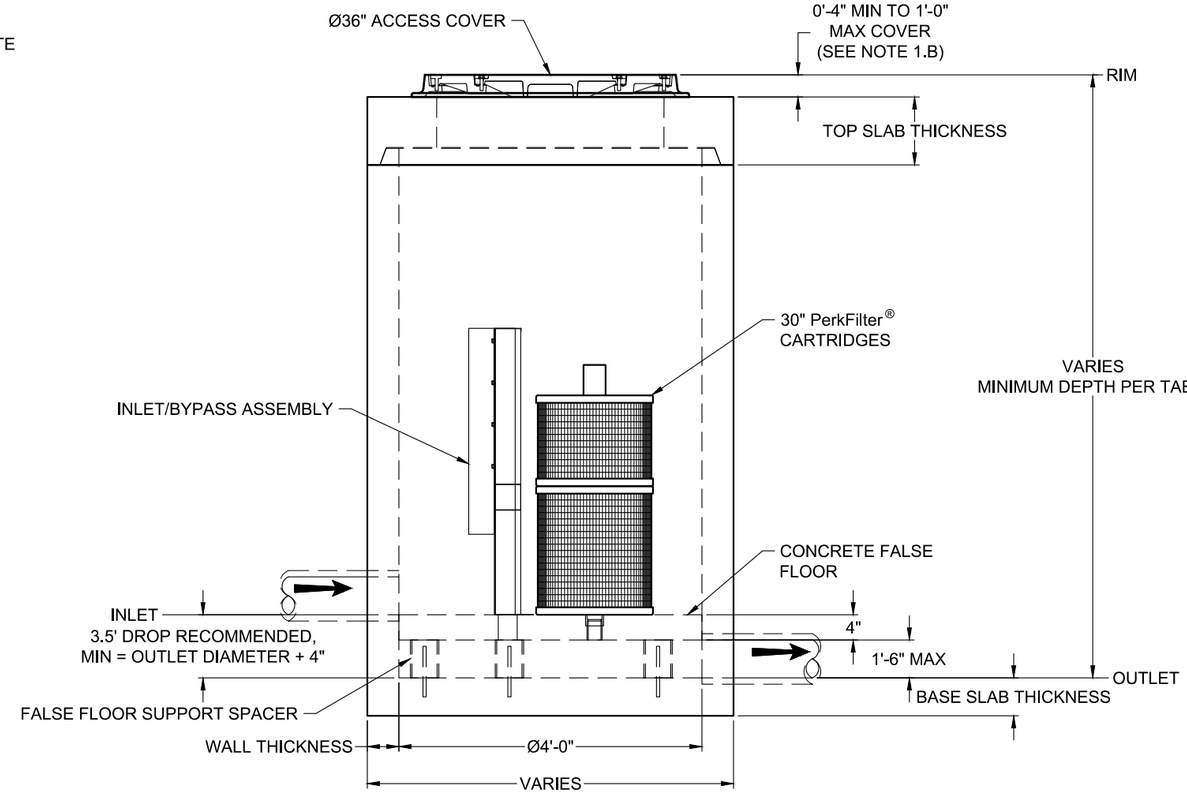
MINIMUM DEPTH	
Outlet Pipe Size	Minimum Rim to Outlet Depth
Ø6"	5.67'
Ø8"	5.92'
Ø10"	6.17'
Ø12"	6.42'
Ø15"	6.67'
Ø18"	6.92'



PLAN VIEW



ISOMETRIC VIEW



ELEVATION VIEW

NOTES:

1. DESIGN LOADINGS:
   A. AASHTO HS-20-44 (WITH IMPACT)
   B. DESIGN SOIL COVER: 1'-0" MAXIMUM
   C. ASSUMED WATER TABLE: BELOW INVERT.
   D. LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
   E. LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
   F. NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
2. CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
3. REINFORCING: REBAR, ASTM A615/A706, GRADE 60
4. CEMENT: ASTM C150
5. REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
6. REFERENCE STANDARD:
   A. ASTM C 478
   B. ASTM C 497
7. THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW OF THIS SUBMITTAL.
8. OVERSIZED HOLES TO ACCOMMODATE SPECIFIC PIPE TYPE MUST BE CONCENTRIC TO PIPE ID. AFTER PIPES ARE INSTALLED, ALL ANNULAR SPACES SHALL BE FILLED WITH A MINIMUM OF 3,000 PSI CONCRETE FOR FULL THICKNESS OF PRECAST WALLS. PIPES ARE TO BE FLUSH WITH THE INSIDE SURFACE OF THE CONCRETE STRUCTURE.
9. CONTRACTOR RESPONSIBLE TO VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS.
10. CONTRACTOR RESPONSIBLE TO ENSURE ADEQUATE BEARING SURFACE IS PROVIDED (I.E. COMPACTED AND LEVEL PER PROJECT SPECIFICATIONS).
11. SECTION HEIGHTS, SLAB/WALL THICKNESSES, AND KEYWAYS ARE SUBJECT TO CHANGE AS REQUIRED FOR SITE REQUIREMENTS AND/OR DUE TO PRODUCT AVAILABILITY AND PRODUCTION FACILITY CONSTRAINTS.
12. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT OLDCASTLE INFRASTRUCTURE.
13. MAXIMUM PICK WEIGHTS:
   A. TOP SLAB: XX,XXX LBS
   B. RISER: XX,XXX LBS
   C. BASE: XX,XXX LBS*
   (* COMBINED WEIGHT OF BASE INCLUDES FALSE FLOOR, AND PRODUCT INTERNALS.)
14. INTERNALS SHALL CONSIST OF CARTRIDGES, INLET/BYPASS ASSEMBLIES, FALSE FLOOR AND FALSE FLOOR SUPPORT SPACERS.

Oldcastle Infrastructure™
A CRH COMPANY

Ph: 800.579.8819 | www.oldcastleinfrastructure.com/stormwater

PerkFilter® Manhole (STANDARD)

Ø48" with 30" Cartridges

CUSTOMER
-

PROJECT NAME
-

SHEET NAME	REVISION	SHEET
Specifier Drawing PFMH-48-30	-	1 OF 1
	REV DATE -	

Media Filtration

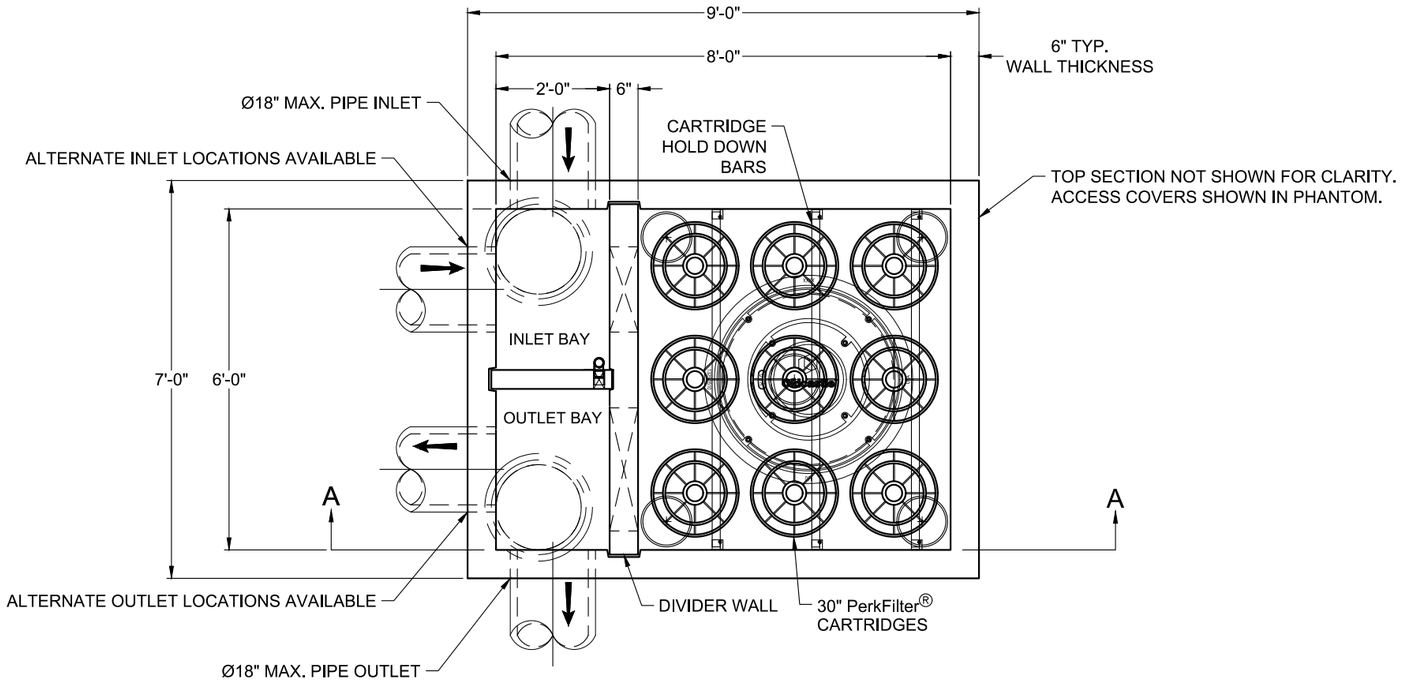
SITE SPECIFIC DATA	
Structure ID	-
Treatment Flow Rate (gpm/cfs)	-
Peak Flow Rate (cfs)	-
Rim Elevation	-

Pipe Data	Pipe Location	Pipe Size	Pipe Type	Invert Elevation
Inlet 1	-	-	-	-
Inlet 2	-	-	-	-
Outlet	-	-	-	-

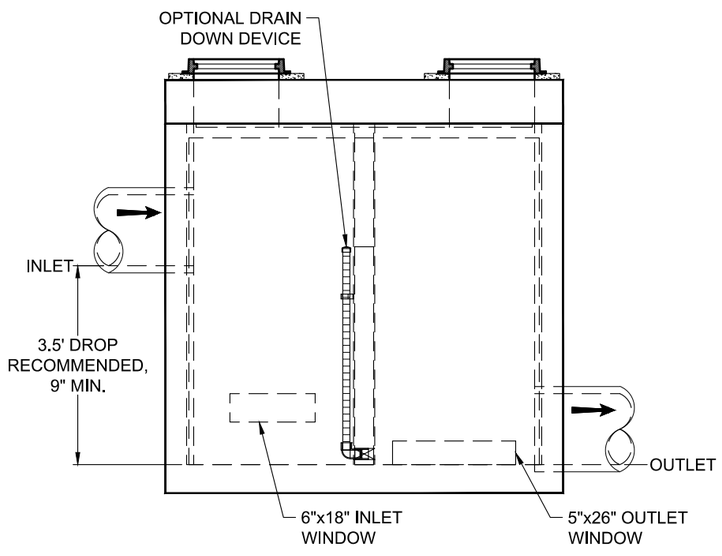
Notes:
-

PERFORMANCE SPECIFICATIONS	
Peak Treatment Capacities:[1]	
Max. Cartridge Quantity	9
NJDEP 80% Removal, 75 micron	0.602 cfs
WA Ecology GULD - Basic & Phosphorus	0.341 cfs
Max. Bypass Capacity	18.3 cfs

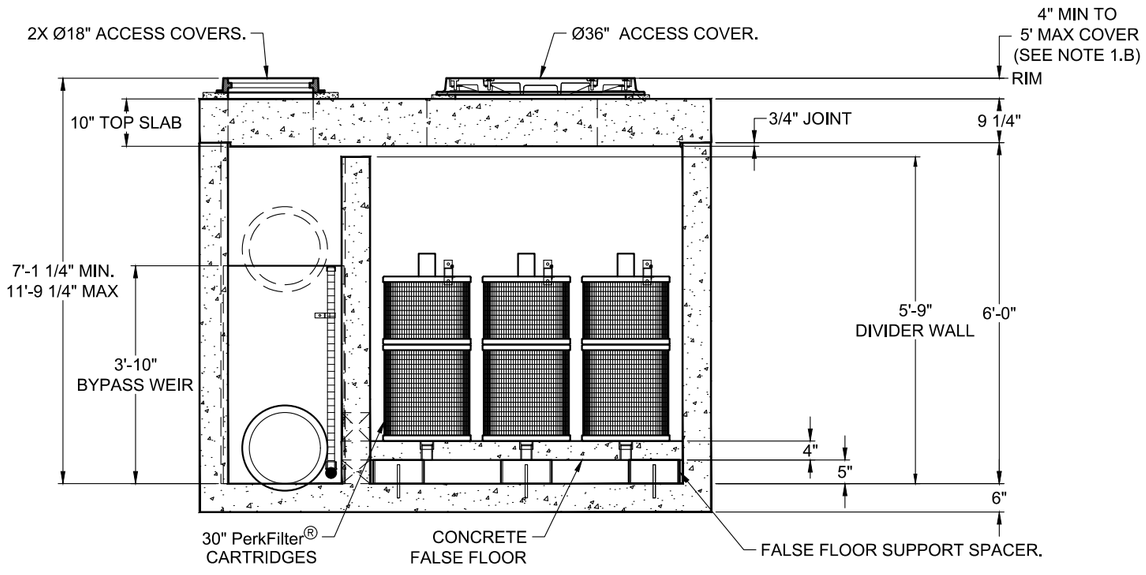
1. Contact Oldcastle for alternative treatment and peak flow capacities.



PLAN VIEW



LEFT END VIEW



SECTION A-A

NOTES:

1. DESIGN LOADINGS:
   A. AASHTO HS-20-44 (WITH IMPACT)
   B. DESIGN SOIL COVER: 5'-0" MAXIMUM
   C. ASSUMED WATER TABLE: BELOW BASE OF PRECAST (ENGINEER-OF-RECORD TO CONFIRM SITE WATER TABLE ELEVATION)
   D. LATERAL EARTH PRESSURE: 45 PCF (DRAINED)
   E. LATERAL LIVE LOAD SURCHARGE: 80 PSF (APPLIED TO 8'-0" BELOW GRADE)
   F. NO LATERAL SURCHARGE FROM ADJACENT BUILDINGS, WALLS, PIERS, OR FOUNDATIONS.
2. CONCRETE 28-DAY MINIMUM COMPRESSIVE STRENGTH: 5,000 PSI MINIMUM.
3. REINFORCING: REBAR, ASTM A615/A706, GRADE 60
4. CEMENT: ASTM C150
5. REQUIRED ALLOWABLE SOIL BEARING CAPACITY: 2,500 PSF
6. REFERENCE STANDARD:
   A. ASTM C890
   B. ASTM C913
   C. ACI 318-14
7. THIS STRUCTURE IS DESIGNED TO THE PARAMETERS NOTED HEREIN. ENGINEER-OF-RECORD SHALL VERIFY THAT NOTED PARAMETERS MEET OR EXCEED PROJECT REQUIREMENTS. IF DESIGN PARAMETERS ARE INCORRECT, REVIEWING ENGINEER/AUTHORITY SHALL NOTIFY OLDCASTLE INFRASTRUCTURE UPON REVIEW OF THIS SUBMITTAL.
8. OVERSIZED HOLES TO ACCOMMODATE SPECIFIC PIPE TYPE MUST BE CONCENTRIC TO PIPE ID. AFTER PIPES ARE INSTALLED, ALL ANNULAR SPACES SHALL BE FILLED WITH A MINIMUM OF 3,000 PSI CONCRETE FOR FULL THICKNESS OF PRECAST WALLS. PIPES ARE TO BE FLUSH WITH THE INSIDE SURFACE OF THE CONCRETE STRUCTURE.
9. CONTRACTOR RESPONSIBLE TO VERIFY ALL SIZES, LOCATIONS, AND ELEVATIONS OF OPENINGS.
10. CONTRACTOR RESPONSIBLE TO ENSURE ADEQUATE BEARING SURFACE IS PROVIDED (I.E. COMPACTED AND LEVEL PER PROJECT SPECIFICATIONS).
11. SECTION HEIGHTS, SLAB/WALL THICKNESSES, AND KEYWAYS ARE SUBJECT TO CHANGE AS REQUIRED FOR SITE REQUIREMENTS AND/OR DUE TO PRODUCT AVAILABILITY AND PRODUCTION FACILITY CONSTRAINTS.
12. FOR SITE SPECIFIC DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT OLDCASTLE INFRASTRUCTURE.
13. MAXIMUM PICK WEIGHTS:
   A. TOP: XX,XXX LBS
   B. BASE: XX,XXX LBS*
   (* COMBINED WEIGHT OF BASE INCLUDES DIVIDER WALLS, FALSE FLOOR, AND PRODUCT INTERNALS.)
14. INTERNALS SHALL CONSIST OF CARTRIDGES, WEIR WALL, FALSE FLOOR, FALSE FLOOR SUPPORT SPACERS, AND DIVIDER WALL.

Media Filtration

Oldcastle Infrastructure™
A CRH COMPANY

Ph: 800.579.8819 | www.oldcastleinfrastructure.com/stormwater

PerkFilter® Vault (STANDARD)
6'x8' With 30" Cartridges

CUSTOMER
-

PROJECT NAME
-

SHEET NAME	REVISION	SHEET
Specifier Drawing PFV-68-30	-	1 OF 1
	REV DATE -	

Oldcastle Infrastructure™ A CRH COMPANY — STORMWATER TREATMENT – DESIGN ASSISTANCE REQUEST

PROJECT INFORMATION

Contact Name: Cooper Danby		Company: Solid Ground Engineering
Email: cdanby@solidgroundpnw.com		Phone: 206-446-3932
Date: 1/5/2024	☐ Rush Request	☐ Site Plan Attached
Project Name: Minor Property		
Location: 8512 E Sunnyside Rd		Regulatory Jurisdiction: Marysville

Type of Site: ■ Residential ☐ Commercial ☐ Mixed Use ☐ Industrial ☐ Other

Treatment Technology: ☐ Bioretention/Biofiltration ■ Media Filtration ☐ Hydrodynamic Separation

DESIGN SPECIFICATIONS

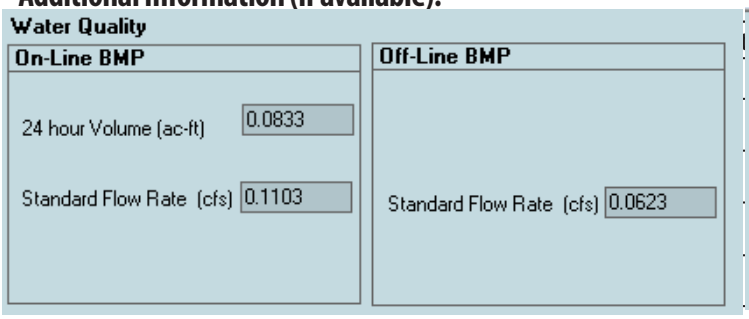
Sizing Methodology:

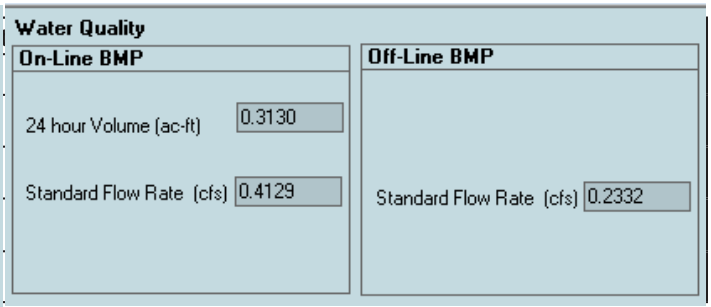
■ Water Quality Flow | ☐ Water Quality Volume | ☐ Downstream of Detention

Site Information:

Structure ID	Drainage Area ○ sf ◉ acres	Percent Impervious (%)	Runoff Coefficient	WQ Flow Rate or Volume ◉ cfs/cf ○ gpm/gal	Peak Flow Rate ◉ cfs ○ gpm
West	1.08	55.6%		0.33 (701 2yr)	1.23 (701unmitigated)
East	4.14	54.1%		1.27 (701 2yr)	4.48 (701unmitigated)

Additional Information (if available):





Note Special Conditions:

☐ Shallow Application

☐ High Groundwater

☐ Limited Drop (PerkFilter Only) _____

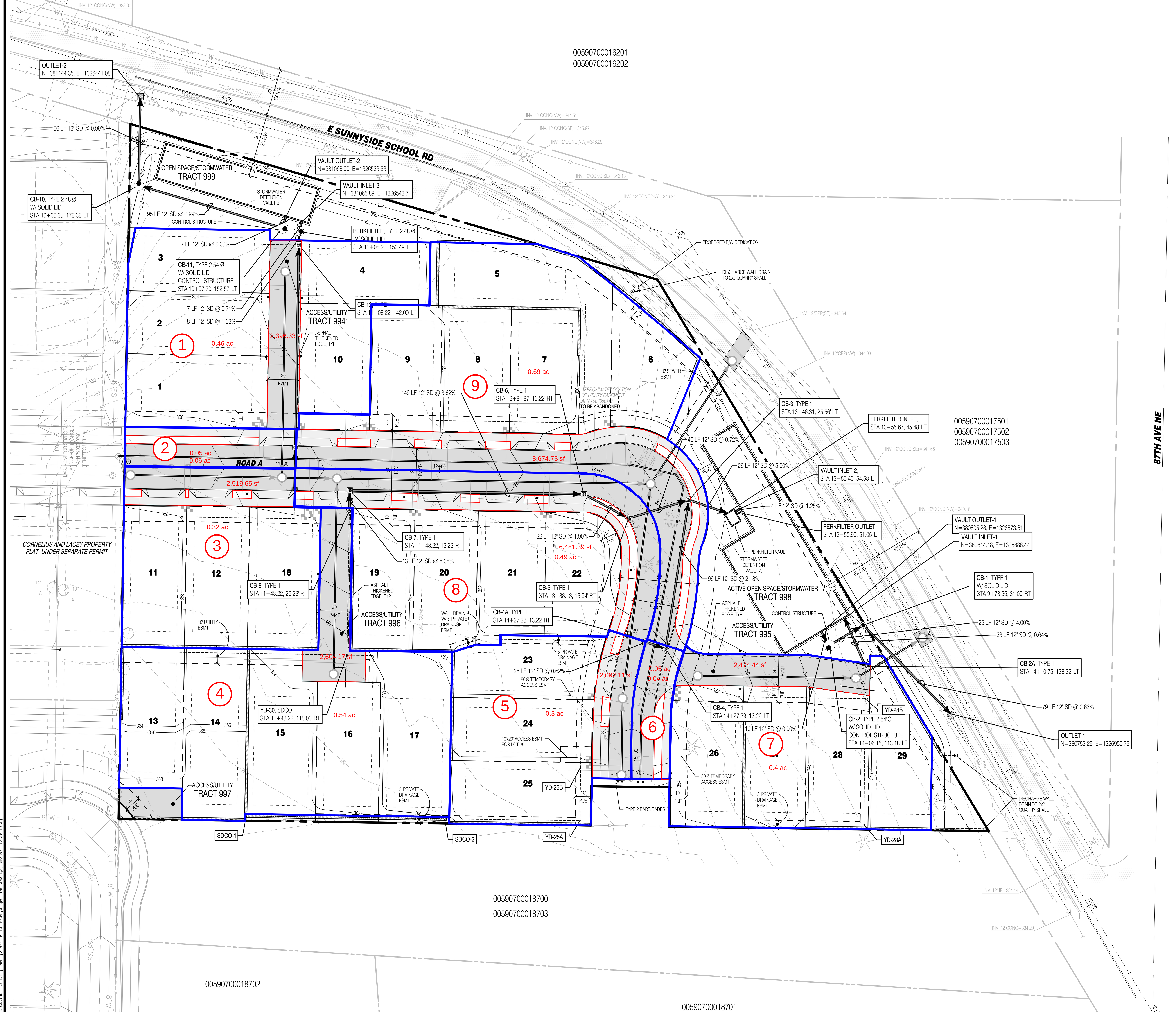
Notes:

Site has 2 detention vaults, thus 2 separate Perkfilters will be needed. Both upstream of detention.

Appendix 5: Conveyance Analysis

1. Conveyance Basins Map
2. SSA Model Layout 1
3. SSA Model Results 1
4. SSA Model Layout 2
5. SSA Model Results 2
6. Manning's Analysis – Vault 1 Discharge
7. Manning's Analysis – Vault 2 Discharge

SW 1/4, SW 1/4, SEC. 36, T. 30N, R5E, W.M. SNOHOMISH COUNTY, WASHINGTON


E SUNNYSIDE SCHOOL RD
87TH AVE NE
ROAD A
OUTLET-2
N=381144.35, E=1326441.08
56 LF 12" SD @ 0.99%
CB-10, TYPE 2 48"Ø
W/ SOLID LID
STA 10+06.35, 178.38' LT
OPEN SPACE/STORMWATER
TRACT 999
STORMWATER DETENTION VAULT B
95 LF 12" SD @ 0.99%
CONTROL STRUCTURE
VAULT OUTLET-2
N=381068.90, E=1326533.53
VAULT INLET-3
N=381065.89, E=1326543.71
PERKFILTER, TYPE 2 48"Ø
W/ SOLID LID
STA 11+08.22, 150.49' LT
CB-11, TYPE 2 54"Ø
W/ SOLID LID
CONTROL STRUCTURE
STA 10+97.70, 152.57' LT
7 LF 12" SD @ 0.00%
7 LF 12" SD @ 0.71%
8 LF 12" SD @ 1.33%
CB-12, TYPE 1
STA 11+08.22, 142.00' LT
ACCESS/UTILITY
TRACT 994
ASPHALT THICKENED EDGE, TYP
00590700016201
00590700016202
PROPOSED R/W DEDICATION
DISCHARGE WALL DRAIN TO 2x2 QUARRY SPALL
0.46 ac
2,395.33 sf
149 LF 12" SD @ 3.62%
CB-6, TYPE 1
STA 12+91.97, 13.22' RT
0.69 ac
APPROXIMATE LOCATION OF UTILITY EASEMENT TO BE ABANDONED
10' SEWER ESMT
CB-3, TYPE 1
STA 13+46.31, 25.56' LT
PERKFILTER INLET
STA 13+55.67, 45.48' LT
00590700017501
00590700017502
00590700017503
40 LF 12" SD @ 0.72%
26 LF 12" SD @ 5.00%
VAULT INLET-2
STA 13+55.40, 54.58' LT
4 LF 12" SD @ 1.25%
PERKFILTER OUTLET
STA 13+55.90, 51.05' LT
VAULT OUTLET-1
N=380805.28, E=1326873.61
VAULT INLET-1
N=380814.18, E=1326888.44
0.05 ac
0.06 ac
8,674.75 sf
2,519.65 sf
0.32 ac
CORNELIUS AND LACEY PROPERTY PLAT UNDER SEPARATE PERMIT
CB-7, TYPE 1
STA 11+43.22, 13.22' RT
13 LF 12" SD @ 5.38%
32 LF 12" SD @ 1.90%
6,481.39 sf
0.49 ac
CB-8, TYPE 1
STA 11+43.22, 26.28' RT
ASPHALT THICKENED EDGE, TYP
ACCESS/UTILITY
TRACT 996
WALL DRAIN W/ 5' PRIVATE DRAINAGE ESMT
CB-5, TYPE 1
STA 13+38.13, 13.54' RT
PERKFILTER VAULT
STORMWATER DETENTION VAULT A
96 LF 12" SD @ 2.18%
ACTIVE OPEN SPACE/STORMWATER
TRACT 998
CONTROL STRUCTURE
ACCESS/UTILITY
TRACT 995
CB-1, TYPE 1
W/ SOLID LID
STA 9+73.55, 31.00' RT
25 LF 12" SD @ 4.00%
33 LF 12" SD @ 0.64%
CB-4A, TYPE 1
STA 14+27.23, 13.22' RT
10 UTILITY ESMT
5' PRIVATE DRAINAGE ESMT
26 LF 12" SD @ 0.62%
8X20 TEMPORARY ACCESS ESMT
2,605.17 sf
2,092.11 sf
0.05 ac
0.04 ac
2,474.44 sf
CB-2A, TYPE 1
STA 14+10.75, 138.32' LT
79 LF 12" SD @ 0.63%
YD-30, SDCO
STA 11+43.22, 118.00' RT
0.54 ac
0.3 ac
CB-4, TYPE 1
STA 14+27.39, 13.22' LT
10 LF 12" SD @ 0.00%
YD-28B
CB-2, TYPE 2 54"Ø
W/ SOLID LID
CONTROL STRUCTURE
STA 14+06.15, 113.18' LT
OUTLET-1
N=380753.29, E=1326955.79
10x20 ACCESS ESMT FOR LOT 25
0.4 ac
8X20 TEMPORARY ACCESS ESMT
5' PRIVATE DRAINAGE ESMT
DISCHARGE WALL DRAIN TO 2x2 QUARRY SPALL
ACCESS/UTILITY
TRACT 997
5' PRIVATE DRAINAGE ESMT
YD-25B
TYPE 2 BARRICADES
SDCO-1
SDCO-2
YD-25A
YD-28A
00590700018700
00590700018703
00590700018702
00590700018701

N

0 30' 60'

LEGEND

SYMBOLS	DESCRIPTION
	REMOVABLE BOLLARD
	"FIRE LANE NO PARKING" SIGN
	LOCK n LOAD RETAINING WALL(UNLESS OTHERWISE NOTED)
	ASPHALT PAVEMENT
	ASPHALT GRIND AND OVERLAY
	CONCRETE PAVEMENT
	FALL PROTECTION FENCING
	STORM MAIN PIPE
	TYPE 1 CATCH BASIN W/ OPEN GRATE
	TYPE 2 CATCH BASIN, SOLID LID
	STORM CLEAN OUT
	DRAIN PIPE
	FRENCH DRAIN
	SEWER MAIN PIPE
	WATER MAIN PIPE

YARD DRAIN TABLE

CITY FILE NO: PA24-003

UTILITY NOTE

THE CONTRACTOR SHALL VERIFY THE LOCATION OF ALL EXISTING UTILITIES PRIOR TO ANY CONSTRUCTION. AGENCIES INVOLVED SHALL BE NOTIFIED WITHIN A REASONABLE TIME PRIOR TO THE START OF CONSTRUCTION.

SURVEY DISCLAIMER

THE TOPOGRAPHIC SURVEY WAS PERFORMED BY PACIFIC COAST SURVEYS. SOLID GROUND ENGINEERING ASSUMES NO LIABILITY AS TO THE ACCURACY AND COMPLETENESS OF THIS DATA. ANY DISCREPANCIES FOUND BETWEEN WHAT IS SHOWN ON THE PLANS AND WHAT IS NOTED IN THE FIELD SHOULD BE BROUGHT IMMEDIATELY TO THE ATTENTION OF THE ENGINEER.

811

SAFETY IS IN YOUR HANDS. EVERY DIG. EVERY TIME.

THOMAS P. ABBOTT · STATE OF WASHINGTON · 56923 · REGISTERED PROFESSIONAL ENGINEER

ENGINEER'S STAMP

REVISIONS

#	DATE	DESCRIPTION

SGE
Solid Ground Engineering
8105 166th Ave NE
Redmond, WA 98052

STORM DRAINAGE PLAN

SOUTH LAKE RIDGE, LLC.

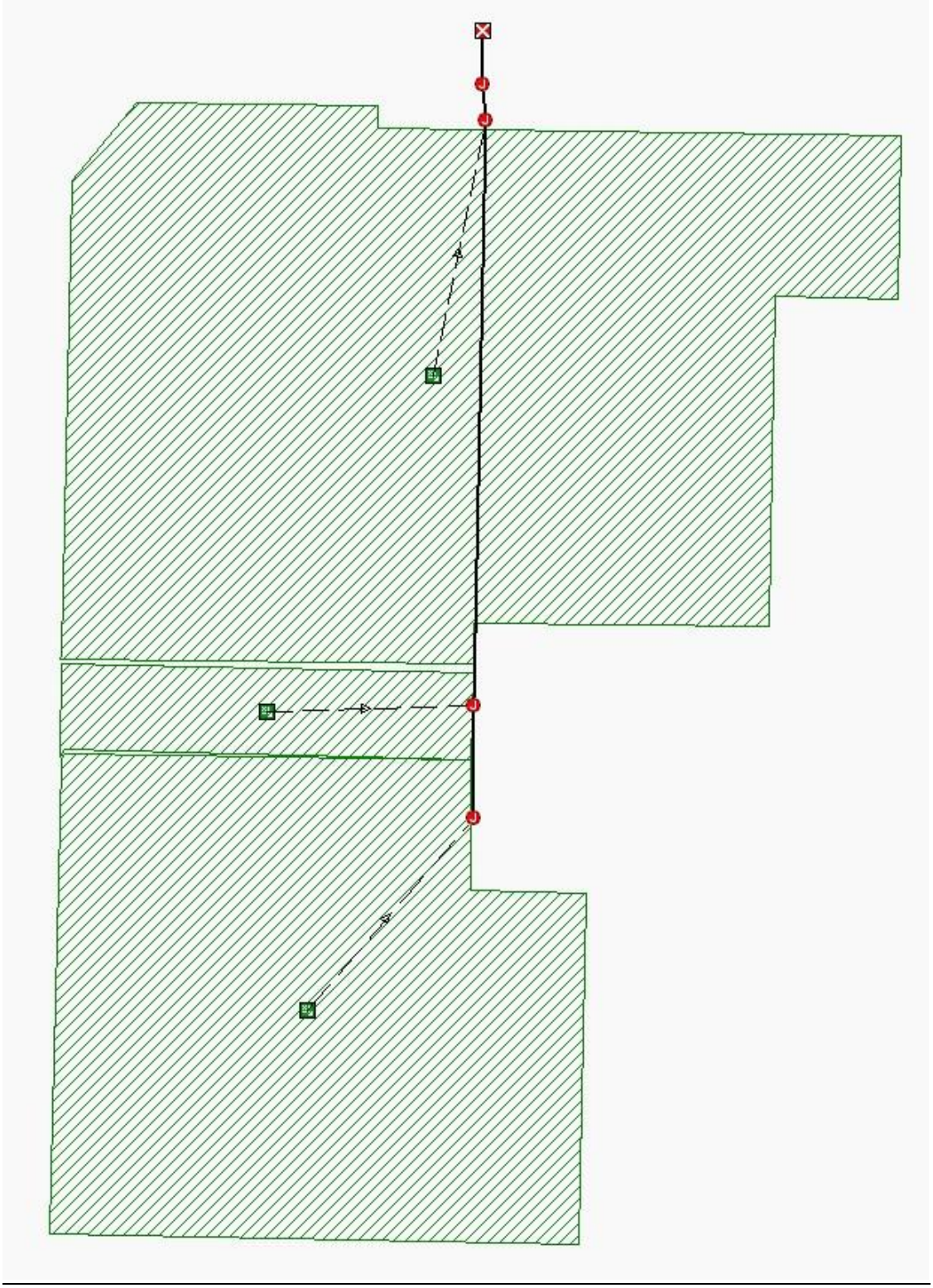
MINOR PROPERTY

8512 E. SUNNYSIDE SCHOOL RD

DRAWN BY:	KMV
CHECKED BY:	TPA
DATE:	2-9-24
JURISDICTION:	CITY OF MARYSVILLE
JOB NUMBER:	23-0011

DR-01

SSA MODEL LAYOUT 1



Project Description

File Name	West Vault SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	3
Nodes	5
Junctions	4
Outfalls	1
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	4
Channels	0
Pipes	4
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	50 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-1	0.46	0.5800	1.28	0.74	0.34	2.04	0 00:10:00
2	Sub-2	0.06	0.6400	0.75	0.48	0.03	0.35	0 00:05:00
3	Sub-3	0.32	0.5900	0.75	0.45	0.14	1.71	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	CB-12	Junction	348.80	352.24	348.80	352.24	10.00	3.09	349.43	0.00	2.81	0 00:00	0.00	0.00
2	CB-13	Junction	351.68	354.33	351.68	354.33	10.00	2.04	352.25	0.00	2.08	0 00:00	0.00	0.00
3	CB-14	Junction	351.81	354.33	351.81	354.33	10.00	1.71	352.38	0.00	1.95	0 00:00	0.00	0.00
4	PERKFILTER	Junction	346.40	352.16	346.40	352.16	10.00	3.09	349.32	0.00	2.84	0 00:00	0.00	0.00
5	Out-01	Outfall	346.35					3.09	347.13					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Link-01	Pipe	PERKFILTER	Out-01	7.00	346.40	346.35	0.7100	12.000	0.0120	3.09	3.26	0.95	4.72	0.78	0.78	0.00	Calculated
2	Pipe - (137)	Pipe	CB-14	CB-13	26.44	351.81	351.68	0.5000	12.000	0.0120	1.69	2.73	0.62	4.31	0.57	0.57	0.00	Calculated
3	Pipe - (139)	Pipe	CB-13	CB-12	128.78	351.68	348.80	2.2300	12.000	0.0120	2.01	5.77	0.35	6.76	0.41	0.41	0.00	Calculated
4	Pipe - (48)	Pipe	CB-12	PERKFILTER	8.49	348.80	348.69	1.2500	12.000	0.0120	3.09	4.32	0.72	5.97	0.63	0.63	0.00	Calculated

Subbasin Hydrology

Subbasin : Sub-1

Input Data

Area (ac)	0.46
Weighted Runoff Coefficient	0.58

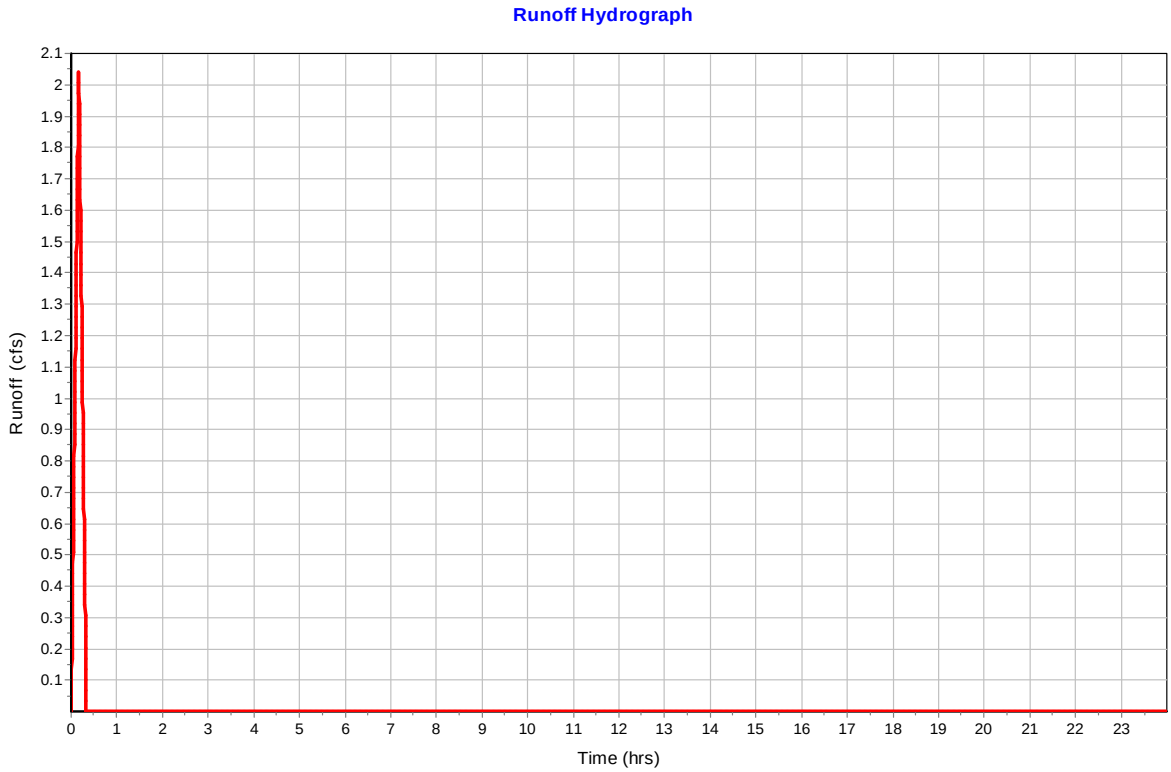
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.33	-	0.72
-	0.13	-	0.24
Composite Area & Weighted Runoff Coeff.	0.46		0.58

Subbasin Runoff Results

Total Rainfall (in)	1.28
Total Runoff (in)	0.74
Peak Runoff (cfs)	2.04
Rainfall Intensity	7.654
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : Sub-1



Subbasin : Sub-2

Input Data

Area (ac)	0.06
Weighted Runoff Coefficient	0.64

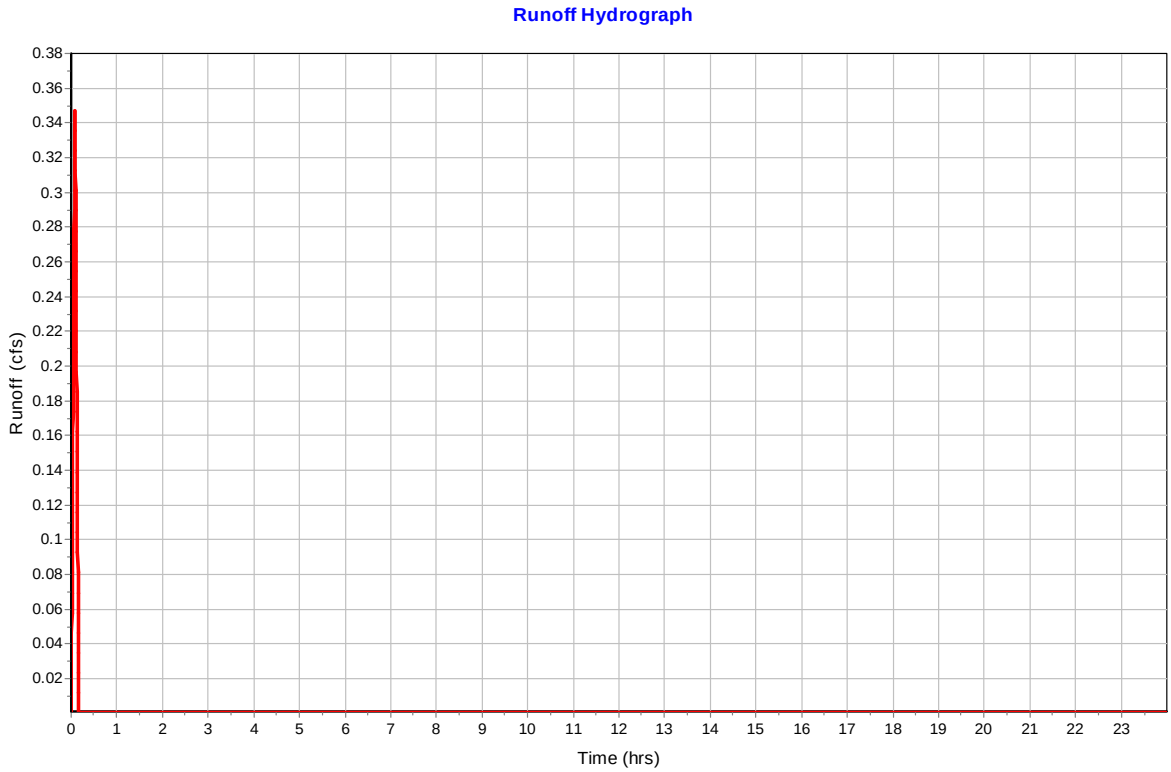
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.05	-	0.72
-	0.01	-	0.24
Composite Area & Weighted Runoff Coeff.	0.06		0.64

Subbasin Runoff Results

Total Rainfall (in)	0.75
Total Runoff (in)	0.48
Peak Runoff (cfs)	0.35
Rainfall Intensity	9.041
Weighted Runoff Coefficient	0.64
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub-2



Subbasin : Sub-3

Input Data

Area (ac)	0.32
Weighted Runoff Coefficient	0.59

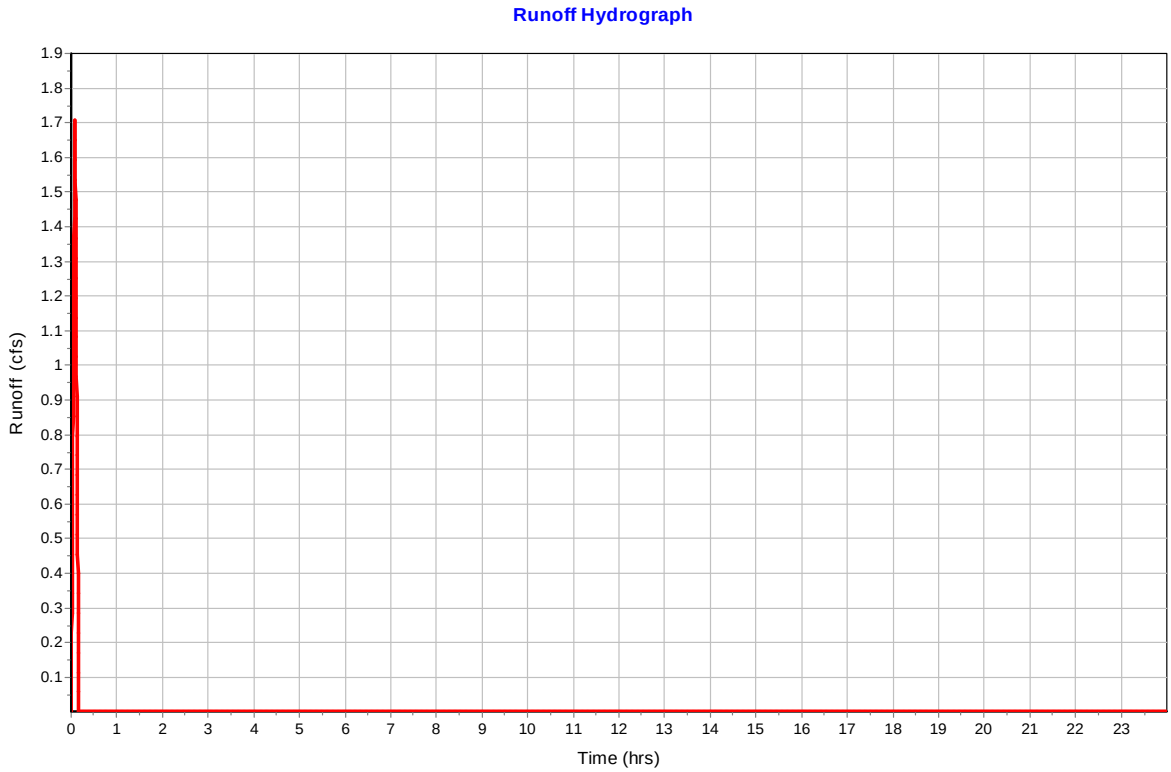
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.23	-	0.72
-	0.09	-	0.24
Composite Area & Weighted Runoff Coeff.	0.32		0.59

Subbasin Runoff Results

Total Rainfall (in)	0.75
Total Runoff (in)	0.45
Peak Runoff (cfs)	1.71
Rainfall Intensity	9.041
Weighted Runoff Coefficient	0.59
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub-3



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	CB-12	348.80	352.24	3.44	348.80	0.00	352.24	0.00	10.00	29.22
2	CB-13	351.68	354.33	2.65	351.68	0.00	354.33	0.00	10.00	19.83
3	CB-14	351.81	354.33	2.52	351.81	0.00	354.33	0.00	10.00	18.28
4	PERKFILTER	346.40	352.16	5.76	346.40	0.00	352.16	0.00	10.00	29.59

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	CB-12	3.09	2.04	349.43	0.63	0.00	2.81	348.81	0.01	0 00:05	0 00:00	0.00	0.00
2	CB-13	2.04	0.35	352.25	0.57	0.00	2.08	351.68	0.00	0 00:05	0 00:00	0.00	0.00
3	CB-14	1.71	1.71	352.38	0.57	0.00	1.95	351.81	0.00	0 00:05	0 00:00	0.00	0.00
4	PERKFILTER	3.09	0.00	349.32	2.92	0.00	2.84	348.70	2.30	0 00:05	0 00:00	0.00	0.00

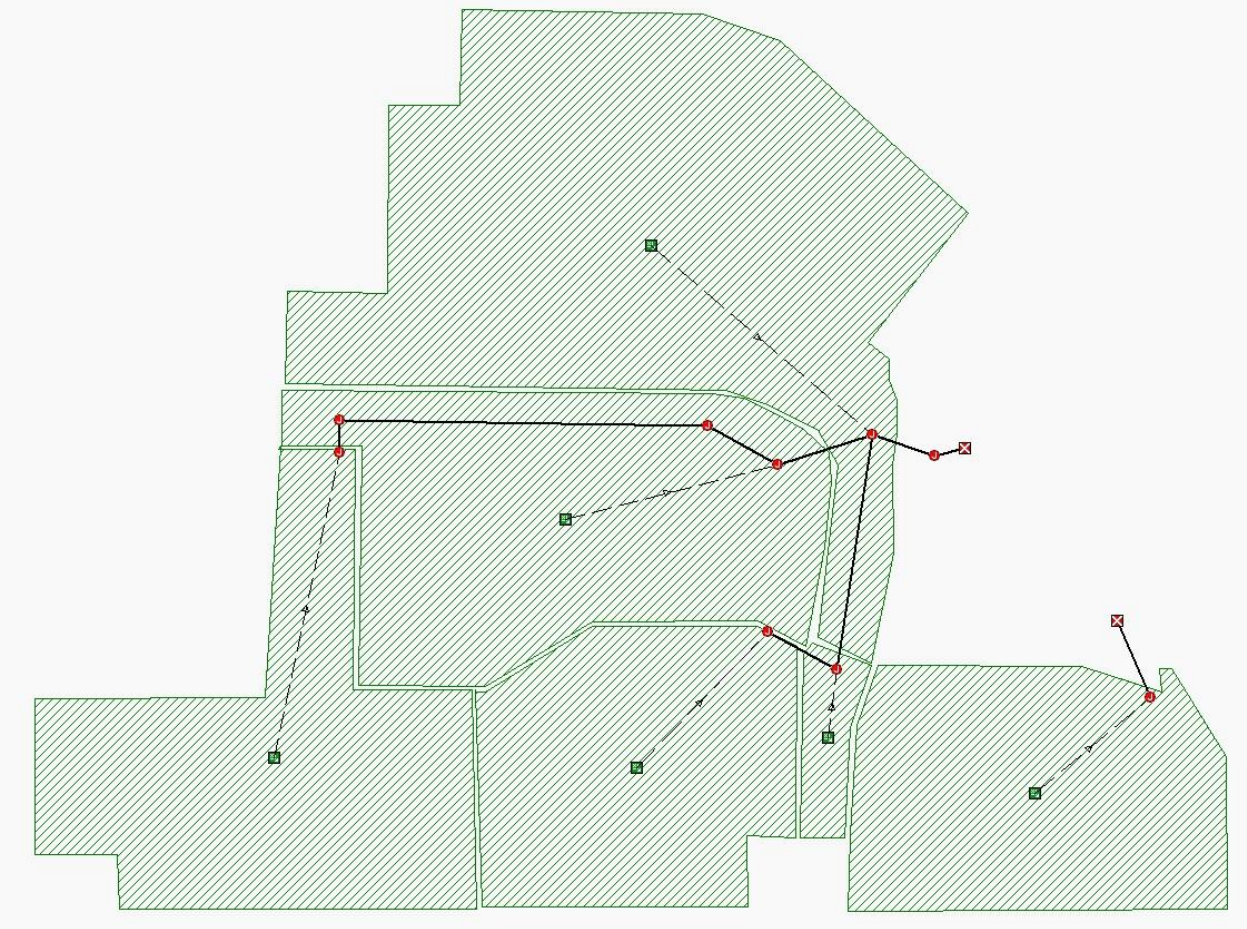
Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-01	7.00	346.40	0.00	346.35	0.00	0.05	0.7100	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Pipe - (137)	26.44	351.81	0.00	351.68	0.00	0.13	0.5000	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Pipe - (139)	128.78	351.68	0.00	348.80	0.00	2.88	2.2300	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	Pipe - (48)	8.49	348.80	0.00	348.69	2.29	0.11	1.2500	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	Link-01	3.09	0 00:05	3.26	0.95	4.72	0.02	0.78	0.78	0.00		Calculated
2	Pipe - (137)	1.69	0 00:05	2.73	0.62	4.31	0.10	0.57	0.57	0.00		Calculated
3	Pipe - (139)	2.01	0 00:05	5.77	0.35	6.76	0.32	0.41	0.41	0.00		Calculated
4	Pipe - (48)	3.09	0 00:05	4.32	0.72	5.97	0.02	0.63	0.63	0.00		Calculated

SSA MODEL LAYOUT 2



Project Description

File Name	East Vault SSA.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	00:00:00	0:00:00
End Analysis On	00:00:00	0:00:00
Start Reporting On	00:00:00	0:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	6
Nodes	11
Junctions	9
Outfalls	2
Flow Diversions	0
Inlets	0
Storage Nodes	0
Links	9
Channels	0
Pipes	9
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	50 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	Sub-4	0.54	0.5800	0.75	0.44	0.24	2.83	0 00:05:00
2	Sub-5	1.11	0.4200	1.97	0.83	0.92	2.76	0 00:20:00
3	Sub-6	0.06	0.6400	0.75	0.48	0.03	0.35	0 00:05:00
4	Sub-7	0.90	0.5800	1.67	0.97	0.87	3.48	0 00:15:00
5	Sub-8	0.49	0.5900	1.28	0.75	0.37	2.21	0 00:10:00
6	Sub-9	0.69	0.5900	0.75	0.45	0.31	3.68	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft^2)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	CB-2A	Junction	340.50	345.69	340.50	345.69	10.00	3.48	341.15	0.00	4.54	0 00:00	0.00	0.00
2	CB-3	Junction	344.10	347.75	344.10	347.75	10.00	8.42	345.09	0.00	2.66	0 00:00	0.00	0.00
3	CB-4	Junction	346.69	350.15	346.69	350.15	10.00	2.76	347.44	0.00	2.70	0 00:00	0.00	0.00
4	CB-4A	Junction	346.85	350.14	346.85	350.14	10.00	2.76	347.61	0.00	2.53	0 00:00	0.00	0.00
5	CB-5	Junction	344.89	347.97	344.89	347.97	10.00	3.94	345.41	0.00	2.57	0 00:00	0.00	0.00
6	CB-6	Junction	345.50	348.56	345.50	348.56	10.00	2.77	346.01	0.00	2.54	0 00:00	0.00	0.00
7	CB-7	Junction	350.90	353.42	350.90	353.42	10.00	2.83	351.33	0.00	2.09	0 00:00	0.00	0.00
8	CB-8	Junction	351.60	354.12	351.60	354.12	10.00	2.83	351.99	0.00	2.14	0 00:00	0.00	0.00
9	Out-1Pipe - (116)	Junction	340.50	349.30	340.50	349.30	10.00	8.42	343.39	0.00	5.91	0 00:00	0.00	0.00
10	Out-1Pipe - (112)	Outfall	340.45					8.42	341.34					
11	Out-1Pipe - (89)	Outfall	340.29					3.47	340.94					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	Link-02	Pipe	Out-1Pipe - (116)	Out-1Pipe - (112)	4.00	340.50	340.45	1.2500	18.000	0.0120	8.42	12.72	0.66	7.69	0.89	0.59	0.00	Calculated
2	Pipe - (116)	Pipe	CB-3	Out-1Pipe - (116)	26.00	344.10	342.80	5.0000	18.000	0.0120	8.42	25.45	0.33	12.92	0.59	0.40	0.00	Calculated
3	Pipe - (38)	Pipe	CB-7	CB-6	148.75	350.90	345.50	3.6300	12.000	0.0120	2.77	7.35	0.38	8.96	0.42	0.43	0.00	Calculated
4	Pipe - (39)	Pipe	CB-8	CB-7	13.06	351.60	350.90	5.3600	12.000	0.0120	2.83	8.94	0.32	10.09	0.39	0.39	0.00	Calculated
5	Pipe - (56)	Pipe	CB-5	CB-3	40.03	344.29	344.10	0.4700	18.000	0.0120	3.94	15.99	0.25	7.50	0.51	0.34	0.00	Calculated
6	Pipe - (57)	Pipe	CB-4	CB-3	95.81	346.69	344.60	2.1800	12.000	0.0120	2.75	5.70	0.48	7.21	0.49	0.49	0.00	Calculated
7	Pipe - (58)	Pipe	CB-4A	CB-4	26.44	346.85	346.69	0.6100	12.000	0.0120	2.76	3.00	0.92	4.34	0.75	0.75	0.00	Calculated
8	Pipe - (59)	Pipe	CB-6	CB-5	32.33	345.50	344.89	1.8800	12.000	0.0120	2.77	5.29	0.52	6.82	0.51	0.51	0.00	Calculated
9	Pipe - (89)	Pipe	CB-2A	Out-1Pipe - (89)	33.41	340.50	340.29	0.6300	18.000	0.0120	3.47	9.02	0.38	4.78	0.65	0.43	0.00	Calculated

Subbasin Hydrology

Subbasin : Sub-4

Input Data

Area (ac)	0.54
Weighted Runoff Coefficient	0.58

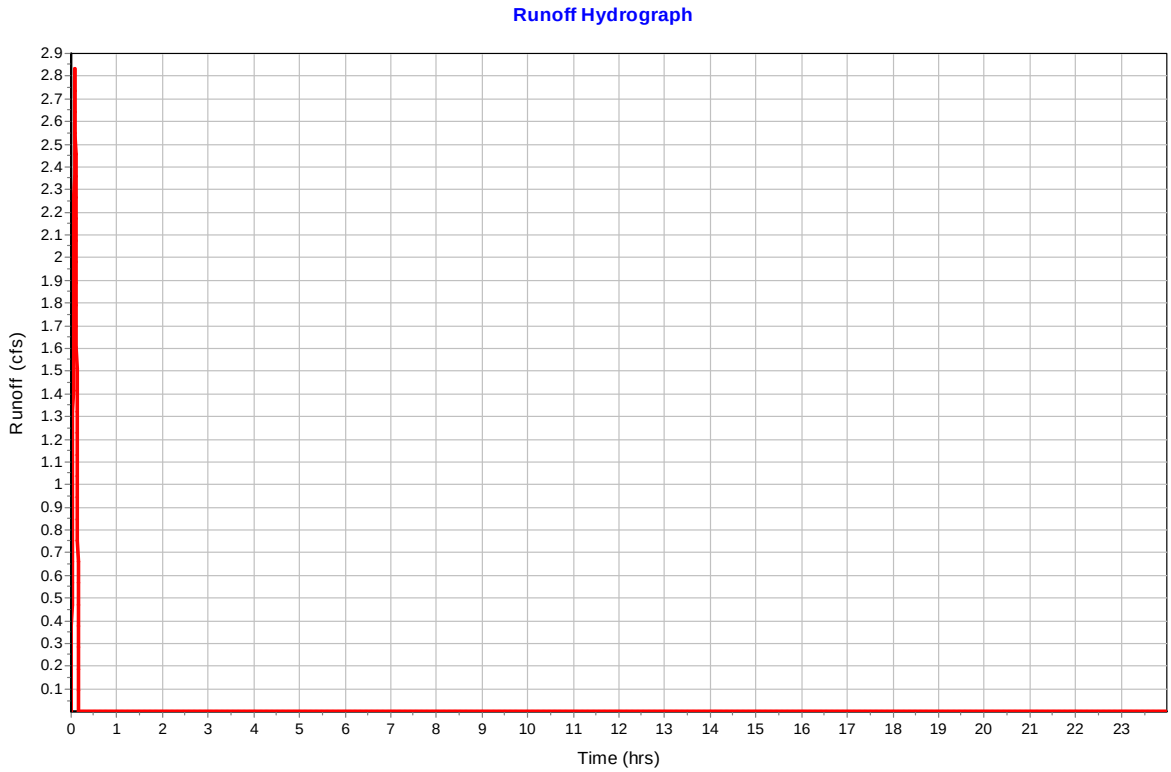
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.38	-	0.72
-	0.16	-	0.24
Composite Area & Weighted Runoff Coeff.	0.54		0.58

Subbasin Runoff Results

Total Rainfall (in)	0.75
Total Runoff (in)	0.44
Peak Runoff (cfs)	2.83
Rainfall Intensity	9.041
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub-4



Subbasin : Sub-5

Input Data

Area (ac)	1.11
Weighted Runoff Coefficient	0.42

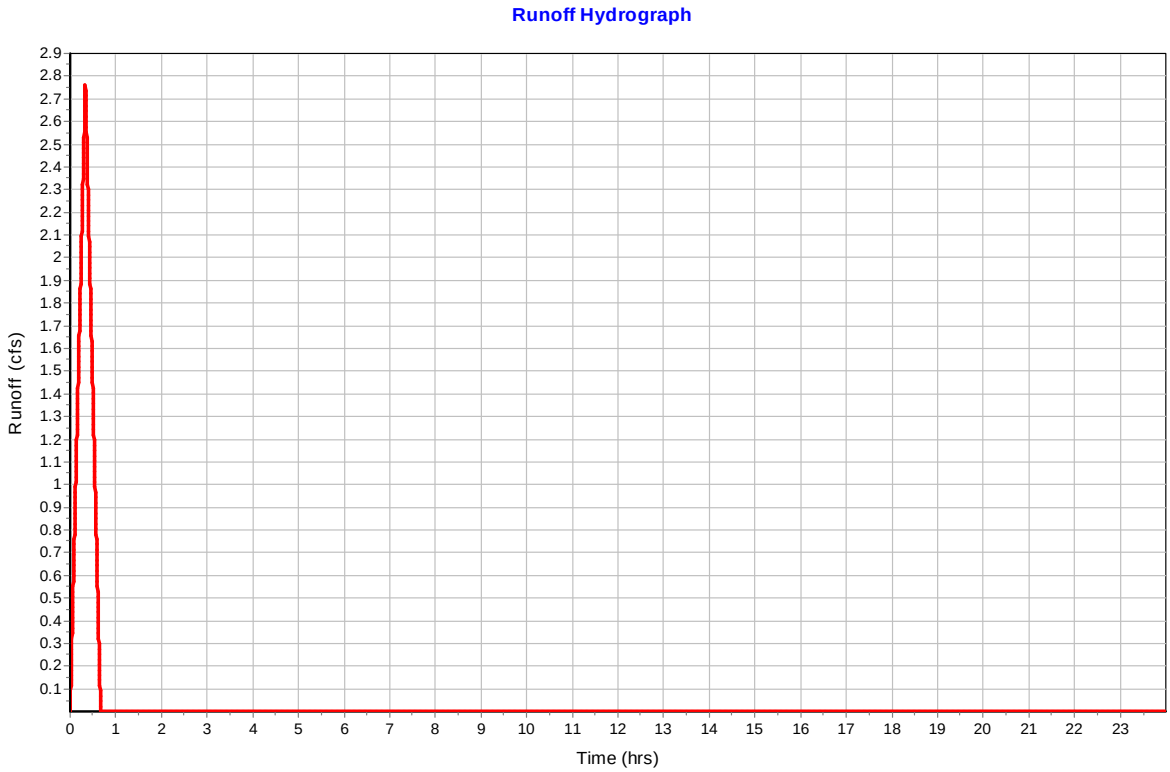
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.41	-	0.72
-	0.7	-	0.24
Composite Area & Weighted Runoff Coeff.	1.11		0.42

Subbasin Runoff Results

Total Rainfall (in)	1.97
Total Runoff (in)	0.83
Peak Runoff (cfs)	2.76
Rainfall Intensity	5.921
Weighted Runoff Coefficient	0.42
Time of Concentration (days hh:mm:ss)	0 00:20:00

Subbasin : Sub-5



Subbasin : Sub-6

Input Data

Area (ac)	0.06
Weighted Runoff Coefficient	0.64

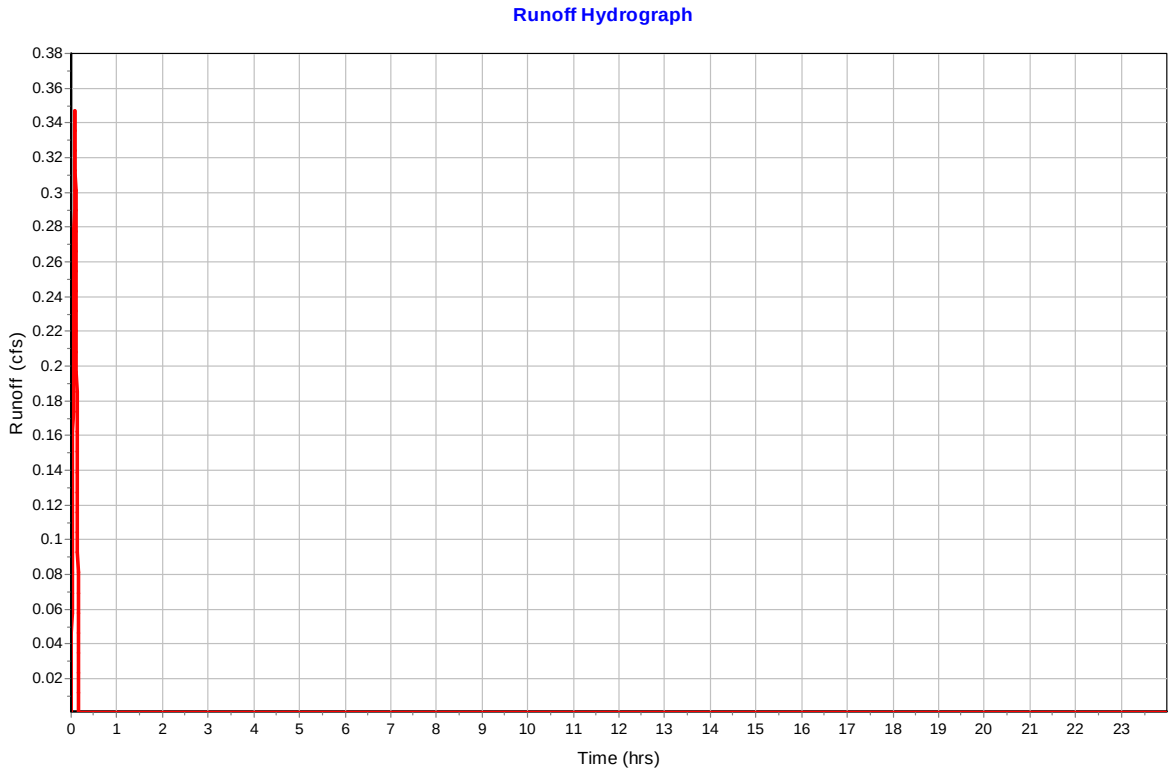
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.05	-	0.72
-	0.01	-	0.24
Composite Area & Weighted Runoff Coeff.	0.06		0.64

Subbasin Runoff Results

Total Rainfall (in)	0.75
Total Runoff (in)	0.48
Peak Runoff (cfs)	0.35
Rainfall Intensity	9.041
Weighted Runoff Coefficient	0.64
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub-6



Subbasin : Sub-7

Input Data

Area (ac)	0.9
Weighted Runoff Coefficient	0.58

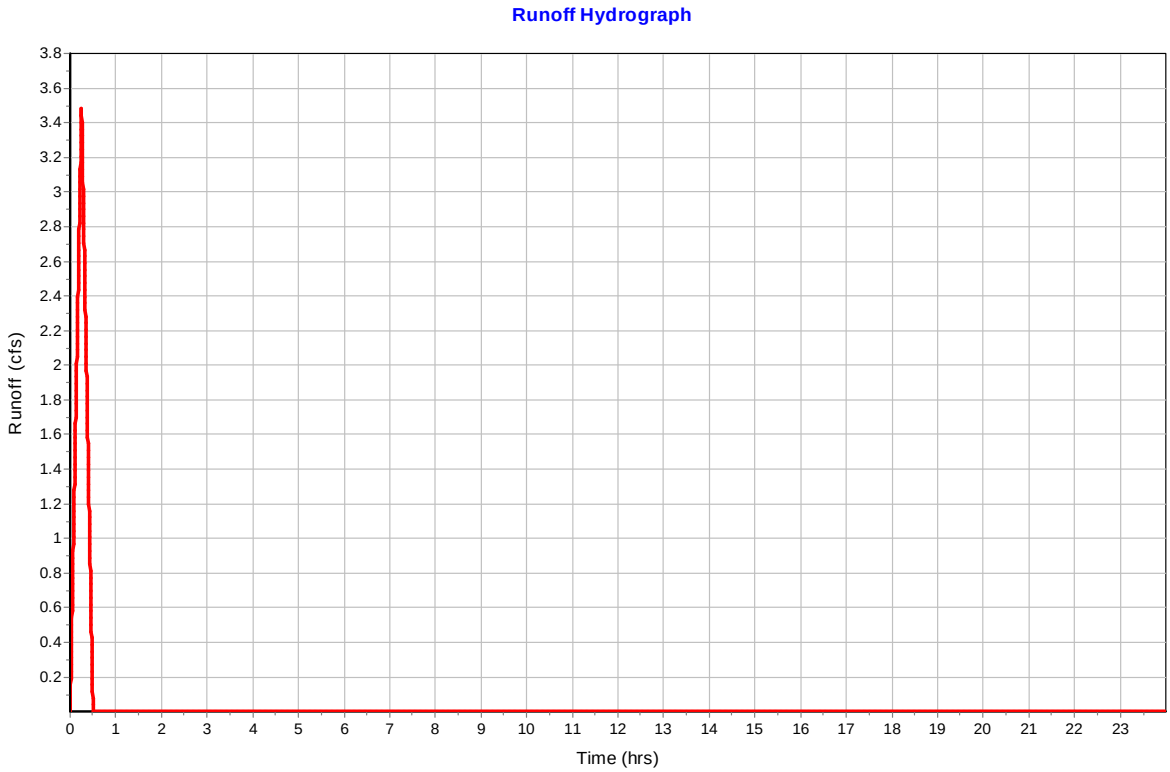
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.63	-	0.72
-	0.27	-	0.24
Composite Area & Weighted Runoff Coeff.	0.9		0.58

Subbasin Runoff Results

Total Rainfall (in)	1.67
Total Runoff (in)	0.97
Peak Runoff (cfs)	3.48
Rainfall Intensity	6.665
Weighted Runoff Coefficient	0.58
Time of Concentration (days hh:mm:ss)	0 00:15:00

Subbasin : Sub-7



Subbasin : Sub-8

Input Data

Area (ac)	0.49
Weighted Runoff Coefficient	0.59

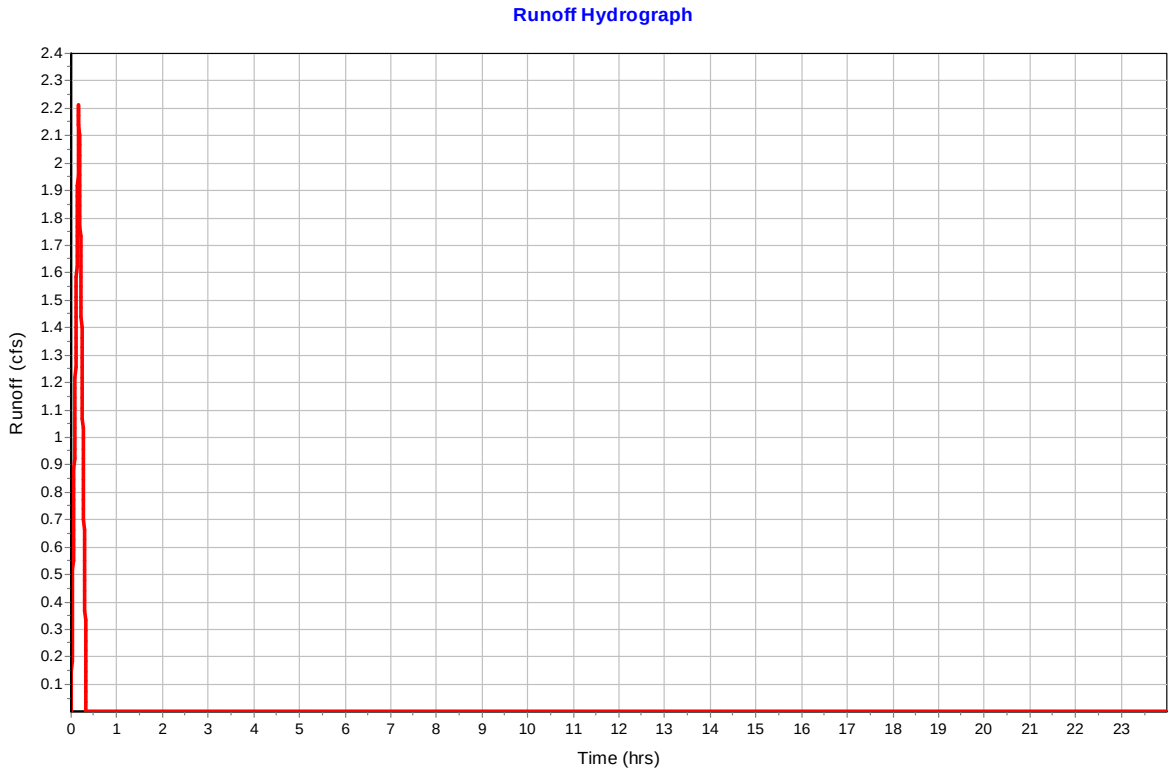
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.36	-	0.72
-	0.13	-	0.24
Composite Area & Weighted Runoff Coeff.	0.49		0.59

Subbasin Runoff Results

Total Rainfall (in)	1.28
Total Runoff (in)	0.75
Peak Runoff (cfs)	2.21
Rainfall Intensity	7.654
Weighted Runoff Coefficient	0.59
Time of Concentration (days hh:mm:ss)	0 00:10:00

Subbasin : Sub-8



Subbasin : Sub-9

Input Data

Area (ac)	0.69
Weighted Runoff Coefficient	0.59

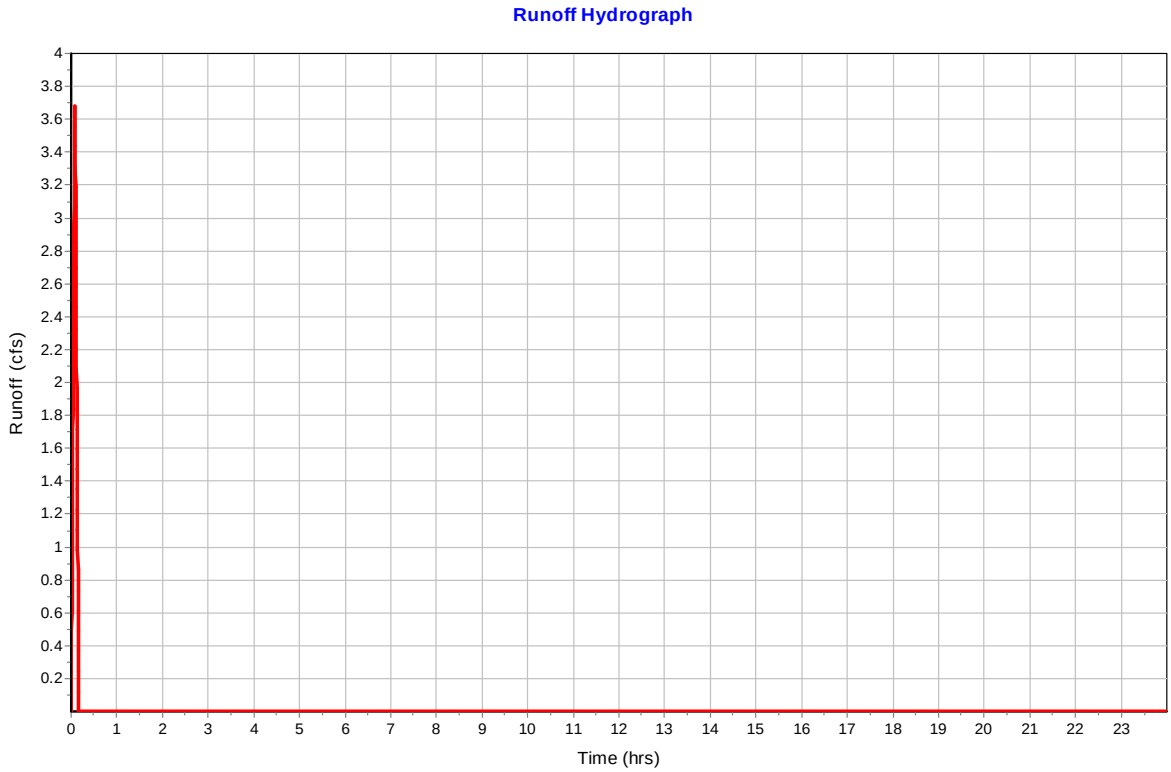
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.5	-	0.72
-	0.19	-	0.24
Composite Area & Weighted Runoff Coeff.	0.69		0.59

Subbasin Runoff Results

Total Rainfall (in)	0.75
Total Runoff (in)	0.45
Peak Runoff (cfs)	3.68
Rainfall Intensity	9.041
Weighted Runoff Coefficient	0.59
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : Sub-9



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	CB-2A	340.50	345.69	5.19	340.50	0.00	345.69	0.00	10.00	44.25
2	CB-3	344.10	347.75	3.65	344.10	0.00	347.75	0.00	10.00	25.80
3	CB-4	346.69	350.15	3.46	346.69	0.00	350.15	0.00	10.00	29.47
4	CB-4A	346.85	350.14	3.29	346.85	0.00	350.14	0.00	10.00	27.46
5	CB-5	344.89	347.97	3.08	344.89	0.00	347.97	0.00	10.00	24.96
6	CB-6	345.50	348.56	3.06	345.50	0.00	348.56	0.00	10.00	24.70
7	CB-7	350.90	353.42	2.52	350.90	0.00	353.42	0.00	10.00	18.28
8	CB-8	351.60	354.12	2.52	351.60	0.00	354.12	0.00	10.00	18.28
9	Out-1Pipe - (116)	340.50	349.30	8.80	340.50	0.00	349.30	0.00	10.00	60.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	CB-2A	3.48	3.48	341.15	0.65	0.00	4.54	340.51	0.01	0 00:15	0 00:00	0.00	0.00
2	CB-3	8.42	3.68	345.09	0.99	0.00	2.66	344.61	0.51	0 00:20	0 00:00	0.00	0.00
3	CB-4	2.76	0.35	347.44	0.75	0.00	2.70	346.70	0.01	0 00:20	0 00:00	0.00	0.00
4	CB-4A	2.76	2.76	347.61	0.76	0.00	2.53	346.86	0.01	0 00:20	0 00:00	0.00	0.00
5	CB-5	3.94	2.21	345.41	0.52	0.00	2.57	344.90	0.01	0 00:05	0 00:00	0.00	0.00
6	CB-6	2.77	0.00	346.01	0.51	0.00	2.54	345.50	0.00	0 00:05	0 00:00	0.00	0.00
7	CB-7	2.83	0.00	351.33	0.43	0.00	2.09	350.90	0.00	0 00:05	0 00:00	0.00	0.00
8	CB-8	2.83	2.83	351.99	0.39	0.00	2.14	351.60	0.00	0 00:05	0 00:00	0.00	0.00
9	Out-1Pipe - (116)	8.42	0.00	343.39	2.89	0.00	5.91	342.81	2.31	0 00:05	0 00:00	0.00	0.00

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate	No. of Barrels
1	Link-02	4.00	340.50	0.00	340.45	0.00	0.05	1.2500	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
2	Pipe - (116)	26.00	344.10	0.00	342.80	2.30	1.30	5.0000	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
3	Pipe - (38)	148.75	350.90	0.00	345.50	0.00	5.40	3.6300	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
4	Pipe - (39)	13.06	351.60	0.00	350.90	0.00	0.70	5.3600	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
5	Pipe - (56)	40.03	344.29	-0.60	344.10	0.00	0.19	0.4700	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
6	Pipe - (57)	95.81	346.69	0.00	344.60	0.50	2.09	2.1800	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
7	Pipe - (58)	26.44	346.85	0.00	346.69	0.00	0.16	0.6100	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
8	Pipe - (59)	32.33	345.50	0.00	344.89	0.00	0.61	1.8800	CIRCULAR	12.000	12.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1
9	Pipe - (89)	33.41	340.50	0.00	340.29	0.00	0.21	0.6300	CIRCULAR	18.000	18.000	0.0120	0.5000	0.5000	0.0000	0.00	No	1

Pipe Results

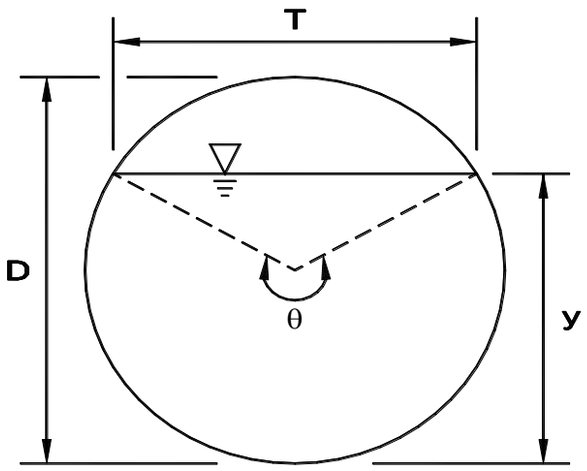
SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	Link-02	8.42	0 00:05	12.72	0.66	7.69	0.01	0.89	0.59	0.00		Calculated
2	Pipe - (116)	8.42	0 00:05	25.45	0.33	12.92	0.03	0.59	0.40	0.00		Calculated
3	Pipe - (38)	2.77	0 00:05	7.35	0.38	8.96	0.28	0.42	0.43	0.00		Calculated
4	Pipe - (39)	2.83	0 00:05	8.94	0.32	10.09	0.02	0.39	0.39	0.00		Calculated
5	Pipe - (56)	3.94	0 00:05	15.99	0.25	7.50	0.09	0.51	0.34	0.00		Calculated
6	Pipe - (57)	2.75	0 00:20	5.70	0.48	7.21	0.22	0.49	0.49	0.00		Calculated
7	Pipe - (58)	2.76	0 00:20	3.00	0.92	4.34	0.10	0.75	0.75	0.00		Calculated
8	Pipe - (59)	2.77	0 00:05	5.29	0.52	6.82	0.08	0.51	0.51	0.00		Calculated
9	Pipe - (89)	3.47	0 00:15	9.02	0.38	4.78	0.12	0.65	0.43	0.00		Calculated

Open Channel Flow Calculator For Circular Pipes	***Land Development Consultants, Inc.***	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Minor Property
Description: Detention Vault 1 Discharge

Project No.: 23-0011
Date: 3/27/2024
Calc. By: CJD

Pipe Diameter (D) =	12	in
Pipe Slope (S) =	0.50	%
Flow Depth (y) =	**0.34**	**ft**
Flowrate (Q) =	0.91	cfs
Mannings Coeff. (n) =	0.009	
Theta Angle (θ) =	2.49	rad
Wetted Area (A) =	0.24	ft^2
Wet. Perimeter (P) =	1.25	ft
Hydraulic Radius (R) =	0.19	ft
Top Width (T) =	0.95	ft
Flow Velocity =	3.86	fps



Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

Hydraulic Radius (R): $R = \frac{A}{P}$

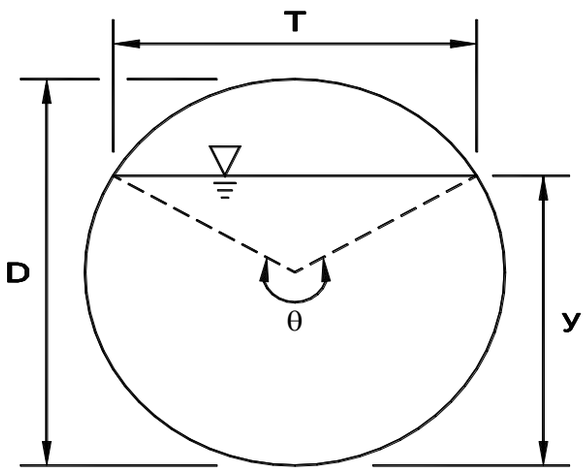
Top Width (T): $T = \sin(\theta/2)d$

Open Channel Flow Calculator For Circular Pipes	**Land Development Consultants, Inc.**	
	14201 NE 200th St. Ste. 100 Woodinville, WA 98072	Tel: (425) 806-1869 Fax: (425) 482-2893

Project Name: Minor Property
Description: Detention Vault 2 Discharge

Project No.: 23-0011
Date: 3/27/2024
Calc. By: CJD

Pipe Diameter (D) =	18	in
Pipe Slope (S) =	0.50	%
Flow Depth (y) =	**0.57**	**ft**
Flowrate (Q) =	3.34	cfs
Mannings Coeff. (n) =	0.009	
Theta Angle (θ) =	2.67	rad
Wetted Area (A) =	0.62	ft^2
Wet. Perimeter (P) =	2.00	ft
Hydraulic Radius (R) =	0.31	ft
Top Width (T) =	1.46	ft
Flow Velocity =	5.37	fps



Formulas:

Theta Angle (θ): If y ≥ r : $\theta = 2\pi - 2a\cos(\frac{y-r}{r})$ where: r = Pipe Radius

If y ≤ r : $\theta = 2a\cos(\frac{r-y}{r})$ where: r = Pipe Radius

Wetted Area (A): $A = \frac{1}{8}(\theta - \sin\theta)d^2$

Wetted Perimeter (P): $P = \frac{1}{2}\theta d$

Hydraulic Radius (R): $R = \frac{A}{P}$

Top Width (T): $T = \sin(\theta/2)d$

Appendix 6: Operations and Maintenance Manual

1. Operations and Maintenance Manual

Table V-A.2: Maintenance Standards - Infiltration (continued)

Maintenance Component	Defect	Conditions When Maintenance Is Needed	Results Expected When Maintenance Is Performed
		(A percolation test pit or test of facility indicates facility is only working at 90% of its designed capabilities. Test every 2 to 5 years. If two inches or more sediment is present, remove).	
Filter Bags (if applicable)	Filled with Sediment and Debris	Sediment and debris fill bag more than 1/2 full.	Filter bag is replaced or system is redesigned.
Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms.	Gravel in rock filter is replaced.
Side Slopes of Pond	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway and Berms over 4 feet in height.	Tree Growth	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Piping	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Emergency Overflow Spillway	Rock Missing	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
	Erosion	See Table V-A.1: Maintenance Standards - Detention Ponds	See Table V-A.1: Maintenance Standards - Detention Ponds
Pre-settling Ponds and Vaults	Facility or sump filled with Sediment and/or debris	6" or designed sediment trap depth of sediment.	Sediment is removed.

Table V-A.3: Maintenance Standards - 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.

Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults) (continued)

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is Performed
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 Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.4: Maintenance Standards - Control Structure/Flow Restrictor

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
General	Trash and Debris (Includes Sediment)	Material exceeds 25% of sump depth or 1 foot below orifice plate.	Control structure orifice is not blocked. All trash and debris removed.
	Structural Damage	Structure is not securely attached to manhole wall. Structure is not in upright position (allow up to 10% from plumb). Connections to outlet pipe are not watertight and show signs of rust. Any holes - other than designed holes - in the structure.	Structure securely attached to wall and outlet pipe. Structure in correct position. Connections to outlet pipe are water tight; structure repaired or replaced and works as designed. Structure has no holes other than designed holes.
Cleanout Gate	Damaged or Missing	Cleanout gate is not watertight or is missing. Gate cannot be moved up and down by one maintenance person. Chain/rod leading to gate is missing or damaged. Gate is rusted over 50% of its surface area.	Gate is watertight and works as designed. Gate moves up and down easily and is watertight. Chain is in place and works as designed. Gate is repaired or replaced to meet design standards.
Orifice Plate	Damaged or Missing	Control device is not working properly due to missing, out of place, or bent orifice plate.	Plate is in place and works as designed.
	Obstructions	Any trash, debris, sediment, or vegetation blocking the plate.	Plate is free of all obstructions and works as designed.
Overflow Pipe	Obstructions	Any trash or debris blocking (or having the potential of blocking) the overflow pipe.	Pipe is free of all obstructions and works as designed.
Manhole	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)	See Table V-A.3: Maintenance Standards - Closed Detention Systems (Tanks/Vaults)
Catch Basin	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins	See Table V-A.5: Maintenance Standards - Catch Basins

Table V-A.5: Maintenance Standards - Catch Basins

Maintenance Component	Defect	Conditions When Maintenance is Needed	Results Expected When Maintenance is performed
General	Trash & Debris	Trash or debris which is located immediately in front of the catch basin opening or is blocking inletting capacity of the basin by more than 10%. Trash or debris (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of six inches clearance from the debris surface to the invert of the lowest pipe. Trash or debris in any inlet or outlet pipe blocking more than 1/3 of its height. Dead animals or vegetation that could generate odors that could cause complaints or dangerous gases (e.g., methane).	No Trash or debris located immediately in front of catch basin or on grate opening. No trash or debris in the catch basin. Inlet and outlet pipes free of trash or debris. No dead animals or vegetation present within the catch basin.
	Sediment	Sediment (in the basin) that exceeds 60 percent of the sump depth as measured from the bottom of basin to invert of the lowest pipe into or out of the basin, but in no case less than a minimum of 6 inches clearance from the sediment surface to the invert of the lowest pipe.	No sediment in the catch basin
	Structure Damage to Frame and/or Top Slab	Top slab has holes larger than 2 square inches or cracks wider than 1/4 inch. (Intent is to make sure no material is running into basin). 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	Top slab is free of holes and cracks. 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. Grout fillet has separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe or any evidence of soil particles entering catch basin through cracks.	Basin replaced or repaired to design standards. Pipe is regrouted and secure at basin wall.
	Settlement/ Misalignment	If failure of basin has created a safety, function, or design problem.	Basin replaced or repaired to design standards.
	Vegetation	Vegetation growing across and blocking more than 10% of the basin opening. Vegetation growing in inlet/outlet pipe joints that is more than six inches tall and less than six inches apart.	No vegetation blocking opening to basin. No vegetation or root growth present.
	Contamination and Pollution	See Table V-A.1: Maintenance Standards - Detention Ponds	No pollution present.
Catch Basin Cover	Cover Not in Place	Cover is missing or only partially in place. Any open catch basin requires maintenance.	Cover/grate is in place, meets design standards, and is secured
	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, meets the design standards, and is installed and aligned with the flow path.

Table V-A.13: Maintenance Standards - Sand Filters (Above Ground/Open) (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
	Flow Spreader	Flow spreader uneven or clogged so that flows are not uniformly distributed across sand filter.	Spreader leveled and cleaned so that flows are spread evenly over sand filter.
	Damaged Pipes	Any part of the piping that is crushed or deformed more than 20% or any other failure to the piping.	Pipe repaired or replaced.

Table V-A.14: Maintenance Standards - Sand Filters (Below Ground/Enclosed)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground Vault.	Sediment Accumulation on Sand Media Section	Sediment depth exceeds 1/2-inch.	No sediment deposits on sand filter section that which would impede permeability of the filter section.
	Sediment Accumulation in Pre-Settling Portion of Vault	Sediment accumulation in vault bottom exceeds the depth of the sediment zone plus 6-inches.	No sediment deposits in first chamber of vault.
	Trash/Debris Accumulation	Trash and debris accumulated in vault, or pipe inlet/outlet, floatables and non-floatables.	Trash and debris removed from vault and inlet/outlet piping.
	Sediment in Drain Pipes/Cleanouts	When drain pipes, cleanouts become full with sediment and/or debris.	Sediment and debris removed.
	Short Circuiting	When seepage/flow occurs along the vault walls and corners. Sand eroding near inflow area.	Sand filter media section re-laid and compacted along perimeter of vault to form a semi-seal. Erosion protection added to dissipate force of incoming flow and curtail erosion.
	Damaged Pipes	Inlet or outlet piping damaged or broken and in need of repair.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened, corrosion/deformation of cover. Maintenance person cannot remove cover using normal lifting pressure.	Cover repaired to proper working specifications or replaced.
	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 Damaged; Includes Cracks in Walls, Bottom, Damage to Frame and/or Top Slab.	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not 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 replaced or repairs made so that vault meets design specifications and is structurally sound. Vault repaired so that no cracks exist wider than 1/4-inch at the joint of the inlet/outlet pipe.
	Baffles/Internal walls	Baffles or walls corroding, cracking, warping and/or showing signs of failure as determined by maintenance/inspection person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired to specifications, and is safe to use as determined by inspection personnel.

Table V-A.15: Maintenance Standards - Manufactured Media Filters

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Below Ground	Sediment Accumulation on Media.	Sediment depth exceeds 0.25-inches.	No sediment deposits which would impede permeability of the

Table V-A.15: Maintenance Standards - Manufactured Media Filters (continued)

Maintenance Component	Defect	Condition When Maintenance is Needed	Results Expected When Maintenance is Performed
Vault			compost media.
	Sediment Accumulation in Vault	Sediment depth exceeds 6-inches in first chamber.	No sediment deposits in vault bottom of first chamber.
	Trash/Debris Accumulation	Trash and debris accumulated on compost filter bed.	Trash and debris removed from the compost filter bed.
	Sediment in Drain Pipes/Clean-Outs	When drain pipes, clean-outs, become full with sediment and/or debris.	Sediment and debris removed.
	Damaged Pipes	Any part of the pipes that are crushed or damaged due to corrosion and/or settlement.	Pipe repaired and/or replaced.
	Access Cover Damaged/Not Working	Cover cannot be opened; one person cannot open the cover using normal lifting pressure, corrosion/deformation of cover.	Cover repaired to proper working specifications or replaced.
	Vault Structure Includes Cracks in Wall, Bottom, Damage to Frame and/or Top Slab	Cracks wider than 1/2-inch or evidence of soil particles entering the structure through the cracks, or maintenance/inspection personnel determine that the vault is not 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 replaced or repairs made so that vault meets design specifications and is structurally sound. 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 person.	Baffles repaired or replaced to specifications.
	Access Ladder Damaged	Ladder is corroded or deteriorated, not functioning properly, not securely attached to structure wall, missing rungs, cracks, and misaligned.	Ladder replaced or repaired and meets specifications, and is safe to use as determined by inspection personnel.
Below Ground Cartridge Type	Media	Drawdown of water through the media takes longer than 1 hour, and/or overflow occurs frequently.	Media cartridges replaced.
	Short Circuiting	Flows do not properly enter filter cartridges.	Filter cartridges replaced.

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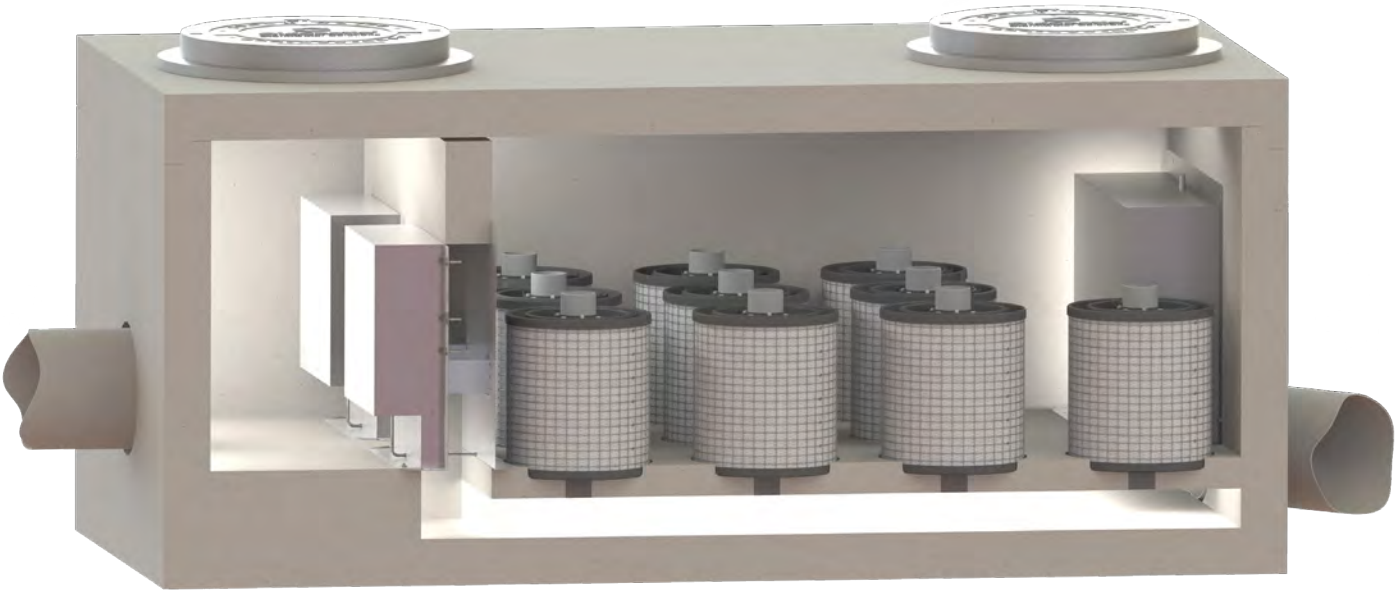
PERKFILTER®

Submittal Package



Water

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Oldcastle Infrastructure™
A CRH COMPANY

MEDIA Filtration

Cartridge Filtration Proven to Reduce Pollutant Loading in Runoff from Urban Developments

Flexible Configurations
Available in vaults, manholes and catch basins with variable inlet/outlet locations.

Superior Flow Rates
High-efficiency treatment in a compact footprint.

Field & Laboratory Tested
Removal of Total Suspended Solids (TSS) and phosphorus.

Internal High-Flow Bypass
Integrated bypass system reduces construction costs by eliminating the need for a separate bypass structure.

Integral Pre-Treatment
Pre-treatment chamber prolongs media lifespan by removing gross pollutants.

Modular Cartridge Construction
Simple design provides for efficient media replacement and cartridge handling.

Washington State Department of Ecology
- TAPE/GULD for basic treatment (TSS) and phosphorus treatment

New Jersey Department of Environmental Protection
- NJCAT certified 80% TSS removal rate

Maryland Department of the Environment
- Approved structural practice for 80% TSS removal

Virginia Department of Environmental Quality
- BMP clearinghouse 50% credit for phosphorus reduction

Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater, polluting downstream receiving waters. The PerkFilter is a stormwater treatment device that utilizes a wide variety of proprietary media to treat specific pollutants of concern.

Oldcastle Infrastructure™
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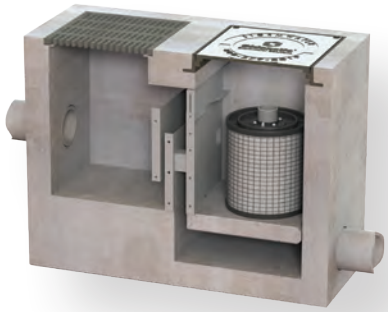
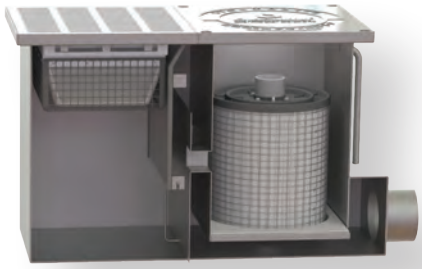
MEDIA
Filtration

Captures and Retains Target Pollutants, Reducing the Total Downstream Discharge Load

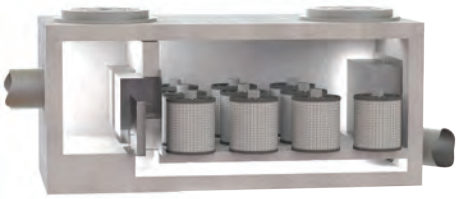


Concrete Catch Basin

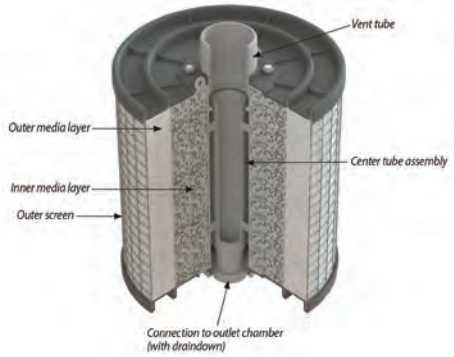
Manhole Configuration



Steel Catch Basin



Vault Configuration



STANDARD CARTRIDGE CAPACITIES		
Cartridge Height Inches	Treatment Capacity (gpm) at Media Surface Loading Rate of:	
	1.5 gpm/ft²**	2.5 gpm/ft²**
12	6.8	12
18	10.2	18
*24	13.6	24
*30	17	30

*Standard cartridge heights are 12 & 18 inches.
24 & 30 inch cartridge use modular stacks.
**Depending on regulatory sizing.

APPLICATIONS

Typical installation locations include:

- Drop inlets or vaults in commercial or residential developments
- Industrial applications
- Pre- or post-treatment for retention/detention systems

PERFORMANCE

Field-tested removal efficiencies of:

- Total Suspended Solids > 80%
- Total Phosphorus > 60%

(800) 579-8819
oldcastleinfrastructure.com

SECTION 4

Inspection & Maintenance

Oldcastle Infrastructure™
A CRH COMPANY

PERKFILTER®

Inspection and Maintenance Guide

Water

PerkFilter Media Filtration System

Description

The PerkFilter is a stormwater treatment device used to remove pollutants from urban runoff. Impervious surfaces and other urban and suburban landscapes generate a variety of contaminants that can enter stormwater and pollute downstream receiving waters. The PerkFilter is a media-filled cartridge filtration device designed to capture and retain sediment, gross solids, metals, nutrients, hydrocarbons, and trash and debris. As with any stormwater treatment system, the PerkFilter requires periodic maintenance to sustain optimum system performance.

Function

The PerkFilter is a water quality treatment system consisting of three chambers: an inlet chamber, a filter cartridge treatment chamber, and an outlet chamber (Figure 1). Stormwater runoff enters the inlet chamber through an inlet pipe, curb opening, or grated inlet. Gross solids are settled out and floating trash and debris are trapped in the inlet chamber. Pretreated flow is then directed to the treatment chamber through an opening in the baffle wall between the inlet chamber and treatment chamber. The treatment chamber contains media-filled filter cartridges (Figure 2) that use physical and chemical processes to remove pollutants. During a storm event, runoff pools in the treatment chamber before passing radially through the cylindrical cartridges from the outside surface, through the media for treatment, and into the center of the cartridge. At the center of the cartridge is a center tube assembly designed to distribute the hydraulic load evenly across the surface of the filter cartridge and control the treatment flow rate. The center tube assembly discharges treated flow through the false floor and into the outlet chamber. A draindown feature built into each cartridge allows the treatment chamber to dewater between storm events.

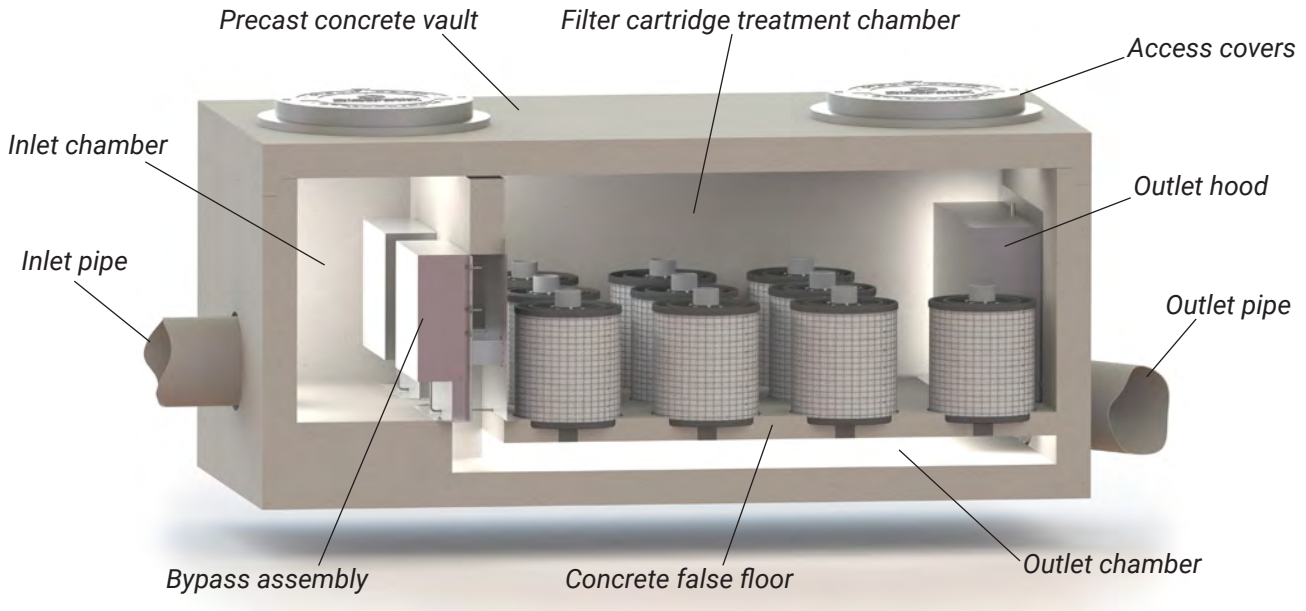
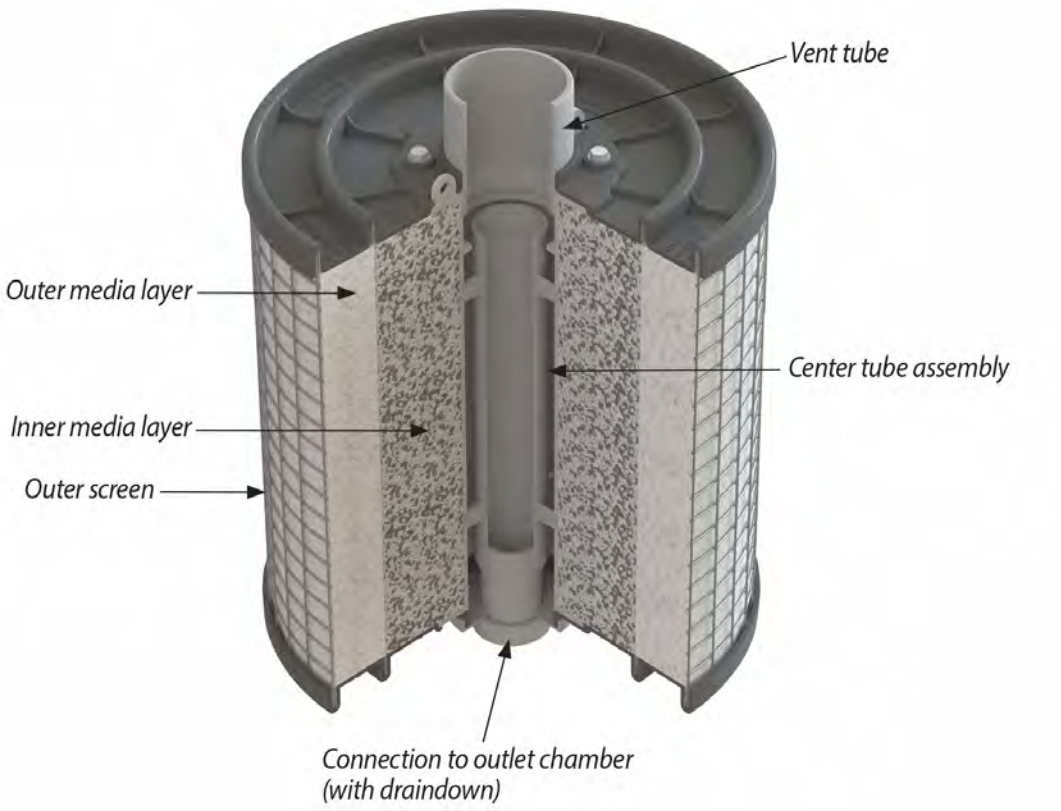


Figure 1. Schematic of the PerkFilter System.

All PerkFilter systems include a high flow bypass assembly to divert flow exceeding the treatment capacity of the filter cartridges around the treatment chamber. The bypass assembly routes peak flow from the inlet chamber directly to the outlet chamber, bypassing the treatment chamber to prevent sediment and other captured pollutants from being scoured and re-entrained by high flow. Treated flow and bypass flow merge in the outlet chamber for discharge by a single outlet pipe.



Configuration

The PerkFilter structure may consist of a vault, manhole, or catch basin configuration. Catch basin units may be fabricated from concrete or steel. Internal components including the PerkFilter cartridges are manufactured from durable plastic and stainless steel components and hardware. All cartridges are 18 inches in diameter and are available in two heights: 12-inch and 18-inch. Cartridges may be used alone or may be stacked (Figure 3) to provide 24-inch and 30-inch combinations. The capacity of each cartridge or cartridge combination is dictated by the allowable operating rate of the media and the outer surface area of the cartridge. Thus, taller cartridges have greater treatment capacity than shorter cartridges but they also require more hydraulic drop across the system. Cartridges may be filled with a wide variety of media but the standard mix is composed of zeolite, perlite and carbon (ZPC).

Access to an installed PerkFilter system is typically provided by ductile iron castings or hatch covers. The location and number of access appurtenances is dependent on the size and configuration of the system.

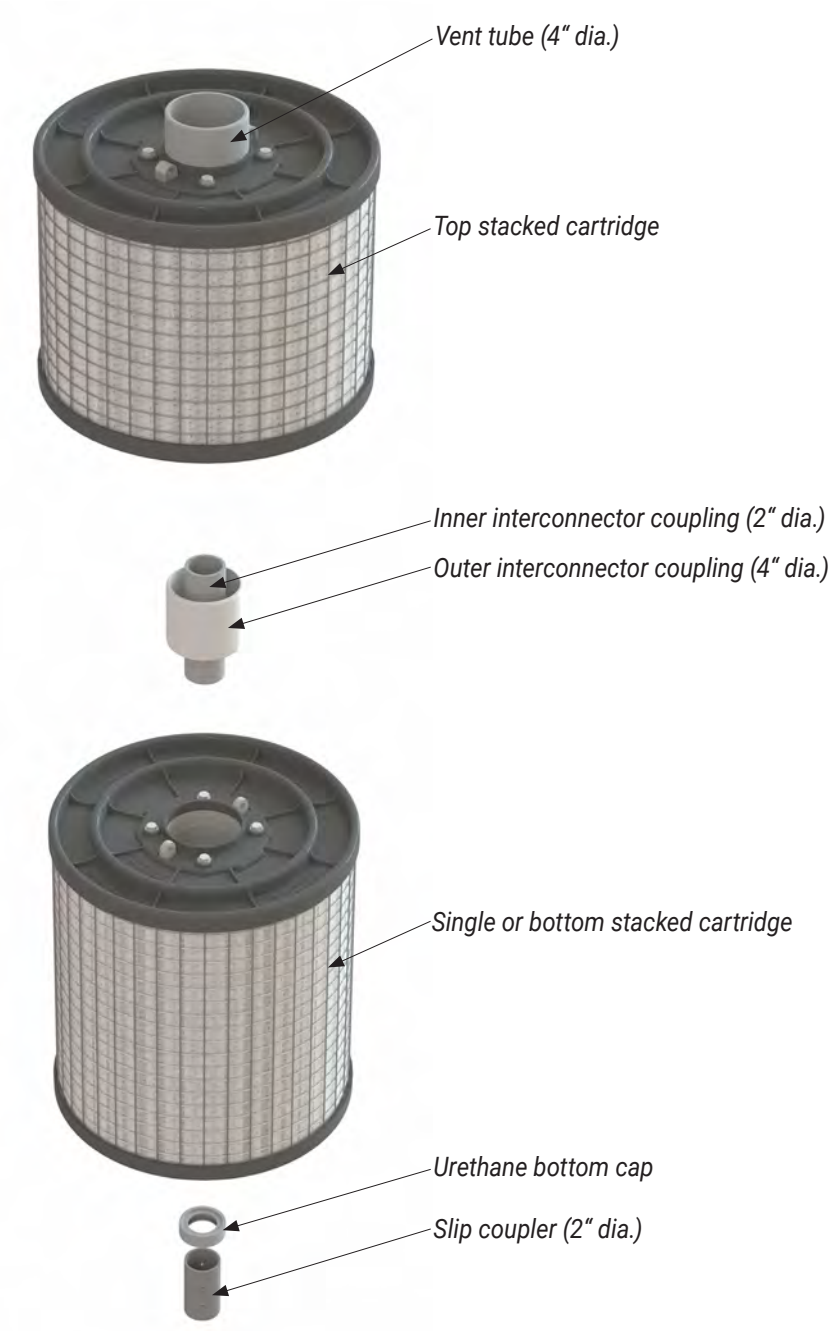


Figure 3. Schematic of stacked cartridges and connector components.

Maintenance Overview

State and local regulations require all stormwater management systems to be inspected on a periodic basis and maintained as necessary to ensure performance and protect downstream receiving waters. Maintenance prevents excessive pollutant buildup that can limit system performance by reducing the operating capacity and increasing the potential for scouring of pollutants during periods of high flow.

Inspection and Maintenance Frequency

The PerkFilter should be inspected on a periodic basis, typically twice per year, and maintained as required. Initially, inspections of a new system should be conducted more frequently to help establish an appropriate site-specific inspection frequency. The maintenance frequency will be driven by the amount of runoff and pollutant loading encountered by a given system. In most cases, the optimum maintenance interval will be one to three years. Inspection and maintenance activities should be performed only during dry weather periods.

Inspection Equipment

The following equipment is helpful when conducting PerkFilter inspections:

- Recording device (pen and paper form, voice recorder, iPad, etc.)
- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Flashlight
- Tape measure
- Measuring stick or sludge sampler
- Long-handled net (optional)

Inspection Procedures

PerkFilter inspections are visual and may be conducted from the ground surface without entering the unit. To complete an inspection, safety measures including traffic control should be deployed before the access covers are removed. Once the covers have been removed, the following items should be checked and recorded (see form provided at the end of this document) to determine whether maintenance is required:

- Inspect the internal components and note whether there are any broken or missing parts. In the unlikely event that internal parts are broken or missing, contact Oldcastle Infrastructure at (800) 579-8819 to determine appropriate corrective action.
- Note whether the inlet pipe is blocked or obstructed. The outlet pipe is covered by a removable outlet hood and cannot be observed without entering the unit.
- Observe, quantify and record the accumulation of floating trash and debris in the inlet chamber. The significance of accumulated floating trash and debris is a matter of judgment. A long-handled net may be used to retrieve the bulk of trash and debris at the time of inspection if full maintenance due to accumulation of floating oils or settled sediment is not yet warranted.

- Observe, quantify and record the accumulation of oils in the inlet chamber. The significance of accumulated floating oils is a matter of judgment. However, if there is evidence of an oil or fuel spill, immediate maintenance by appropriate certified personnel is warranted.
- Observe, quantify and record the average accumulation of sediment in the inlet chamber and treatment chamber. A calibrated dipstick, tape measure, or sludge sampler may be used to determine the amount of accumulated sediment in each chamber. The depth of sediment may be determined by calculating the difference between the measurement from the rim of the PerkFilter to the top of the accumulated sediment and the measurement from the rim of the PerkFilter to the bottom of the PerkFilter structure. Finding the top of the accumulated sediment below standing water takes some practice and a light touch, but increased resistance as the measuring device is lowered toward the bottom of the unit indicates the top of the accumulated sediment.
- Finally, observe, quantify and record the amount of standing water in the treatment chamber around the cartridges. If standing water is present, do not include the depth of sediment that may have settled out below the standing water in the measurement.

Maintenance Triggers

Maintenance should be scheduled if any of the following conditions are identified during the inspection:

- Internal components are broken or missing.
- Inlet piping is obstructed.
- The accumulation of floating trash and debris that cannot be retrieved with a net and/or oil in the inlet chamber is significant.
- There is more than 6” of accumulated sediment in the inlet chamber.
- There is more than 4” of accumulated sediment in the treatment chamber.
- There is more than 4” of standing water in the treatment chamber more than 24 hours after end of rain event.
- A hazardous material release (e.g. automotive fluids) is observed or reported.
- The system has not been maintained for 3 years (wet climates) to 5 years (dry climates).

Maintenance Equipment

The following equipment is helpful when conducting PerkFilter maintenance:

- Suitable clothing (appropriate footwear, gloves, hardhat, safety glasses, etc.)
- Traffic control equipment (cones, barricades, signage, flagging, etc.)
- Socket and wrench for bolt-down access covers
- Manhole hook or pry bar
- Confined space entry equipment, if needed
- Flashlight
- Tape measure
- 9/16” socket and wrench to remove hold-down struts and filter cartridge tops
- Replacement filter cartridges
- Vacuum truck with water supply and water jet

Contact Oldcastle Infrastructure at (800) 579-8819 for replacement Filter cartridges. A lead time of four weeks is recommended.

Maintenance Procedures

Maintenance should be conducted during dry weather when no flow is entering the system. Confined space entry is necessary to maintain vault and manhole PerkFilter configurations. Only personnel that are OSHA Confined Space Entry trained and certified may enter underground structures. Confined space entry is not required for catch basin PerkFilter configurations. Once safety measures such as traffic control are deployed, the access covers may be removed and the following activities may be conducted to complete maintenance:

- Remove FLoating trash, debris and oils from the water surface in the inlet chamber using the extension nozzle on the end of the boom hose of the vacuum truck. Continue using the vacuum truck to completely dewater the inlet chamber and evacuate all accumulated sediment from the inlet chamber. Some jetting may be required to fully remove sediment. The inlet chamber does not need to be reFIlled with water after maintenance is complete. The system will FIll with water when the next storm event occurs.
- Remove the hold-down strut from each row of FIlter cartridges and then remove the top of each cartridge (the top is held on by four 9/16” bolts) and use the vacuum truck to evacuate the spent media. When empty, the spent cartridges may be easily lifted off their slip couplers and removed from the vault. The couplers may be left inserted into couplings cast into the false FLoor to prevent sediment and debris from being washed into the outlet chamber during washdown.
- Once all the spent cartridges have been removed from the structure, the vacuum truck may be used to evacuate all accumulated sediment from the treatment chamber. Some jetting may be required to fully remove sediment. Take care not to wash sediment and debris through the openings in the false FLoor and into the outlet chamber. All material removed from the PerkFilter during maintenance including the spent media must be disposed of in accordance with local, state, and/or federal regulations. In most cases, the material may be handled in the same manner as disposal of material removed from sumped catch basins or manholes.
- Place a fresh cartridge in each cartridge position using the existing slip couplers and urethane bottom caps. If the vault is equipped with stacked cartridges, the existing outer and inner interconnector couplers must be used between the stacked cartridges to provide hydraulic connection. Transfer the existing vent tubes from the spent cartridges to the fresh cartridges. Finally, reFIt the struts to hold the fresh cartridges in place.
- Securely replace access covers, as appropriate.
- Make arrangements to return the empty spent cartridges to Oldcastle Infrastructure.

PerkFilter
Inspection and Maintenance Log

Location_____

Structure Configuration and Size:

Inspection Date_____

☐ Vault _____feet x _____feet
☐ Manhole _____feet diameter
☐ Catch Basin _____feet x _____feet

Number and Height of Cartridge Stacks:

Count_____each ☐12" ☐ 18" ☐ 24" ☐ 30"

Media Type:

☐ ZPC ☐ Perlite ☐ Other_____

Condition of Internal Components ☐ Good ☐ Damaged ☐ Missing	Notes:
Inlet or Outlet Blockage or Obstruction ☐ Yes ☐ No	Notes:
Floating Trash and Debris ☐ Significant ☐ Not Significant	Notes:
Floating Oils ☐ Significant ☐ Not Significant ☐ Spill	Notes:
Sediment Depth in Inlet Chamber ☐ Inches of Sediment:_____	Notes:
Sediment Depth in Treatment Chamber ☐ Inches of Sediment:_____	Notes:
Standing Water in Treatment Chamber ☐ Inches of Standing Water:_____	Notes:

Maintenance Required

☐ **Yes - Schedule Maintenance** ☐ **No - Inspect Again in _____ Months**

PERKFILTER®

OUR MARKETS

BUILDING STRUCTURES

COMMUNICATIONS

WATER

ENERGY

TRANSPORTATION